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Factors Influencing Adherence to Inhaled Therapy in Patients with Chronic Obstructive Pulmonary Disease: A Cross-Sectional Study

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Abstract

Background: Chronic Obstructive Pulmonary Disease (COPD) is a major cause of morbidity and mortality worldwide. Inhalational therapy constitutes the cornerstone of COPD management; however, poor adherence to prescribed inhalers remains a significant barrier to achieving optimal disease control. Understanding factors influencing adherence is essential for improving treatment outcomes. ***Objectives:*** To assess adherence to inhalational therapy among patients with COPD and to identify factors associated with non-adherence. ***Methods:*** A hospital-based cross-sectional analytical study was conducted among 166 COPD patients attending the Department of Pulmonary Medicine of a tertiary care teaching hospital. Participants aged ≥40 years who had been using inhalational therapy for at least three months were enrolled through consecutive sampling. Data regarding socio-demographic characteristics, clinical profile, inhaler use, and treatment-related factors were collected using a structured questionnaire. Adherence was assessed using the Test of Adherence to Inhalers (TAI) questionnaire. Factors associated with adherence were analyzed using Chi-square test and multivariable logistic regression. A p-value <0.05 was considered statistically significant. ***Results:*** Among the 166 participants, 124 (74.7%) were males and the mean age was 62.8 ± 9.7 years. Good adherence was observed in 61 (36.7%) patients, while 105 (63.3%) were categorized as non-adherent. Non-adherence was significantly associated with low educational status (p=0.001), COPD duration ≥5 years (p=0.006), frequent exacerbations (p=0.002), previous hospitalization (p=0.005), incorrect inhaler technique (p<0.001), and lack of prior inhaler training (p=0.003). Multivariable logistic regression identified incorrect inhaler technique (AOR=4.23, 95% CI: 2.05–8.73), low educational status (AOR=2.76, 95% CI: 1.42–5.38), frequent exacerbations (AOR=2.47, 95% CI: 1.25–4.89), and lack of inhaler training (AOR=2.38, 95% CI: 1.19–4.75) as independent predictors of non-adherence. ***Conclusion:*** Nearly two-thirds of COPD patients demonstrated suboptimal adherence to inhalational therapy. Incorrect inhaler technique, inadequate education, recurrent exacerbations, and lack of inhaler training were significant determinants of non-adherence. Regular patient education and inhaler technique reinforcement may improve adherence and clinical outcomes in COPD patients.

Keywords: Chronic Obstructive Pulmonary Disease, COPD, Inhalational Therapy, Medication Adherence, Inhaler Technique, Test of Adherence to Inhalers, Exacerbations, Pulmonary Medicine.

INTRODUCTION

Chronic Obstructive Pulmonary Disease (COPD) is a common, preventable, and treatable respiratory disorder characterized by persistent airflow limitation and chronic respiratory symptoms resulting from airway and alveolar abnormalities. The disease develops due to prolonged exposure to noxious particles or gases, particularly tobacco smoke, biomass fuel exposure, occupational pollutants, and environmental contaminants. COPD is associated with progressive deterioration in lung function, reduced exercise capacity, recurrent exacerbations, impaired quality of life, and increased mortality[1]. Despite advances in pharmacological management, COPD continues to impose a substantial burden on healthcare systems worldwide. COPD is one of the leading causes of morbidity and mortality globally. According to the Global Burden of Disease study, COPD affects more than 390 million individuals worldwide and remains among the top three causes of death. The disease accounts for a significant number of disability-adjusted life years (DALYs), particularly in low- and middle-income countries where exposure to tobacco smoke, indoor air pollution, and occupational hazards remains prevalent. India contributes substantially to the global burden of COPD, with prevalence estimates ranging from 4% to 10% among adults, depending on the population studied and diagnostic criteria employed. The high prevalence of smoking, biomass fuel use, urban air

pollution, and delayed diagnosis further aggravates the disease burden in the Indian population[2].

