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Original Research Article

PREVALENCE OF POOR INHALER TECHNIQUE AND ITS ASSOCIATION WITH ASTHMA CONTROL AMONG ADULTS IN BENGALURU: A CROSS-SECTIONAL STUDY

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ABSTRACT

Background: Incorrect inhaler technique is a major contributor to poor asthma outcomes globally, particularly in developing countries where patient education and follow-up are inconsistent. Evaluating technique and its relationship with asthma control is essential for planning targeted interventions. The aim is to determine the prevalence of poor inhaler technique and its association with asthma control among adults with asthma in Bengaluru.

Materials and Methods: A hospital-based cross-sectional study was conducted among 200 adult asthma patients using inhaled therapy for ≥1 month. Inhaler technique was assessed using a standardized device-specific checklist, and asthma control was evaluated using the Asthma Control Test (ACT). Data were analyzed using descriptive statistics, chi-square test, and risk estimates, with $p < 0.05$ considered statistically significant.

Results: Poor inhaler technique was identified in 116 patients (58%). Suboptimal asthma control (ACT < 20) was found in 133 participants (66.5%). A significant association between poor technique and suboptimal control was noted, with 81.9% of poorly controlled patients demonstrating incorrect inhaler use ($\chi^2 = 29.4$, $p < 0.001$). The mean number of critical errors was 2.3 ± 1.1. Pressurized metered-dose inhalers (pMDIs) showed the highest proportion of incorrect technique.

Conclusion: Poor inhaler technique is common among adults with asthma in Bengaluru and is strongly associated with suboptimal asthma control. Routine inhaler demonstration, reinforcement, device-specific education, and incorporation of structured teaching strategies are recommended to improve clinical outcomes.

Keywords: Inhaler technique. Asthma control. ACT score.

INTRODUCTION

Asthma is a chronic inflammatory airway disorder characterized by episodic and variable respiratory symptoms such as wheezing, cough, chest tightness, and dyspnea, along with reversible airflow limitation and bronchial hyperresponsiveness. Effective asthma management requires both pharmacological and non-pharmacological interventions, with inhaled medications forming the cornerstone of treatment due to their targeted pulmonary delivery, rapid onset, and reduced systemic side effects. Despite global recommendations from the Global Initiative for Asthma (GINA), poor inhaler technique remains a widespread barrier that compromises drug deposition in lower airways, resulting in suboptimal asthma control, frequent exacerbations, increased health-care utilization, and impaired quality of life. Research indicates that more than 50% of asthma patients demonstrate at least one critical inhaler handling error, with errors commonly related to improper device actuation–inhalation coordination, insufficient inspiratory flow, failure to breath-hold post-inhalation, and incorrect priming or loading technique. Such errors vary by device type, with pressurized metered dose inhalers (pMDI) showing highest coordination errors whereas dry powder inhalers (DPI) often demonstrate inadequate inspiratory force. Asthma control assessment is

essential to determine symptom stability, functional limitations, and future exacerbation risk.[1,2]

Validated asthma control scoring tools include the Asthma Control Test (ACT), Childhood ACT (for pediatrics), Asthma Control Questionnaire (ACQ), and GINA symptom control assessment. ACT is a five-item, patient-reported outcome measure scored on a 5-point Likert scale, with total score ranging from 5 to 25, where ≤19 indicates poorly controlled asthma. ACQ consists of 7 symptom and bronchodilator use components scored on a 0–6 scale, with ≥1.5 indicating poor control. These scoring systems help categorize patients into well-controlled, partially controlled, or uncontrolled groups, enabling clinical decision-making and therapeutic step-up or step-down strategies. Identifying determinants associated with poor inhaler technique is particularly relevant in densely populated Indian metro cities such as Bengaluru, where high pollution indices, allergen exposure, and rapid urbanization contribute to rising asthma burden.[3]

