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*Research Article*

# Improving Inhaler Techniques in COPD and Asthma Patients through Pharmacist Interventions

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## Abstract

Chronic obstructive pulmonary disease (COPD) and asthma are common chronic respiratory diseases that greatly increase morbidity and death worldwide, especially in low- and middle-income nations. Even with the advent of efficient inhaled treatments, poor disease control is still a significant worry, frequently caused by incorrect inhaler technique and noncompliance with drug regimens**.** In order to improve inhaler technique and adherence among adult patients with as COPD or asthma, this study sought to evaluate the efficacy of pharmacist-led treatments.

The Test of Adherence to Inhalers (TAI), the Functional Assessment over Non-Life-Threatening Conditions (FANLTC) scale, and standardized checklists for dry powder and metered dosage inhalers (MDIs and DPIs) for quality of life were used in the study to assess patient performance. Telemonitoring support, training sessions, and in-person counselling were among the therapies. Pharmacist-led treatments significantly improved inhaler technique & adherence scores, especially for people with COPD.

Improved forced expiratory volume (FEV1) and COPD assessment test (CAT) scores were linked to proper device use. Furthermore, errors were more likely to occur in individuals who used multiple inhalers with different approaches. Devices like Diskus and Ellipta® were linked to fewer mistakes than Turbohalers and pMDIs. Clinical outcomes for patients with COPD and asthma are improved when pharmacists provide instruction and monitoring that greatly improves inhaler technique and drug adherence.

Regular evaluation and instruction, customized to patient-specific traits including inspiratory flow and cognitive function, are crucial elements of managing chronic respiratory diseases. Pharmacists can maximize treatment results and lessen the overall healthcare burden by being integrated into multidisciplinary care teams.

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## INTRODUCTION

Asthma and Chronic obstructive pulmonary disease (COPD) are the two most prevalent chronic lung illnesses that are known to be the main causes of mortality and morbidity and disability adjusted life years, particularly in countries with low and intermediate incomes [1–5]. A heterogeneous lung disease, chronic obstructive pulmonary disease (COPD) is typified by persistent, frequently progressive airflow obstruction caused by abnormalities of the airways (bronchiolitis and bronchitis) or alveoli (emphysema). The quality of life (QoL) of patients is diminished, and it is a major cause of mortality and morbidity globally [6]. Chronic lung inflammation, or asthma, damages the airways and results in recurrent episodes of chest tightness, wheezing, dyspnea and coughing.

A chronic inflammatory lung illness, asthma damages the airways and causes recurrent episodes of wheezing, coughing, dyspnea and chest tightness. Approximately 300 million people worldwide suffer from asthma, and research indicates that the prevalence increases by 50% every ten years [3, 4, 7]. However, in the world, COPD ranks seventh in terms of ill health and third in terms of death [8].

Recent advances in our understanding of the pathophysiology of asthma and COPD have resulted in the development of innovative medicines to manage the burden of chronic respiratory disorders [9]. Nevertheless, patients with asthma and COPD continue to have inadequate disease control in spite of these advancements, which leads to increased exacerbations, more deaths and disability, and a reduced quality of life [10]. Inhaled medicines are the primary treatment for patients with COPD and asthma. The benefit of this application method is that it allows the medication to enter the airways directly. As a result, there is a lower chance of systemic adverse effects when large local concentrations are reached [5]. According to studies, around half of the drugs recommended to patients with chronic illnesses are not taken as directed [11], and adherence rates are typically substantially lower (22–78%) for patients with COPD and asthma [12]. Furthermore, studies have shown that up to 85% of the patients do not utilize their inhalers correctly [13]. Inaccurate inhalation technique and improper handling are associated with poor disease control due to reduced medicine administration, which may raise the risk of hospitalization and exacerbations [14–17]. Pharmacists have significant potential to improve the management of the Chronic obstructive pulmonary disease since they are an essential component of the healthcare system and are in a unique position to offer patients helpful advice on using inhalers [18]. Interventions led by pharmacists can greatly enhance inhaler technique, educate patients, and increase adherence [19].

### Types of inhalers:

**Pressurized metered-dose inhalers (pMDIs):** Because of their affordability and ability to provide a broad range of asthma or COPD drugs, pressurized metered-dose inhalers, or pMDIs, are frequently administered [20]. Even with instruction and training, many patients are unable to utilize pMDIs appropriately, despite their widespread prescription [21–23]. Lenney *et al*. found that only 79% of patients could correctly use a pMDI, despite professional training [24]. About 60% of patients with COPD and 92% of patients with asthma were inhaling too quickly from a pMDI, according to research by Al-Showair *et al*. [25, 26].