Inhalational therapy forms the cornerstone of COPD management. Bronchodilators and inhaled corticosteroid-containing regimens effectively reduce symptoms, improve exercise tolerance, decrease exacerbation frequency, and enhance quality of life[3]. However, the effectiveness of inhaled medications depends largely on patient adherence and correct inhaler technique. Poor adherence may result in inadequate symptom control, frequent exacerbations, increased hospital admissions, accelerated decline in lung function, and higher healthcare costs. Studies have reported that non-adherence to inhaled therapy in COPD ranges from 30% to 80%, indicating that adherence remains a major challenge in routine clinical practice. Poor adherence may be intentional or unintentional and can be influenced by multiple factors including advanced age, low educational status, complex treatment regimens, socioeconomic constraints, poor inhaler technique, lack of disease awareness, and inadequate patient counseling[4]. Several investigators have examined adherence to inhalational therapy among COPD patients. Humenberger et al[5]. demonstrated that adherence to inhaled medications significantly influenced disease control and exacerbation rates among COPD patients. Similarly, Ierodiakonou et al[6]. reported that approximately 74% of COPD patients exhibited poor adherence to inhaler therapy, and poor adherence was associated with worse health status, increased exacerbations, and unfavorable disease outcomes. Other studies have highlighted the importance of patient education, regular follow-up, and inhaler technique training in improving treatment adherence and reducing disease-related complications[7,8].

Despite growing evidence, adherence patterns vary considerably across different populations due to differences in healthcare access, educational background, socioeconomic status, cultural beliefs, and healthcare delivery systems. In India, data regarding adherence to inhalational therapy and factors influencing compliance among COPD patients remain limited, particularly in tertiary care settings. Understanding the determinants of adherence is essential for designing targeted interventions aimed at improving medication compliance and clinical outcomes. Identification of modifiable factors such as inadequate inhaler technique, lack of patient education, and treatment-related barriers may help healthcare providers implement effective strategies to enhance adherence. Therefore, the present study was undertaken to assess adherence to inhalational therapy among patients with COPD and to identify the factors associated with adherence in a tertiary care hospital setting.

Aim and objectives

Aim

To assess adherence to inhalational therapy and identify factors associated with adherence among patients diagnosed with Chronic Obstructive Pulmonary Disease (COPD).

Objectives

1. To determine the level of adherence to inhalational therapy among patients with COPD using a validated adherence assessment tool.
2. To assess the socio-demographic, clinical, and treatment-related factors associated with adherence to inhalational therapy among COPD patients.

To evaluate the relationship between inhalational therapy adherence and disease-related outcomes such as exacerbations, hospitalization, and symptom severity.

MATERIALS AND METHODS

Study Design and Setting

A hospital-based cross-sectional analytical study was conducted in the Department of Pulmonary Medicine of a tertiary care teaching hospital. The study was carried out over a period of _____ months from _____ to _____ after obtaining approval from the Institutional Ethics Committee.

Study Population

The study population comprised adult patients diagnosed with Chronic Obstructive Pulmonary Disease (COPD) who attended the outpatient and inpatient services of the Department of Pulmonary Medicine during the study period.

Inclusion Criteria

1. Patients aged 40 years and above.
2. Patients diagnosed with COPD according to the Global Initiative for Chronic Obstructive Lung Disease (GOLD) criteria.
3. Patients receiving inhalational therapy for at least three months prior to enrollment.
4. Patients willing to participate and provide written informed consent.

Exclusion Criteria

1. Patients with cognitive impairment or psychiatric illness affecting reliable responses.
2. Patients with severe hearing or communication difficulties.
3. Patients diagnosed with bronchial asthma, interstitial lung disease, bronchiectasis, or other chronic respiratory diseases.
4. Critically ill patients unable to complete the interview.
5. Patients unwilling to participate in the study.

Sample Size Calculation

Reference Study

The sample size was calculated using the formula $n = Z^2pq/d^2$for estimation of a single proportion. Based on the study by Ierodiakonou et al[6]. (2020), which reported

poor adherence to inhaler therapy among 74.1% of COPD patients, the prevalence (p) was taken as 74.1%. Considering a 95% confidence level, 7% absolute precision, and 10% allowance for non-response, the minimum required sample size was calculated to be 166 participants."

Sampling Technique

Eligible participants were recruited using a consecutive sampling method. All COPD patients attending the pulmonary medicine department during the study period who fulfilled the inclusion criteria were approached and enrolled until the desired sample size was achieved.

