



RESEARCH ARTICLE

ASSESSMENT OF PEAK INSPIRATORY FLOW FOR OPTIMAL INHALER DEVICE SELECTION IN COPD PATIENTS: A CROSS-SECTIONAL STUDY

D. Pravalika and P.Chakradhar Reddy

1. Department of Pulmonary Medicine, Santhiram Medical College and General Hospital.

Manuscript Info

Manuscript History

Received: 18 April 2025

Final Accepted: 21 May 2025

Published: June 2025

Key words:-

COPD, Peak Inspiratory Flow, Inhaler Device, Dry Powder Inhaler, In-Check DIAL

Abstract

Background: Inhaled therapy remains the cornerstone of COPD management. Peak Inspiratory Flow (PIF) is a critical determinant in the appropriate use of dry powder inhalers (DPIs). Failure to match the device to the patient's PIF may result in subtherapeutic outcomes.

Objective: To evaluate the PIF among COPD patients and assess its implication in selecting the most suitable inhaler device.

Methods: A cross-sectional observational study was conducted among 50 COPD patients attending Department of Pulmonary medicine OPD, Santhiram Medical College and General Hospital, Nandyal. PIF (Peak inspiratory flow) was measured using the In-Check DIAL device adjusted to match common inhaler resistance. Data were analyzed for correlation with age, severity of disease (GOLD stage), and inhaler technique.

Results: 36% of patients had suboptimal PIF (<60 L/min) for high-resistance DPIs. Suboptimal PIF was significantly associated with older age and higher GOLD stage ($p < 0.05$).

Conclusion: A significant proportion of COPD patients had inadequate inspiratory flow for effective DPI use. Routine PIF assessment should be integrated into inhaler device selection to ensure optimal therapeutic benefit.

"© 2025 by the Author(s). Published by IJAR under CC BY 4.0. Unrestricted use allowed with credit to the author."

Introduction:-

Chronic Obstructive Pulmonary Disease (COPD) is a major cause of morbidity and mortality globally. Inhaled bronchodilators and corticosteroids remain the mainstay of treatment. Dry powder inhalers (DPIs) are commonly used but require sufficient inspiratory effort to deliver the drug effectively. Peak Inspiratory Flow (PIF) is a physiological parameter reflecting a patient's ability to generate sufficient inspiratory force against a given resistance. Failure to match the device to the patient's PIF may result in subtherapeutic outcomes.

Inhaled therapies utilize a range of delivery systems such as pressurized metered-dose inhalers (pMDIs), Breath actuated inhaler (BAIs), dry powder inhalers (DPIs), and nebulizers. Among these, Single Inhaler Therapy (SIT)—which combines all essential medications into one device—has demonstrated favorable clinical outcomes. Evidence from large pragmatic randomized trials has shown that SIT contributes to improved respiratory health and lung function in COPD patients.

Corresponding Author:-D. Pravalika

Address:-Department of Pulmonary Medicine, Santhi Ram Medical College and General Hospital.

Recent studies have highlighted the growing significance of assessing Peak Inspiratory Flow (PIF) when choosing appropriate inhalers for COPD maintenance. Notably, the prevalence of suboptimal PIF among stable COPD patients appears highly variable, potentially due to inconsistencies in measurement methods, differing definitions of optimal PIF, and the diverse characteristics of both patients and disease states. Despite its clinical importance, research remains limited regarding the determinants and consequences of inadequate PIF in this population.

This study aims to evaluate the PIF among COPD patients and determine its influence on selecting an appropriate inhaler device.

Materials and Methods:-

A Cross-sectional observational study done in 50 COPD patients diagnosed as per spirometry, attending Pulmonary Medicine Department OPD at Santhiram Medical College and General hospital, Nandyal, from January 2025 to May 2025.

Inclusion Criteria:

1. Age ≥ 40 years.
2. Clinically stable patients with a confirmed diagnosis of COPD based on GOLD guidelines (post-bronchodilator $FEV_1/FVC < 0.70$).
3. No acute exacerbation of COPD in the past 4 weeks.
4. Ability to perform reproducible inspiratory maneuvers using the In-Check DIAL device.