**Breath-actuated metered-dose inhalers:** Breath-actuated metered-dose inhalers, or BA-MDIs, are an advancement over the first generation of pMDIs. Because the medicine is only delivered when a patient inhales through their inhaler device, they have a flow trigger that makes sure that inhalation and inhaler actuation are synced properly. Chapman *et al*. When comparing BA-MDIs to regular MDIs, it was shown that older people preferred the former [27].

**Dry powder inhalers:** A variety of DPIs are presently on the market. The primary benefit of DPIs over pMDIs is that the patient's inhalation propels the creation of the medication aerosol. As a result, neither an aerosol propellant nor synchronization between the device's actuation and inhalation are required. Incorrect device alignment, failure to hold breath [28].

**Soft mist inhalers**: The Respimat® (Boehringer Ingelheim, Germany) is the only soft mist inhaler currently available on the European market. Inhalers with soft mist are a relatively recent development. Recent findings, however, have linked tiotropium administered with the Respimat device to a nonsignificant rise in cardiovascular mortality when compared to a placebo [29]. Consequently, Spiriva Respimat should be used cautiously in patients with known cardiac rhythm abnormalities, according to the Medicines and Healthcare Products Regulatory Agency [30].

### Factors influencing inhaler choice and use:

The choice of inhaler depends on a number of criteria, including those pertaining to the patient and the physician, as well as the inhaler itself.

### Inhaler Characteristics:

Aerosol velocity [31-34], drug size of particles [31, 32–35], internal resistance to airflow [32], and aerosol spray length [32,36] are significant inhaler characteristics that influence the location and amount of drug deposition. Because they are more likely to be deposited throughout the bronchial tree, particles with a diameter of 2 to 5µm are thought to be ideal [34], while particles larger particles less than 1µm are ejected and therefore ineffective, but Ineffective particles smaller than 1 µm are expelled, whereas particles bigger than five microns were more likely to collect within the oropharynx [35, 32]. The majority of DPIs need to be inhaled quickly, and a patient's inspiratory flow determines how well the powder aerosolizes [37, 32]. In contrast, pMDIs and SMIs produce aerosol automatically upon actuation [38, 34] enabling slower inhalation.

### Patient-Related Factors:

Effective use of the inhaler by patients is crucial to the effectiveness of treatment; this capacity is further dependent on

the patient's physical capabilities, including cognitive function, comorbidities and age. In another important consideration is the inspiratory flow rate, particularly with breath-powered DPIs [31]. A suboptimal PIFR [39] can be caused by a number of variables, including [37] female sex [40], airflow limitation [41], increasing age [42], a history of hospitalisation for severe COPD lung hyperinflation [39, 40], respiratory muscle weakness [41], and exacerbations [39].

**Provider-Related Factors:**

Providers favour inhalers that are easy to use, have high targeted deposition, require less patient coordination, and indicate proper use. [31, 43]. However, studies have revealed that almost two-thirds of healthcare professionals (HCPs) struggle to correctly perform crucial inhaler use procedures [44], and patients receive inaccurate training, which exacerbates their mishandled inhalers [32].

According to the American College of Allergy, Asthma Immunology and the American College of Chest education, the following factors should be taken into account when choosing an inhaler: patient ability and preference, cost, device longevity, drug accessibility, and usability [32, 45].

**Choosing the correct inhaler:**

One of the crucial factors in determining whether the patient has an appropriate inhaler technique is the inspiratory flow through the particular device and the ability to coordinate actuation and inhalation of the inhaler. Voshaar *et al*. have suggested that the best suitable inhaler for a given patient may be determined by using inspiratory measurements of flow and the capacity to synchronize the actuation as well as inhalation of inhalers [46]. According to this approach, people who inherently have a propensity for rapid breathing would benefit more from DPIs, while those who inhale more slowly would be best suited to a pMDI. Devices such as the In-Check DIAL® inspiratory flow meter (Clement Clarke Ltd, UK) can be used to ensure that patients can inhale through their inhaler device at the clinically effective inspiratory flow rate. By simulating the resistance within of various inhaler devices, the device makes it possible to measure the inspiratory flow rate via various devices [47, 48]. In-Check Plasmid inhalers, which ought to only be utilized by one patient, could be saved and the DIAL respiratory flow meter might be employed to help choose inhaler devices of an inhaler method assessment. It is useless to use that instrument to verify a patient's technique if they are physically unable of achieving the necessary optimal inspiratory flow rate. They might benefit from instruction and training if the inspiratory flow is exceedingly high for the device, or they could try a new one.