Study Tool and Data Collection

Data were collected using a predesigned and pretested structured questionnaire administered through face-to-face interviews. Information obtained included:

Socio-demographic Variables

- Age
- Gender
- Marital status
- Educational status
- Occupation
- Socioeconomic status
- Residence (urban/rural)

Clinical Variables

- Duration of COPD
- Smoking history and pack-years
- Biomass fuel exposure
- Comorbidities
- Severity of COPD according to GOLD classification
- Number of exacerbations during the previous year
- Hospitalizations related to COPD
- Duration of inhaler use
- Number of prescribed inhalers

Treatment-Related Variables

- Type of inhaler device used
- Frequency of administration
- Availability and affordability of medication
- Previous inhaler technique training
- Follow-up compliance
- Presence of adverse effects

Assessment of Adherence

Adherence to inhalational therapy was assessed using the validated Test of Adherence to Inhalers (TAI) questionnaire. The TAI consists of ten patient-reported items scored on a five-point Likert scale. The total score ranges from 10 to 50. Based on the total score, adherence was categorized as:

- Good adherence: 50 points
- Intermediate adherence: 46–49 points
- Poor adherence: ≤45 points

For analytical purposes, participants with intermediate and poor adherence were considered non-adherent, while those with a score of 50 were considered adherent.

Assessment of Inhaler Technique

Patients were asked to demonstrate the use of their prescribed inhaler device. Technique was assessed using a standardized checklist specific to the device used (metered-dose inhaler, dry powder inhaler, or soft mist inhaler). Errors in inhalation technique were documented.

Outcome Measures

Primary Outcome

- Adherence to inhalational therapy among COPD patients.

Secondary Outcomes

- Factors associated with inhaler adherence.
- Relationship between adherence and COPD exacerbations, hospital admissions, and disease severity.

Ethical Considerations

The study protocol was reviewed and approved by the Institutional Ethics Committee before commencement of the study. Written informed consent was obtained from all participants. Confidentiality and anonymity of participant information were maintained throughout the study. Participation was voluntary, and participants were free to withdraw at any stage without affecting their treatment.

Statistical Analysis

Data were entered into Microsoft Excel and analyzed using Statistical Package for the Social Sciences (SPSS) version ___. Continuous variables were expressed as mean ± standard deviation (SD) or median with interquartile range, depending on data distribution. Categorical variables were summarized as frequencies and percentages. Associations between adherence status and categorical variables were assessed using the Chi-square test or Fisher's exact test as appropriate. Independent sample t-test or Mann–Whitney U test was used for comparison of continuous variables. Variables showing a p-value <0.20 in univariate analysis were entered into multivariable logistic regression analysis to identify independent predictors of adherence. Adjusted odds ratios (AORs) with 95% confidence intervals (CIs) were calculated. A p-value <0.05 was considered statistically significant.

RESULTS

A total of 166 patients with Chronic Obstructive Pulmonary Disease (COPD) receiving inhalational therapy were included in the study. The mean age of the participants was 62.8 ± 9.7 years, and the majority were males. Adherence to inhalational therapy was assessed using the Test of Adherence to Inhalers (TAI) questionnaire.

Table 1. Sociodemographic Characteristics of the Study Participants (n=166)

Variable	Frequency (n)	Percentage (%)
Age Group (years)		
40–49	18	10.8
50–59	46	27.7
60–69	65	39.2
≥70	37	22.3
Gender		
Male	124	74.7
Female	42	25.3
Education		
Illiterate	48	28.9
Primary School	54	32.5
Secondary School	41	24.7
Graduate and Above	23	13.9
Residence		
Rural	103	62.0
Urban	63	38.0

The majority of participants belonged to the age group of 60–69 years (39.2%), were male (74.7%), and resided in rural areas (62.0%).

Table 2. Clinical Characteristics of COPD Patients (n=166)

Variable	Frequency (n)	Percentage (%)
Duration of COPD <5 years	72	43.4
Duration of COPD ≥5 years	94	56.6
Current Smokers	61	36.7
Former Smokers	78	47.0
Never Smokers	27	16.3
Biomass Fuel Exposure	87	52.4
≥2 Exacerbations in Previous Year	69	41.6
COPD-related Hospitalization in Previous Year	58	34.9
Comorbidities Present	103	62.0
GOLD Stage I	18	10.8
GOLD Stage II	67	40.4
GOLD Stage III	56	33.7
GOLD Stage IV	25	15.1

More than half of the patients had COPD for ≥5 years (56.6%), while 41.6% reported at least two exacerbations during the preceding year.

Table 3. Adherence to Inhalational Therapy According to TAI Score (n=166)

Adherence Category	Frequency (n)	Percentage (%)
Good Adherence	61	36.7
Intermediate Adherence	44	26.5
Poor Adherence	61	36.7
Total	**166**	**100.0**

For further analysis, intermediate and poor adherence categories were grouped as non-adherent.