Exclusion Criteria:

1. Current exacerbation of COPD or hospitalization within the past 4 weeks.
2. Presence of significant neuromuscular disorders (e.g., myasthenia gravis, ALS) that impair respiratory effort.
3. Patients with cognitive impairment or dementia preventing proper inhaler use or cooperation during testing.
4. Concurrent diagnosis of asthma, interstitial lung disease, or bronchiectasis.
5. Patients with facial deformities, tracheostomy, or other anatomical conditions impeding PIF measurement.

Data Collection:

- Demographics: Age, sex, smoking history, BMI.
- Clinical data: GOLD stage, mMRC dyspnea score, current inhaler use
- PIF Measurement: Using In-Check DIAL, adjusted for DPI resistance (60–90 L/min optimal range)

Statistical Analysis:

Data were analyzed using SPSS v25. Mean, SD, and percentages were calculated. Chi-square and Student's t-tests were used for group comparisons. A p-value < 0.05 was considered statistically significant.

Results:-

A total of 50 patients were enrolled. The mean age was 64.2 ± 8.3 years. Among them, 42 (84%) were male, and 28 (56%) were current smokers. Based on GOLD staging, 17 patients (34%) were in stage II, 22 (44%) in stage III, and 9 (18%) in stage IV.

Table 1:- Baseline Characteristics (n = 50)

Baseline characteristic		Number of patients	percentage
Age		64.2 $\pm$ 8.3	
Sex	Males	42	84%
	Females	8	16%
Current smokers		28	56%
GOLD 1		2	4%
GOLD 2		17	34%
GOLD 3		22	44%
GOLD 4		9	18%
BMI	underweight	17	34%
	normal	22	44%
	overweight	4	8%
	obese	1	2%

Peak Inspiratory Flow

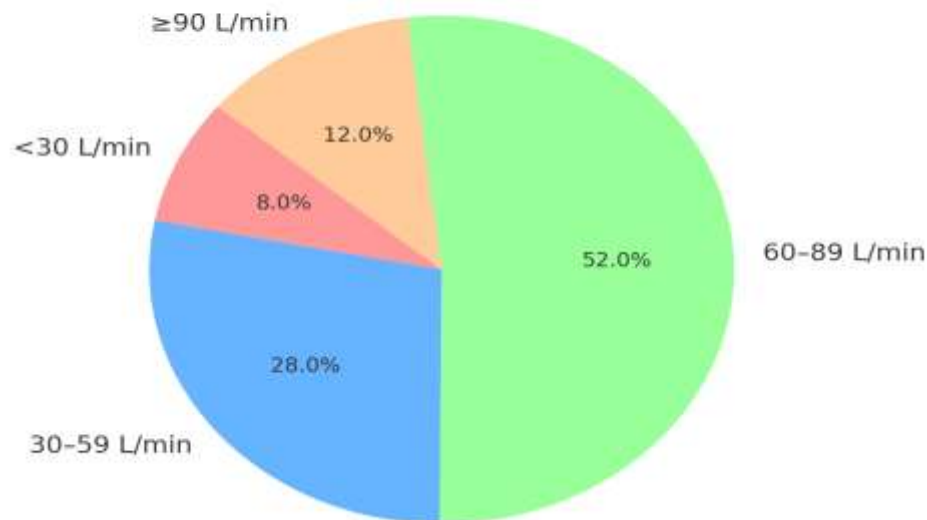
Overall, 18 patients (36%) had suboptimal PIF (<60 L/min) for high-resistance DPIs. Among these, the majority were GOLD stage III or IV. Notably, 11 of the 18 patients with low PIF were over the age of 70. A statistically significant association was found between increasing age and lower PIF values ($p = 0.004$), as well as between higher GOLD stage and suboptimal PIF ($p = 0.01$).

Only 6 patients (12%) achieved ≥ 90 L/min, suitable for high-resistance DPIs without concern. Some patients with borderline PIF (60–65 L/min) reported inconsistent inhaler technique despite device familiarity, indicating a need for both objective and subjective assessment.