Additionally, limited patient education, linguistic diversity, low health-literacy levels, inadequate pharmacist-led counseling, and absence of standardized inhaler demonstration checkpoints further increase the likelihood of improper device usage. Therefore, quantifying the prevalence of poor inhaler technique and evaluating its association with asthma control among adults in Bengaluru may provide critical evidence for strengthening patient education, training-based interventions, device-specific counselling, and protocol-driven follow-up. The present study aims to generate local-level evidence to support healthcare policy planning, clinical practice recommendations, and asthma education programs to optimize disease outcomes.[4]

Aim: To determine the prevalence of poor inhaler technique and its association with asthma control among adults in Bengaluru.

Objectives:

1. To assess the frequency of improper inhaler technique among adult asthma patients using a standardized checklist.
2. To evaluate asthma control status among participants using validated asthma control scoring tools.
3. To analyze the association between inhaler technique and level of asthma control.

MATERIALS AND METHODS

Source of Data: Primary data was obtained from adult asthma patients attending outpatient departments of selected tertiary-care and chest clinics in Bengaluru.

Study Design: A hospital-based cross-sectional observational study.

Study Location: Department of Pulmonology and affiliated outpatient clinics in Bengaluru city.

Study Duration: Six-month study duration, including recruitment, assessment, and documentation.

Sample Size: A total of 200 adult asthma patients meeting eligibility criteria were included.

Inclusion Criteria:

- Adults aged 18 years and above diagnosed with bronchial asthma by a qualified physician.
- Patients using inhaled asthma medications for at least one month.
- Ability to understand study instructions and provide informed consent.

Exclusion Criteria:

- Acute severe asthma requiring emergency management.
- Coexisting COPD, bronchiectasis, ILD, tuberculosis, or major psychiatric/neuromuscular disorders affecting inhaler usage.
- Patients on nebulizer-only therapy.

Procedure and Methodology: Eligible participants were enrolled consecutively after informed consent. A structured proforma recorded demographic details, duration of asthma, inhaler device type, training history, and treatment adherence. Inhaler technique was evaluated using a validated 10-step device-specific checklist (for pMDI, DPI, and MDI + spacer). Performance was observed directly and scored as correct, partial, or incorrect. Critical errors were documented. Asthma control was assessed using the Asthma Control Test (ACT) and categorized into well-controlled (≥20), partially controlled (16–19), and uncontrolled (≤15). Participants scoring ≥1 critical inhaler error were classified as having poor inhaler technique.

Sample Processing: No biological samples were collected; scoring sheets and checklists were maintained securely.

Statistical Methods: Data was entered into MS Excel and analyzed using SPSS v25. Descriptive statistics (frequency, mean, SD, proportion) were presented. Association between inhaler technique and asthma control was analyzed using Chi-square or Fisher's exact test. Logistic regression was applied to identify predictors, and $p<0.05$ was considered statistically significant.

Data Collection: Data was collected by trained investigators using observation-based scoring and interviewer-administered questionnaires, ensuring privacy and confidentiality.

RESULTS

[Table 1] demonstrates the prevalence of poor inhaler technique among adults with asthma and its crude association with asthma control levels in the study population (N = 200). More than half of the participants, 116 (58.0%), exhibited poor inhaler technique, which was significantly higher than the hypothesized proportion of 50%, as indicated by a one-sample z-value of 2.26 (p = 0.024, 95% CI: 51.2%–64.8%). Additionally, suboptimal asthma

control, defined as an ACT score below 20, was reported in 133 (66.5%) participants, also significantly higher than the reference value of 50% ($z = 4.67$, $p < 0.001$, 95% CI: 60.0%–73.0%). The relationship between inhaler technique and asthma control showed a clinically meaningful and statistically significant association. Participants with poor technique had a markedly higher proportion of suboptimal control (95 out of 116; 81.9%) compared to those with good technique (38 out of 84; 45.2%). The calculated risk difference was 36.7%, with a 95% CI of 23.9%–49.4%, and the chi-square test confirmed a strong statistical significance ($\chi^2 = 29.4$, $df = 1$, $p < 0.001$).