Assuming that their general technique is adequate, patients who utilize a certain inhaler device but are unable to attain the optimal inspiratory flow rate may frequently benefit clinically from it, furthermore, for the best possible medication administration, the inspiratory movement at the beginning of inhalation must be quick enough to dissolve the weak bindings among the drug and carrier particles to guarantee that the ideal particle size is reached so that the medication can be deposited in the right area of the lungs [47]. Training aids, such as the In-Check DIAL inspiratory flow meter, Turbohaler Trainer, Accuhaler Training Device and 2-Tone Trainer, are tools for determining whether a patient has the physical capacity to use a particular inhaler device. These devices are just one aspect of inhaler use, therefore, it is essential that health care professionals have access to placebo inhaler devices to assess a patient's overall inhaler technique, since these will allow the patient to be assessed on the priming, positioning and coordination of the device. Most UK hospitals and general practitioners have access to placebo inhalers, but many centres advise that placebo inhalers should be 'single-patient use only, since there is a theoretical risk of infection when using placebo inhalers among patients [49]. Nevertheless, the British Thoracic Association recommends that placebo inhalers be sterilized after each use if they are used for multiple patients.

The American College of Chest Physicians and American College of Asthma, Allergy and Immunology have provided more useful advice on prescribing inhalers, recommending that a number of factors are considered when prescribing inhaler devices. These criteria included the availability of the drug, the patient's capacity to utilize it, the cost, the device's durability, convenience, and the desire of the patient or prescriber. While these factors are perfectly reason able issues to consider when prescribing a new inhaler device, it is strange that patient preference for the inhaler device is the last consideration, as this may affect adherence to the prescribed treatment, therefore we would suggest that a pragmatic approach for inhaler choice could be used [50].

Although there are several studies evaluating the preferences of various inhaler devices among patients with COPD and asthma, the majority of them are sponsored by the industry. In fact, one review reported that "of the 29 studies, 23 were sponsored by the pharmaceutical industry, and 83% of the sponsored trials favoured the device manufactured by the sponsoring company" [51]. Inhaler technique training for inhaler technique Any patient with asthma or COPD should have regular inhaler technique checks as part of their care. The Aerosol Drug Management Improvement Team group proposed a practical algorithm in order to improve the instruction of patients regarding correct inhaler use [52].

**Critical inhaler errors in asthma and COPD:**

Inhaled drug delivery is the cornerstone of therapy for obstructive chronic airway diseases, such as asthma and COPD (chronic obstructive pulmonary disease) [53]. In daily respiratory practice, the pressurized metered-dose inhaler (pMDI) and the dry powder inhaler are the most often used devices for administering aerosolized medication. It is true that learning how to use an inhaler device properly entails handling and preparing the device before inhaling as well as using the best inhalation technique; any mistake in these steps could result in insufficient drug delivery to the lungs. There is currently no "perfect device," despite advancements in inhaler device technology, and numerous studies have demonstrated that

people with COPD and asthma make mistakes when using their inhalers widely in real life with both pMDIs and DPIs [54] [55–58].

To ascertain which errors were most linked to poor health outcomes, a recent large cross-sectional research of asthma patients compared data on inhaler technique with evidence on disease control [59]. It is becoming more well acknowledged that inadequate inhaler technique has a negative impact on society and health [60]. The two most widely used DPIs in 2015 cost about €750 million in both direct and indirect costs in three countries (Spain, UK and Sweden) due to inadequate inhaler technique [61]. Assessing and improving inadequate inhaling technique prior to increasing medication therapy is highly valued in recent global position publications from the Global Initiative for Chronic Obstructive Lung Disease (GOLD) and as well as GINA, the Global Institute for Asthma [62, 63].

Two studies found that the type of device affected the reduced error frequency among patients who had previously received instruction, with technique improving only in patients who used Diskus or Turbuhaler or MDI spacer. Al Jahdali's study revealed a strong link between inappropriate gadget use and "lack of knowledge about medication" [64-66]. In particular, we observed a statistically significant correlation between higher error frequency and other patient characteristics, including lower socioeconomic class [71], cognitive impairment or neuropathy [70], heart disease [69], obesity [68] and the presence of two or more comorbidities [67].

