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Evaluation of technique of dry powder inhaler and metered dose inhaler in chronic obstructive pulmonary disease or asthma patients

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Abstract:

Background: Chronic Obstructive Pulmonary Disease (COPD) and asthma are common respiratory conditions managed primarily via inhaled therapies. Improper inhalation techniques can lead to therapeutic failure and worsen disease outcomes. This study aimed to assess the effectiveness of an intervention to improve inhalation techniques in COPD and asthma patients using rotahaler devices.

Method: The study was conducted at the pulmonology outpatient department of Manipal Teaching Hospital from March 2024 to September 2024, following ethical approval. Patients with COPD or asthma using metered-dose inhalers (MDIs) or dry powder inhalers (DPIs) and a follow-up duration of at least one month were included. Baseline technique scores were recorded using a pre-defined scoring chart. An intervention, including counselling and physical demonstration, was provided, and scores were reassessed immediately and at follow-up. Data were analysed using SPSS.

Result: A total of 109 participants were enrolled. At baseline, 85 participants (78%) achieved perfect MDI scores. Following the intervention, nearly all participants (23/24) who initially scored less than perfect achieved a full score. After follow up, 19 of these participants (82.6%) maintained their improved performance, while 5 (17.4%) experienced minor declines.

Conclusion: The intervention significantly improved inhalation techniques, with most participants retaining the improvement after one month. Periodic reinforcement may benefit a minority. Common errors in steps such as mouthpiece placement and breath-holding highlight areas for targeted education to sustain effective inhalation techniques.

Keywords: Asthma, COPD, Inhalation technique, Intervention

How to cite

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Introduction

Chronic Obstructive Pulmonary Disease (COPD) is a heterogeneous lung condition marked by persistent airflow obstruction, with symptoms such as dyspnea, cough, and expectoration, caused by airway abnormalities or alveolar emphysema.[1] Asthma, a chronic inflammatory disorder, involves airway hyper-responsiveness, leading to recurrent episodes of wheezing, breathlessness, chest tightness, and coughing, especially at night or early morning.[4] The risk factors for both COPD and asthma includes genetic factors like α1-antiproteinase deficiency and environmental factors such as pollution, biomass fuels, occupational hazards, recurrent infections, and allergens.[2,3,5]

Inhaled medications are the preferred treatment for both COPD and asthma, as they deliver drugs directly to the site of action via inhalation technique, ensuring rapid effects with minimal side effects.[6] These medications target the bronchioles for localized therapeutic effects, with the clinical response depending on the inhalation technique and inhaler device used.[7,8] Training in proper inhalation technique has been shown to improve medication adherence and effectiveness in COPD and asthma patients.[9] Thus, the impact of awareness and training on inhalation technique among patients needs to be evaluated, which is the focus of this study.

This study aims to assess the effectiveness of interventions on the inhalation technique of DPI or MDI in COPD and asthma patients by comparing inhalational technique scores before and after training on inhalational technique. Additionally, this study also aims to identify critical mistakes made by patients during inhalation, highlighting the importance of proper counseling when prescribing inhaled medications.

Method

A prospective, interventional study was conducted among known cases of COPD who are currently being treated and either using MDI or DPI. The study was conducted among outpatients in Manipal Teaching Hospital after receiving approval from Institutional research committee of Manipal Teaching Hospital approval no MCOMS/IRC/601/GA. The study was conducted from March 2024 to September 2024 after obtaining written consent from each participants.

The study included known cases of COPD and bronchial asthma patients who had been using metered-dose inhalers (MDI) or dry powder inhalers (DPI) for at least three months. Patients newly diagnosed with COPD or bronchial asthma, those unwilling to participate or not providing consent, and those with terminal illnesses or severe eye diseases were excluded. The sample size was calculated based on an incidence of obstructive lung disease of approximately 10% (p=10%, q=90%)[10], a margin of error (e) of 6%, and a 95% confidence interval (z=1.96). Using the formula $n=(z^2xpxq)/e^2$, the required sample size was determined to be 95.