Table 1: Prevalence of poor inhaler technique and crude association with asthma control (N = 200)

Measure	Category / Comparison	n (%) or Mean ± SD	Effect & test of significance	95% CI	p-value
Prevalence of poor inhaler technique	Poor technique present	116 (58.0%)	One-sample z vs 50%: z = 2.26	51.2% – 64.8%	0.024
	Poor technique absent (good technique)	84 (42.0%)	–	–	–
Suboptimal asthma control (ACT < 20)*	Poorly / partly controlled (ACT ≤ 19)	133 (66.5%)	One-sample z vs 50%: z = 4.67	60.0% – 73.0%	<0.001
	Well controlled (ACT ≥ 20)	67 (33.5%)	–	–	–
Association between poor technique and suboptimal control	Poor technique: 95/116 with ACT ≤ 19 (81.9%) vs good technique: 38/84 (45.2%)	–	Risk difference = 36.7%; $\chi^2 = 29.4$, df = 1	RD: 23.9% – 49.4%	<0.001

*ACT = Asthma Control Test.

Table 2: Frequency and pattern of improper inhaler technique using standardized checklist (N = 200)

Measure	Category / Comparison	n (%) or Mean ± SD	Effect & test of significance	95% CI	p-value
Overall inhaler technique status	Poor technique	116 (58.0%)	One-sample z vs 50%: z = 2.26	51.2% – 64.8%	0.024
	Good technique	84 (42.0%)	–	–	–
Mean number of critical errors per patient	–	2.3 ± 1.1	One-sample t vs 2.0 errors: t = 3.86, df = 199	2.15 – 2.45	<0.001
Device type distribution	Pressurized MDI (pMDI)	118 (59.0%)	–	–	–
	Dry powder inhaler (DPI)	61 (30.5%)	–	–	–
	MDI + spacer	21 (10.5%)	–	–	–
Poor technique by device type	pMDI: 78/118 (66.1%); DPI: 28/61 (45.9%); MDI + spacer: 10/21 (47.6%)	–	χ^2 (2×3) = 7.77, df = 2 (poor vs good across devices)	RD (pMDI–DPI) = 5.1% – 35.3%	0.021
	Comparison: pMDI vs DPI (poor technique prevalence)	–	Risk difference = 20.2% (pMDI higher poor-technique prevalence)	5.1% – 35.3%	0.009

[Table 2] details the frequency, error patterns, and device-related distribution of improper inhaler technique among the study participants. A total of 116 individuals (58.0%) demonstrated poor inhaler technique, which was statistically higher than the expected baseline proportion ($z = 2.26$, $p = 0.024$). The mean number of critical errors per user was 2.3 ± 1.1, and this value was significantly above the reference mean of 2.0 errors ($t = 3.86$, $p < 0.001$, 95% CI: 2.15–2.45), indicating widespread technique-related issues even among those trained. Regarding device preference, pressurized metered-dose inhalers (pMDI) were the most commonly used inhalation systems (59.0%), followed by dry-powder inhalers (30.5%) and MDI-spacer combinations (10.5%). Poor inhaler technique varied significantly across device types ($p = 0.021$), with pMDI users showing the highest rate of technique errors (66.1%), compared to DPI (45.9%) and MDI + spacer (47.6%). The risk difference between pMDI and DPI users was 20.2% (95% CI: 5.1%–35.3%, $p = 0.009$).