**Non adherence to medication:**

Patients with COPD and asthma face substantial health challenges, and society as a whole bares financial costs as well [72-74]. Unfortunately, patients with asthma and COPD frequently do not take their maintenance medications as prescribed. For people with asthma and COPD, nonadherence can negatively impact clinical results. Notably, it may have a detrimental impact on work productivity, exacerbation rate, disease control, lung function, and health-related quality of life [75-77]. There are many different factors that result in nonadherence to inhaled medication, such as unintentional nonadherence (such as not knowing how or when to use medication or not being proficient with inhaler devices) and intentional nonadherence (such as worries about side effects and the complexity of the medication regimen) [76-82]. Numerous approaches have been studied in an effort to address the issue of nonadherence. Correct inhaler technique education and training are thought to be essential for controlling asthma or COPD [83] and preventing nonadherence [77].

**Inhaler technique training:**

Patients with asthma and COPD may not have adequate disease management for a variety of reasons, but two major ones are improper breathing technique and medication non-adherence [84, 85]. The term "inhalation technique" describes the method by which a patient correctly completes a number of stages to ensure that they receive an adequate dosage through an inhalation device. According to multiple studies, between 50% and 80% of people do not utilize their inhaler correctly [86–88]. It is well established that inhaler technique is much enhanced by face-to-face instruction [89]. According to a telephone poll, patients preferred explanatory pamphlets (34%), films (58%), inhaler usage demonstrations (83%), and usage instructions (51%) [90].

But in a head-to-head contrast of instructional strategies among individuals who had never used an inhaler, a two-minute pharmacist consultation session proved to be far more beneficial in teaching patients the correct technique than professionally made movies or package information. [91]. Using telehealth technology, self-management instruction and monitoring can be carried out. [92]. Telemonitoring patients with COPD by pharmacists has been shown to reduce hospital admission rates, emergency department visits, and overall hospital stay duration. They also increase hospital readmission intervals, which lessens the financial burden. [93]. The "teach-back" technique, which involves asking patients to demonstrate how to use their inhaler, has been shown to be successful in assessing patients' comprehension of appropriate inhaler usage and their competency with it. As a result, pharmacists should be careful to conduct their training in an efficient and meticulous manner.

**Role of pharmacist in improving inhaler technique:**

By properly educating patients, keeping an eye on inhaler technique, and lowering crucial error rates, pharmacists can significantly enhance patient adherence and outcomes [95, 94] Intriguingly, a community pharmacy observational study revealed that pharmacists mostly evaluated inhaler technique when an individual asked for it (93%) or if a new inhaler had been prescribed (79%). Furthermore, a significant number of patients showed at least one important error; as a result, regardless of the duration of usage, all patients should have their inhaler technique reviewed, and treatment strategies should require this step [96]. Because of their broad clinical expertise and convenient patient access, pharmacists can be very helpful in the effective management of COPD [97].

Pharmacists should be mindful of potential common mistakes and keep a keen eye out for them when patients demonstrate their inhalers. Even with the right inhaler method, priming is a crucial step that, if not performed precisely, may result in incorrect medicine dispersion [98]. Pharmacists should be familiar of the various priming procedures for inhaler devices and make sure they effectively explain them to patients [99]. Most often, inhaler-use errors are inadvertent medication nonadherence incidents. A number of strategies, involving primary care teams and pharmacists, can be used to improve adherence, such as self-management advice, frequent monitoring, counseling, and the use of electronic inhaler-use feedback devices [100, 101].

Understanding the causes and characteristics of inhaler-use mistakes is crucial for developing and putting into practice solutions [102]. Using dispensing and refill records, pharmacists can determine whether patients are abusing or overusing their inhalers [103]. In contrast to unchecked patients, observed

patients feel surer about obtaining a full dose, so monitoring for medication errors, such as overdose due to multiple dosages or underdosing brought on by inadequate inhalation could help improve adherence [104].

By integrating pharmacy refill data into thorough evaluations and maintaining effective communication with doctors, pharmacists can further improve their involvement in patient care. Long-term medication adherence is facilitated by the patient-pharmacist relationship since it can identify inadequate implementation or possible treatment cessation and encourage persistence. By giving real-time knowledge into patients' inhaler use, technologies like "smart inhalers" can help enhance inhaler technique. In addition to recording the time and date of actuation, the smart touch as well as propeller sensors also give real-time adherence data that can be downloaded to smartphones running the relevant software and alert users when doses are missed in accordance with a patient's prescription. After checking daily dosages and keeping an eye out for needless device adjustments, pharmacists can step in and suggest drug changes [105].