Table 2:- Peak Inspiratory Flow Measurements.

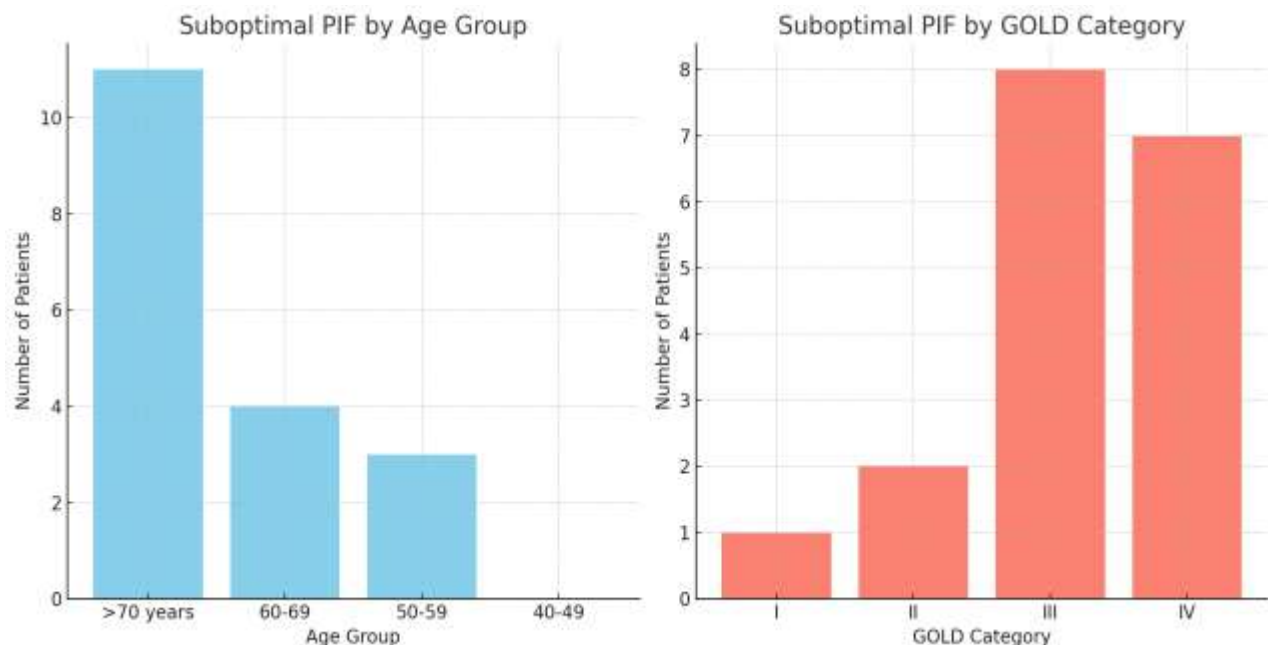
PIF	No of patients	percentage
<30 L/min	4	8%
30–59 L/min	14	28%
60–89/min	26	52%
>90L/min	6	12%

Peak Inspiratory Flow Distribution (N=50)



Among 18 patients with suboptimal PIF 11 were over age 70 years, 4 patients were over age 60 years and 3 were over 50 years. As per GOLD category, majority were in GOLD III and IV Groups with 8 and 7 patients respectively.

Baseline characteristic		No of patients with Suboptimal PIF (PIF<60L/min)
Age	>70 years	11
	60-69	4
	50-59	3
	40-49	0
GOLD Category	I	1
	II	2
	III	8
	IV	7



Discussion:-

This study highlights the clinical relevance of measuring Peak Inspiratory Flow in COPD patients prior to prescribing dry powder inhalers. Our data show that over one-third of patients could not achieve the inspiratory effort required for effective drug dispersion from high-resistance DPIs. These findings are consistent with previous studies such as Mahler et al. and Loh et al., which reported similar rates of suboptimal PIF in elderly COPD populations.