Table 3: Asthma control status based on Asthma Control Test (ACT) (N = 200)

Measure	Category / Comparison	n (%) or Mean ± SD	Effect & test of significance	95% CI	p-value
Overall ACT score	ACT total score	18.1 ± 4.3	One-sample t vs 20 (target for good control): t = −6.25, df = 199	17.5 – 18.7	<0.001
Asthma control categories (ACT)	Well controlled (ACT ≥ 20)	67 (33.5%)			
	Partially controlled (ACT 16–19)	59 (29.5%)	Overall distribution vs equal 1/3 each: $\chi^2 = 1.69$, df = 2	–	0.43
	Uncontrolled (ACT ≤ 15)	74 (37.0%)			

[Table 3] represents asthma control status as measured through the Asthma Control Test (ACT). The mean ACT score among the participants was 18.1 ± 4.3, significantly lower than the reference

target score of 20 for well-controlled asthma, with a one-sample t-value of −6.25 ($p < 0.001$, 95% CI: 17.5–18.7). Based on ACT classification, 67 participants (33.5%) achieved well-controlled asthma, while 59 (29.5%) had partially controlled asthma, and 74 (37.0%) were categorized as uncontrolled. The distribution of asthma control categories did not significantly deviate from equal theoretical distribution across the three groups ($\chi^2 = 1.69$, $p = 0.43$).

Table 4: Association between inhaler technique and level of asthma control (N = 200)

Measure	Category / Comparison	n (%)
Asthma control by technique	Poor technique (n = 116) – Well controlled	21 (18.1%)
	Poor technique – Partially controlled	40 (34.5%)
	Poor technique – Uncontrolled	55 (47.4%)
	Good technique (n = 84) – Well controlled	46 (54.8%)
	Good technique – Partially controlled	19 (22.6%)
	Good technique – Uncontrolled	19 (22.6%)

$\chi^2 = 29.96$, df = 2; Cramér's V = 0.39 (moderate association) $p<0.001$

[Table 4] explores the association between inhaler technique quality and asthma control outcomes. Among those with poor inhaler technique (n = 116), only 21 (18.1%) achieved well-controlled asthma, whereas 40 (34.5%) were partially controlled and 55 (47.4%) were uncontrolled. In contrast, among individuals with good inhaler technique (n = 84), more than half 46 (54.8%) achieved well-controlled asthma, while uncontrolled asthma was observed in only 19 (22.6%). The difference between the two groups was statistically significant, with a chi-square value of 29.96 (df = 2, $p < 0.001$) and a Cramér's V of 0.39, indicating a moderate strength of association.

DISCUSSION

In [Table 1], poor inhaler technique was documented in 58.0% of patients, which is very similar to the ~60% prevalence of incorrect inhaler use reported by et al (20),[5] in a large multicentric study of adults with asthma and COPD, where most patients made at least one significant handling error. A comprehensive study by et al (20),[6] also showed that only about one-third of patients worldwide demonstrate correct inhaler use, with poor technique ranging between 27–36%, and higher in real-world settings, underscoring that our observed prevalence lies at the higher but still plausible end of this spectrum. The finding that two-thirds of our cohort (66.5%) had suboptimal asthma control (ACT < 20) is in line with global estimates that a substantial proportion of treated asthmatics remain uncontrolled despite guideline-based therapies, largely due to adherence and technique issues.

The strong crude association between poor technique and suboptimal asthma control in Table 1 (81.9% vs 45.2%; $\chi^2 = 29.4$, $p < 0.001$) mirrors the direction and magnitude of associations reported elsewhere. Mahesh PA et al (2025),[7] found that such errors were significantly associated with increased exacerbations, hospitalizations, and poorer symptom control across multiple studies. Similarly, Madan K et al (2020),[8] reviewed the relationship between inhalation errors and outcomes and concluded that most studies demonstrate worse disease control and higher healthcare utilization among patients with incorrect technique, and that improvement in technique over time correlates with better outcomes. Thus, our data reinforce the concept that poor inhaler technique is not merely a procedural issue but a key modifiable determinant of asthma control.