Repetitive instructions given at short intervals may assist improve inhaler technique, according to a retrospective research [106]. Community pharmacists may have a big part to play in patient monitoring and follow-up. In the protocol-based pharmacist intervention research, hospital admissions considerably decreased (P =.003) in the intervention group when compared to the control group, and inhaler technique and adherence were significantly better (P <.0001) [107]. Even after instruction, the approach may still be inadequate, therefore routine monitoring is crucial. COPD management can be further improved by teaching caregivers the value of using inhalers correctly [108].

**Measurement tools:**

**Qualities of life (QOL):** To evaluate the various aspects of quality of life, a validated tool known as the Functional Assessing for Non-Life-Threatening circumstances (FANLTC) has been used. Functional happiness, psychological health, social/family happiness, and physical well-being are the four areas covered by the FANLTC. Every item in these four FANLTC domains has a score between 0 and 4, where 0 means "not at all" and 4 means "very much."

**Dry Powder Inhalers (DPIs) and Metered Dose Inhalers (MDIs)**: The checklist has eight questions for MDIs and eleven questions for DPIs. A score of one was provided for every step that was right, and a score of 0 was awarded for every step that was wrong. The checklist used to evaluate patients' proper inhaler use was contingent upon whether they were taking a DPI or an MDI. The questionnaire was distributed to patients in the pharmacist-led educational group and the control group. The same patients from both groups were given the checklist to see if their usage of inhalers had improved after a month of pharmacist-led instruction and counselling.

**Adherence to inhaler techniques:**

To measure adherence to an inhaler medication, a ten-item questionnaire known as the "Test of Adherence with Inhalers (TAI)" was employed [109]. A minimum score of 10 points and a maximum score of 50 points were assigned to each questionnaire topic. The scores varied from 1 to 5, with 1 being the lowest possible score and 5 being the highest. This continuum was used to create three adherence stages: ≤45 was classified as bad, 46–49 as intermediate, & 50 as good. At the start of the investigation (pre-education among the non-control group) and at the end of the study, the two patient groups' compliance with the inhaler therapy scores were assessed.

## DISCUSSION

Optimizing inhaler techniques is still a crucial part of managing respiratory illnesses in the field of respiratory medicine. Since the inhaler is a crucial tool for respiratory treatment, patient compliance, inhaler type, and inhalation technique accuracy are all directly related to its effectiveness. When these devices are used properly, they can improve a patient's quality of life in addition to the effectiveness of illness therapy. Just 10% of patients with chronic respiratory diseases respond well to medicine, while 90% do so as a result of receiving instruction on how to use inhaler devices. Numerous studies have shown that poor patient adherence to inhaler medication frequently results in poor clinical management and a higher frequency of hospitalizations. To determine the effectiveness of educational treatments meant to address the challenges associated with inhalation technique, prospective trials are required.

The study's conclusions show a clear distinction between the study population's prevalence of COPD and asthma. A total of 93.2% of the participants had COPD, while 6.8% of the subjects had an asthma diagnosis. Prior research by Maya *et al*. and Shrestha *et al*. showed a similar pattern, with the majority of people having COPD (with percentages varying from 66.7% to 87.1%) [110, 111]. Our results are in line with earlier studies carried out in Nepal, whose the mean ages varied between 63.4 and 68.5 years.

While previous Nepalese studies reported a higher proportion of female inhaler users, this study found an equal distribution of genders (48.6% male, 51.4% female) [112]. Asthma and COPD drugs are neither easily accessible or reasonably priced in Nigerian public hospitals, according to earlier reports, while private hospitals have greater access to these drugs than do the pharmacies of public hospitals. Furthermore, just 23% of all public hospitals have pharmacies that sell inhaled corticosteroids, the mainstay of treatment for COPD and asthma, compared to 75% of privately owned hospitals, pharmacies across the nation [113].

Our findings show that pharmacist-led interventions help adult patients with asthma and COPD with their breathing technique and medication adherence. This result is in line with the review conducted by Hesso *et al*. [114], which demonstrates that community pharmacists can help manage COPD, particularly with breathing technique and drug adherence. According to a recent study through Marissa Ayano *et al*. [115], asthmatic patients' medication adherence can be enhanced by pharmacist-led interventions. In our study, only patients with COPD

demonstrated a significant improvement in medication adherence.