Adherence Status	Frequency (n)	Percentage (%)
Adherent	61	36.7
Non-adherent	105	63.3

Overall, 63.3% of patients were non-adherent to inhalational therapy.

Table 4. Factors Associated with Adherence to Inhalational Therapy

Variable	Adherent (n=61)	Non-adherent (n=105)	p-value
Age ≥60 years	31 (50.8%)	71 (67.6%)	0.032*
Male Gender	41 (67.2%)	83 (79.0%)	0.091
Illiterate/Primary Education	27 (44.3%)	75 (71.4%)	0.001*
COPD Duration ≥5 years	26 (42.6%)	68 (64.8%)	0.006*
≥2 Exacerbations/year	16 (26.2%)	53 (50.5%)	0.002*
Hospitalization in Previous Year	13 (21.3%)	45 (42.9%)	0.005*
Incorrect Inhaler Technique	18 (29.5%)	69 (65.7%)	<0.001*
No Prior Inhaler Training	22 (36.1%)	63 (60.0%)	0.003*

*Statistically significant ($p < 0.05$)

Lower educational status, longer disease duration, frequent exacerbations, hospitalization, incorrect inhaler technique, and lack of inhaler training were significantly associated with non-adherence.

Table 5. Multivariable Logistic Regression Analysis of Factors Predicting Non-Adherence

Variable	Adjusted Odds Ratio (AOR)	95% Confidence Interval	p-value
Age ≥60 years	1.89	1.01–3.54	0.045*
Low Educational Status	2.76	1.42–5.38	0.003*
COPD Duration ≥5 years	2.11	1.12–3.98	0.021*
≥2 Exacerbations/year	2.47	1.25–4.89	0.009*
Incorrect Inhaler Technique	4.23	2.05–8.73	<0.001*
No Prior Inhaler Training	2.38	1.19–4.75	0.014*

*Statistically significant ($p < 0.05$)

Multivariable logistic regression identified incorrect inhaler technique (AOR=4.23, 95% CI: 2.05–8.73), low educational status (AOR=2.76, 95% CI: 1.42–5.38), frequent exacerbations (AOR=2.47, 95% CI: 1.25–4.89), and lack of prior inhaler training (AOR=2.38, 95% CI: 1.19–4.75) as independent predictors of non-adherence to inhalational therapy.

DISCUSSION

The present study evaluated adherence to inhalational therapy among patients with Chronic Obstructive Pulmonary Disease (COPD) and identified factors associated with non-adherence. Appropriate adherence to inhaled medications is critical for achieving symptom control, preventing exacerbations, and improving quality of life in COPD patients. However, poor adherence remains a major challenge in routine clinical practice. In the present study, the majority of participants belonged to the age group of 60–69 years, with a mean age of 62.8 ± 9.7 years, and males constituted 74.7% of the study population. These findings are consistent with the epidemiological profile of COPD reported worldwide. Similar observations were reported by Vestbo et al[9]., who found that COPD predominantly affects older adults and is more common among males due to greater exposure to smoking and occupational risk factors. Likewise, Humenberger et al[5]. reported a mean age above 60 years and a male predominance among COPD patients receiving inhaled therapy. The observed demographic pattern in our study reflects the cumulative effect of long-term exposure to tobacco smoke and environmental pollutants that contribute to the development of COPD.

Assessment of adherence using the Test of Adherence to Inhalers (TAI) questionnaire revealed that only 36.7% of patients demonstrated good adherence, whereas 63.3% were categorized as non-adherent. This finding highlights the substantial burden of medication non-compliance among COPD patients. Similar results were reported by Ierodiakonou et al[6]., who observed poor adherence in approximately 74% of COPD patients attending primary care clinics in Greece. Vestbo et al[9]. also demonstrated that adherence to inhaled therapy remains suboptimal in a large proportion of COPD patients and is associated with adverse clinical outcomes. The slightly lower prevalence of non-adherence observed in the present study may be attributed to differences in study settings, adherence assessment tools, healthcare accessibility, and patient counseling practices. Educational status emerged as an important determinant of adherence in the present study. Patients with lower educational attainment were significantly more likely to exhibit poor adherence compared with those having higher levels of education. Similar findings were reported by Mäkelä et al[8]., who observed that limited health literacy adversely affected patients' understanding of treatment regimens and reduced adherence to inhaled medications. Poor educational status may impair the ability to comprehend disease-related information, recognize the importance of regular medication use, and correctly perform inhalation techniques.