Several factors contribute to low PIF in COPD, including age-related muscle weakness, air trapping, and hyperinflation. GOLD stage III and IV patients, due to reduced lung compliance and diaphragmatic flattening, often exhibit impaired inspiratory mechanics. Consequently, the current practice of prescribing a “one-size-fits-all” DPI approach should be reconsidered. Incorporating PIF measurement into routine COPD assessment may improve patient outcomes by guiding more personalized inhaler prescriptions.

In our study, low PIF was most common among elderly patients and those with severe disease, suggesting that this subgroup would benefit more from alternative delivery systems like pressurized metered-dose inhalers (pMDIs) with spacers or breath actuated inhalers (BAIs). Interestingly, some patients using high-resistance DPIs were unaware of their poor inhalation technique, highlighting the limitation of relying solely on visual assessment by healthcare providers.

Routine incorporation of PIF measurement into COPD management could significantly improve therapeutic outcomes. The In-Check DIAL device offers a simple, non-invasive method to tailor inhaler prescriptions. It also provides an opportunity for patient education and inhaler training when suboptimal performance is detected.

Despite its utility, PIF assessment is underutilized in clinical practice, possibly due to lack of awareness, time constraints, or access to devices. Wider implementation of this approach requires awareness among clinicians and integration into clinical guidelines.

Device Resistance and Clinical Implications

Different dry powder inhalers (DPIs) have varying internal resistances, which influence the Peak Inspiratory Flow (PIF) required for optimal drug delivery. Many patients, especially those with advanced COPD or frailty, may be unable to generate sufficient flow to effectively use high-resistance devices.

Table 2:- Common inhalers and resistance requirements.

Inhaler Device	Examples	PIF Requirement	Dependence on Technique
DPI	Rotahaler diskus	Moderate to high	High
pMDI	Salbutamol, ICS/LABA MDI	Low	High (requires coordination)
BAI	Synchobreathe	Low to moderate	Low

Conclusion:-

Peak Inspiratory Flow measurement is a valuable, underused tool in COPD care. A significant proportion of patients may be unable to generate sufficient flow for DPI use. Routine PIF screening during inhaler selection could enhance treatment efficacy and reduce the risk of therapeutic failure.

Incorporating this simple step into routine practice can facilitate a more personalized and effective approach to inhaler therapy, ultimately improving adherence, disease control, and patient outcomes.

References:-

1. Mahler DA, et al. Peak inspiratory flow rate as a criterion for dry powder inhaler use in chronic obstructive pulmonary disease. *Ann Am Thorac Soc.* 2013;10(5):416–8.
2. Duarte AG, et al. Peak inspiratory flow rate and the use of dry powder inhalers in patients with COPD. *Chest.* 2020;158(5):2186–94.
3. Loh CH, et al. Can patients use dry powder inhalers correctly? *Chest.* 2022;161(4):982–4.
4. Usmani OS, et al. Critical inhaler errors in asthma and COPD: a systematic review of impact on health outcomes. *Respir Res.* 2018;19(1):10.
5. Leung JM, et al. Assessment of peak inspiratory flow rate in COPD patients using dry powder inhalers: a systematic review. *Int J Chron Obstruct Pulmon Dis.* 2021;16:1561–74.
6. Sharma G, et al. Consensus statement on inhalational therapy for respiratory diseases: A joint initiative by Indian Chest Society and National College of Chest Physicians. *Lung India.* 2019;36(Suppl):S1–S16.
7. Loh CH, et al. Inhaler technique and peak inspiratory flow in COPD: Comparison of real-world users of different DPIs. *Int J Chron Obstruct Pulmon Dis.* 2022;17:1719–27.
8. Laube BL, et al. What the pulmonary specialist should know about the new inhalation therapies. *Eur Respir J.* 2011;37(6):1308–31.
9. Balloira A, et al. Cost-effectiveness and health outcomes associated with inhaler misuse in COPD. *Int J Chron Obstruct Pulmon Dis.* 2020;15:3151–60.
10. Global Initiative for Chronic Obstructive Lung Disease (GOLD). Global Strategy for the Diagnosis, Management, and Prevention of Chronic Obstructive Pulmonary Disease: 2024 Report. Available from: <https://goldcopd.org/>