Patients who met the inclusion criteria, were enrolled in this study. Patient demographic profile was filled up after taking the written consent with them. It was followed by pre-defined score chart of MDI or DPI was adapted from Cipla leaflet. Each steps was assessed and was scored as per score chart of MDI or DPI. Each correct step was scored one and incorrect or missed step will be scored zero. Baseline score was taken before the intervention.

Immediate intervention to improve the technique was done through counseling based on the standard technique of using MDI or DPI in the form of physical demonstration. The

improvement in inhaler-using technique was evaluated by scoring after counselling and on follow up.

Data collected during the study were analyzed using the Statistical Package for Social Sciences (SPSS) software version 25. Descriptive statistical analysis was conducted to summarize the demographic and clinical characteristics of the participants, including frequencies, percentages, measure of central tendency and measure of dispersion, as appropriate.

Result

In total 109 cases analyzed, the study population consisted of 26.61% males and 73.39% females, with a mean age of 36±7.78 years, ranging from 13 to 74 years. The majority were married (67.89%), from joint families (53.21%) and with a significant proportion having completed school-level education (32.11%) and working primarily in agriculture (45.87%). Family income sources were varied, with agriculture contributing 31.19%, family business 24.77%, and remittance 20.18%, Table 1.

In the study population only 2% of the participants currently smoked, while the remaining 98% either quit or never smoked. Similarly, only 3% currently consumed alcohol, with 97% having either quit or never drank, Figure 1.

Out of the 109 participants, 24(22%) had Chronic Obstructive Pulmonary Disease (COPD), while the remaining 85 (70%) had asthma, Figure 2. The majority of participants (36.7%) had been living with their disease for 1 to 5 years, followed by 30.3% with a disease duration of 1 to 6 months, one-fifth (20.2%) with 6 months to 1 year, and a smaller group (12.8%) with over 6 years of disease duration.

Most participants (70.6%) had less than 1 year of experience with MDI use, Table 2. Most participants (90.7%) had no associated co-morbidities, while 6.5% had hypertension and one patient had diabetes mellitus. Two participants had thyroid disorders.

Among all participants 85(78%) of them successfully completed the entire checklist of MDI steps correctly before the demonstration. Among participants with less than one year of MDI experience, there was a wide range of scores, from 4 to 8, yet the majority (61 out of 77) scored 8. Participants with 1-5 years of experience also performed well, with most (21 out of 29) scoring 8, while only a few had slightly lower scores, ranging from 4 to 7. The small number of participants with 6-10 years (1 person) and more than 10 years of experience (2 participants) all scored 8.

After the demonstration, nearly all participants (23 out of 24) achieved the perfect score of 8, highlighting the effectiveness of the demonstration in improving MDI technique. One month later, among those who had scored less than 8 in the pre-demonstration assessment, the majority (82.6%) still scored 8, but a small percentage (17.4%) showed a slight decrease in their performance. This suggests that periodic reinforcement may be needed to maintain the technique over time, though the minimal decline in scores indicates good retention overall.

In terms of specific steps, actions like exhaling to residual volume, inhaling slowly, pressing the canister, and head posture were well understood and correctly performed by all participants, regardless of their total score before the demonstration. However, mouthpiece placement and breath-holding were more commonly misunderstood, with 45.8% and 29.2% of participants (among those who scored less than 8) failing to perform these steps correctly.

Table 1. Sociodemographic characteristics of outpatients for COPD and asthma, n=109

Variables	n	%
Age (years)		
Mean age		36.0±7.78
Range		13-74
Sex		
Female	80	73.39
Male	29	26.61
Marital status		
Married	74	67.89
Unmarried	33	30.28
Widowed/widowers	2	1.83
Family type		
Joint families	58	53.21
Nuclear families	49	44.95
Extended families	2	1.83
Educational background		
Illiterate	24	22.02
School level/slc	35	32.11
Intermediate-level	28	25.69
Bachelor's or higher	22	20.18
Current occupation		
Agriculture	50	45.87
Unemployed	15	13.76
Business	16	14.68
Pension	13	11.93
Service/salaried	12	11.01
Household work	2	1.83
Wage labour	1	0.92
Major source of household income		
Agriculture	34	31.19
Family business	27	24.77
Remittance	22	20.18
Private/government jobs	12	11.01
Pension	13	11.93
Daily wages	1	0.92