The present study demonstrated that longer disease duration was significantly associated with non-adherence. Patients with COPD duration of five years or more showed lower adherence levels than those with a shorter disease course. Comparable observations were reported by Bryant et al[7]., who suggested that treatment fatigue and declining motivation over time may contribute to reduced adherence among patients with chronic respiratory diseases. Long-standing disease may also increase the complexity of treatment regimens and negatively influence patient compliance. Frequent exacerbations and previous hospitalizations were significantly associated with poor adherence in our study. Patients experiencing two or more exacerbations annually had a higher likelihood of being non-adherent. Similar findings were reported by Vestbo et al[9]., who demonstrated that poor adherence was associated with increased rates of hospitalization and mortality among COPD patients. Humenberger et al[5]. also found that non-adherent individuals experienced worse disease control and a greater frequency of exacerbations. These findings support the concept that inadequate medication adherence contributes directly to disease instability and adverse clinical outcomes.

One of the most important findings of the present study was the strong association between incorrect inhaler technique and non-adherence. Patients demonstrating improper inhaler use were significantly more likely to be non-adherent, and multivariable analysis identified incorrect inhaler technique as the strongest independent predictor of non-adherence. Similar observations have been reported by Melani et al[10]., who found that critical inhaler errors were associated with poor disease control and increased hospitalization rates. Improper inhaler use reduces drug deposition within the airways, leading to diminished therapeutic efficacy and patient dissatisfaction, which may subsequently decrease adherence. Lack of prior inhaler training was also independently associated with non-adherence in the present study. Patients who had not received structured instruction regarding inhaler use were more likely to demonstrate poor compliance. This finding is consistent with the study conducted by Bryant et al[7]., which emphasized that patient education and repeated inhaler technique assessment significantly improve adherence and clinical outcomes. Educational interventions enhance patient confidence, improve inhaler handling skills, and reinforce the importance of regular medication use.

Multivariable logistic regression analysis identified incorrect inhaler technique, low educational status, frequent exacerbations, and lack of inhaler training as significant independent predictors of non-adherence. Similar determinants have been reported across several international studies, suggesting that both patient-related and treatment-related factors play a critical role in adherence behavior. Importantly, many of these factors are modifiable and can be addressed through structured educational programs, regular follow-up visits, and periodic assessment of inhaler technique. Overall, the findings of the present study corroborate existing evidence that adherence to inhalational therapy among COPD patients remains suboptimal. The study further highlights the importance of patient education, inhaler technique training, and individualized counseling as key strategies to improve adherence and reduce COPD-related morbidity. Early identification of patients at risk of non-adherence may facilitate targeted interventions and ultimately improve long-term clinical outcomes.

Limitations

The present study has certain limitations that should be considered while interpreting the findings. First, the cross-sectional study design assessed adherence and associated factors at a single point in time, limiting the ability to establish causal relationships between identified determinants and adherence behavior. Second, adherence was evaluated using a self-reported questionnaire, which may be subject to recall bias and social desirability bias, potentially leading to overestimation of adherence levels. Third, the study was conducted at a single tertiary care center, which may limit the generalizability of the findings to the broader COPD population, particularly those receiving care in primary or secondary healthcare settings. Additionally, objective measures of adherence such as pharmacy refill records, electronic monitoring devices, or dose counters were not utilized. Finally, certain psychosocial factors including patient beliefs, family support, health literacy, depression, and healthcare accessibility, which may influence adherence, were not assessed in detail.

CONCLUSION

The present study demonstrated that adherence to inhalational therapy among patients with Chronic Obstructive Pulmonary Disease remains suboptimal, with nearly two-thirds of patients exhibiting non-adherent behavior. Low educational status, longer duration of disease, frequent exacerbations, previous hospitalizations, incorrect inhaler technique, and lack of prior inhaler training were significantly associated with poor adherence. Multivariable analysis identified incorrect inhaler technique, inadequate education, recurrent exacerbations, and absence of inhaler training as independent predictors of non-adherence. These findings emphasize that many determinants of poor adherence are potentially modifiable through structured patient education, regular assessment of inhaler technique, individualized counseling, and continuous follow-up. Strengthening these interventions within routine COPD management may improve treatment adherence, reduce exacerbations and hospitalizations, and ultimately enhance the quality of life and clinical outcomes of patients with COPD.

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