[Table 2] further elaborates the pattern of inhaler misuse. The mean number of critical errors (2.3 ± 1.1) and the significantly higher than expected error burden are consistent with device-specific observational studies that have documented multiple critical steps being performed incorrectly by the majority of users. Daniel J et al (2021),[9] reported high frequencies of device-specific errors when standardized checklists were used across different inhaler platforms, emphasizing that even "user-friendly" devices do not guarantee correct use in routine practice.[5] Our finding that pMDI users had the highest prevalence of poor technique (66.1%), significantly higher than DPI users (45.9%; risk difference 20.2%), echoes earlier reports that pMDIs tend to generate more coordination-related errors than DPIs, particularly in busy outpatient settings and among patients with limited prior training. This supports targeted educational interventions focused on pMDI handling, spacer use, and breath–actuation coordination.

[Table 3] shows that the mean ACT score in our cohort was 18.1, significantly below the threshold of 20 for well-controlled asthma. This is comparable to outpatient data from Indian settings where a majority of patients fall into partially controlled or uncontrolled categories on ACT despite being on maintenance inhaler therapy. BM D et al (2021),[10] found that a large proportion of asthmatics had poor or partial control and that incorrect inhaler technique and lack of reinforcement were key contributors. Narasimhan R et al (2025),[11] similarly reported suboptimal control and highlighted that both adherence and technique deficiencies were widespread among Indian asthma patients, reinforcing the public health relevance of our findings in the Bengaluru context.

The stratified analysis in [Table 4] clearly demonstrates the clinical impact of inhaler technique on control status. Among patients with poor technique, nearly half (47.4%) were in the

uncontrolled category, and fewer than one in five (18.1%) achieved well-controlled asthma. In contrast, among those with good technique, more than half (54.8%) had well-controlled disease and only 22.6% were uncontrolled, with a statistically significant and moderately strong association (Cramér's V = 0.39). This pattern is consistent with the multicentric study by Reddy KB et al (2021),[12] which showed that patients with incorrect technique had significantly poorer disease control scores and higher rates of exacerbations compared to those using inhalers correctly. Madan K et al (2021),[13] also reported a significant association between incorrect technique and uncontrolled asthma in Indian adults, reinforcing that our observed relationship is robust and externally valid. Review by Narasimhan R et al (2021),[14] supports this interpretation by demonstrating that reduction in inhalation errors over time is consistently associated with improved clinical outcomes, including better symptom scores and fewer exacerbations.

CONCLUSION

The present cross-sectional study conducted among 200 adult asthma patients in Bengaluru revealed a high prevalence of poor inhaler technique (58%), demonstrating that incorrect device handling remains a major, yet preventable, barrier to optimal asthma management. Additionally, suboptimal asthma control was observed in two-thirds of the participants, and a statistically significant association between poor inhaler technique and inadequate asthma control was established, with individuals demonstrating incorrect technique exhibiting a markedly higher proportion of uncontrolled asthma based on ACT scores. The findings underscore that inappropriate inhaler use is not merely a procedural error but a clinically relevant determinant of disease outcome. These results highlight the urgent need for routine inhaler technique assessment, structured counseling, device-specific demonstration, periodic re-evaluation, and integration of standardized inhaler education modules in routine clinical practice. Strengthening healthcare provider training, involving pharmacists or nurse educators, and implementing patient-centered programs may significantly improve asthma symptom control, reduce exacerbation burden, and improve quality of life for asthma patients in metropolitan settings like Bengaluru.

Limitations

1. Cross-sectional design limits causal inference; therefore, the temporal relationship between inhaler technique improvement and asthma control could not be established.
2. Single-city, facility-based recruitment may limit generalizability to rural populations, other socioeconomic strata, and different healthcare delivery settings.
3. Self-reported measures such as ACT scores might be influenced by recall and social desirability bias.
4. Assessment limited to observed technique at one time point, without evaluation of real-life daily use or adherence patterns.
5. Potential unmeasured confounders such as environmental exposure, comorbid allergic rhinitis, psychological factors, and pharmacological adherence were not deeply explored.
6. Device training history was self-reported and not verified from medical records, which may introduce information bias.

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