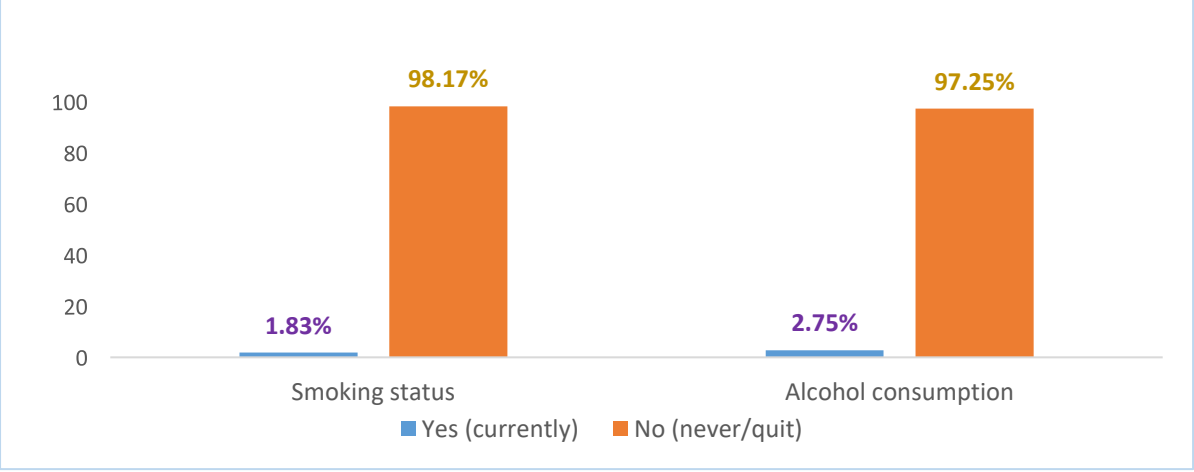

Figure 1. Smoking and alcohol consumption status of COPD and asthma patients, n=109

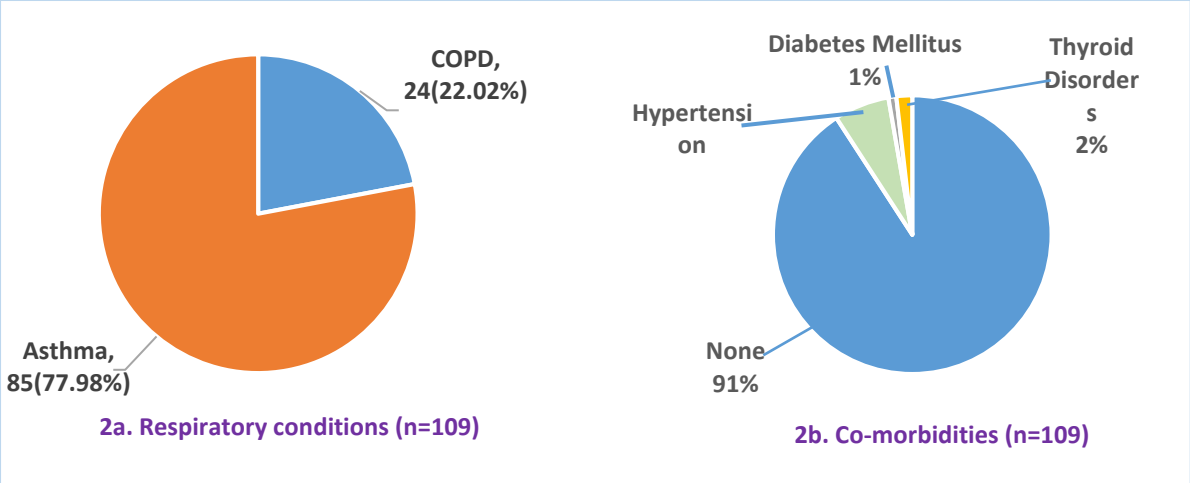

Figure 2. Clinical conditions of outpatients who underwent for evaluation of inhaler techniques (n=109)

Table 2. Disease duration and MDI use experience of outpatients for COPD and asthma, n=109

Variable	n	%
Disease duration		
1-6 months	33	30.28
6 months to 1 year	22	20.18
1-5 years	40	36.70
Over 6 years	14	12.84
Duration of MDI use		
Less than 1 year	77	70.64
1-5 years	29	26.61
6-10 years	1	0.92
More than 10 years	2	1.83

Discussion

The findings of our study highlight a significant gap in the proper use of inhalation devices among patients with COPD and asthma. Critical errors were identified, such as improper mouthpiece placement (45.8%) and insufficient breath-holding (29.2%), which are consistent with global evidence showing widespread issues in inhaler technique. These deficiencies directly impact drug delivery efficiency and patient outcomes, underscoring the importance of effective training interventions.

Similar findings have been documented globally. In Spain, only 9% of patients demonstrated correct inhalation techniques, with errors mirroring those in our study.[15] Likewise, in Italy, 24% of pMDI users exhibited improper techniques, and studies from the UK report a decline in proper usage over decades, reflecting the need for consistent education.[15] Comparatively, a 2011 study showed significant post-training improvements, with errors reducing from 78.9% to 28.3%, aligning with our intervention results where nearly all participants achieved a perfect score immediately after demonstration.[12]

However, our follow-up revealed that 17.4% of participants showed diminished performance after a month, emphasizing the challenge of skill retention. Moreover, one study demonstrated significant improvements in inhaler technique among healthcare professionals following targeted training, indicating that education can lead to measurable enhancements in practice.[11]

Among all participants 85(78%) of them successfully completed the entire checklist of MDI steps correctly before the demonstration, indicating a high level of pre-existing competence despite varying levels of experience with MDI. Among participants with less than one year of MDI experience, there was a wide range of scores, from 4 to 8, yet the majority (61 out of 77) scored 8, suggesting that many had a strong understanding of MDI use despite limited experience. Participants with 1-5 years of experience also performed well, with most (21 out of 29) scoring 8, while only a few had slightly lower scores, ranging from 4 to 7, showing a generally positive trend. The small number of participants with 6-10 years (1 person) and more than 10 years of experience (2 participants) all scored 8, reflecting high proficiency. Thus, in this study had comparatively better use of inhalational technique prior to training in comparison to various study.[11,15]

The type of device also influences technique quality. A large-scale study analyzing over 3,800 questionnaires found that critical errors, such as failure to exhale before actuation and inadequate breath-holding, occurred across devices but were more frequent with pMDIs (76%) compared to breath-actuated inhalers (49–55%). [13]Similarly, a study reported higher error rates with pMDIs, suggesting that device choice should align with patient capability.[14]

While our study demonstrates the effectiveness of initial training, it also reveals the necessity of regular follow-ups and tailored strategies, particularly for older patients, to reinforce skills and ensure sustained improvement in inhalation techniques. The limitations of our study include a short follow-up period and reliance on a single-center population, which may limit generalizability. Future research should explore long-term training models and device-specific interventions to address these challenges comprehensively.

Recommendations from our findings could be tailoring training programs to address device-specific challenges and implementing periodic assessments to reinforce skills. Future strategies should focus on personalized interventions, particularly for populations prone to errors, such as older adults or those using complex inhaler devices.

Conclusion

Our study underscores the effectiveness of targeted demonstration in significantly improving inhaler technique, with nearly all participants achieving correct use immediately after training. However, persistent errors in critical steps, such as mouthpiece placement and breath-holding, highlight the need for focused education on these aspects. The slight decline in correct technique observed after one month underscores the importance of continuous reinforcement through regular follow-up sessions. These findings support integrating structured and recurring inhaler education into COPD and asthma management protocols to ensure sustained improvement in technique and optimize therapeutic outcomes.

Author contribution

Concept design: CPA, GM, SB, AY, SJ; Literature search: GM, SB, SJ; Data collection: GM, AY, SB, SJ; Data analysis: SB; Draft manuscript: CPA, GM, SB, SJ; Final manuscript and accountability: all

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Conflict of interest

None

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Supplementary material

The data and supplementary material that support the findings of this study are available from the corresponding author upon reasonable request.

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