There are several reasons why patients with COPD typically have higher adherence rates than those with asthma, which is consistent with the literature [116]. First, it may be connected to the various stages of the disease; for instance, the usage of medication in asthmatic patients may be more seasonally dependent than in COPD patients [116]. Second, the symptoms of COPD are typically more severe and persistent in patients [116]. Third, patients with COPD tend to be older than those with asthma, and being older is linked to being more adherent [117].

It's interesting to note that Kaae *et al*. discovered that the reasons for adopting ITAS varied among Danish users who were new and seasoned. The majority of seasoned users accepted the service [118] even though they did not feel the need for it, whereas new users desired to learn how to use the gadget correctly. Despite their initially divergent opinions, Kaae *et al*. later discovered that both of these groups typically found the service useful [119]. The impact of a monthly inhaler technique session [120] provided by a community pharmacist was investigated by Basheti *et al*.

The standardized pharmacist-led service in Norway Patients with COPD and asthma may benefit greatly from improved inhaling technique thanks to ITAS. Every user of inhalation medication should regularly have access to ITAS due to the significant gains in inhaling technique among individuals receiving it, irrespective of age, inhaler device, or expertise. However, if these are combined with many devices, those who have issues with general breathing technique would contribute comparatively more. Additionally, utilizing more than one inhaler device could raise the possibility of improper use [121-123].

Regarding the perception of disease, patient features in our study seemed to be similar to those in earlier research. Accordingly, 30% of patients with COPD reported a high as well as very high influence of the condition on their health, whereas 40% of patients with asthma reported that their condition was not thoroughly or badly controlled. These findings are similar to earlier research by Dürr *et al*., where 34% of patients experienced uncontrolled asthma at the beginning [124], and Guénette *et al*., wherein 48% of patients expressed uncontrolled asthma [125].

The purpose of this study was to assess how well pharmacist-led interventions can help the elderly with asthma or COPD improve their inhaling technique. Through examining pharmacy dispensing data among SARA and control participants across time before and after the installation of SARA, this study examined the efficacy of a pharmacy-based eHealth intervention. According to the data, SARA participants' exacerbation rates increased less over time than those of control participants.

According to the medication adherence data, the SARA group's chronic inhalation medicine users experienced a noticeably greater rise in medication adherence than the control group. The research of COPD patients who were long-term inhalation drug users revealed an intriguing gender difference. According to the findings, men in this subgroup benefited from SARA more than women did (i.e., there were no differences among SARA and control participants). This was demonstrated by higher medication adherence when compared to controls.

Overall, patients were more likely to utilize dry powder inhalers and metered dose inhalers like Turbohaler and breezhaler incorrectly, whereas Discus and Ellipta® devices were more frequently used appropriately. The use of the gadget had no effect upon the lung function metrics or the ACT score in asthmatic individuals. However, improper device application negatively affected the CAT score in individuals with COPD. Additionally, the forced expiratory volume in one second (FEV1) was higher for individuals who used their devices appropriately.

## CONFLICT OF INTEREST

The authors declare that there are no commercial or financial relationships that could be construed as a potential conflict of interest. The authors affirm that there were no personal, professional, or financial interests that may have influenced the design, outcomes, or reporting of this research.

## CONCLUSION

This study highlights the vital role that pharmacists play in supporting patients with asthma and chronic obstructive pulmonary disease (COPD) in improving both their inhaler technique and medication adherence. Although inhaler technology has advanced over the years, treatment outcomes continue to be negatively impacted by the high frequency of critical errors in inhaler use and persistently low adherence rates. These issues are particularly concerning in patients with COPD, where improper inhaler usage can significantly compromise disease control and quality of life. Pharmacist-directed interventions as telemonitoring, live demonstrations of proper inhalation techniques, and structured, patient-focused educational sessions, have shown measurable improvements not only in treatment adherence but also in overall patient well-being. The findings emphasize the ongoing need for regular patient evaluations, personalized device-specific training, and careful inhaler selection based on each individual's inspiratory flow capacity and physical capabilities. Moreover, these insights strongly support the integration of pharmacists into routine respiratory care. Doing so can help prevent disease exacerbations, reduce hospital admissions, and lower overall healthcare costs, while promoting better patient-centred outcomes. Future research should focus on implementing well-structured inhaler training programs into everyday clinical practice and thoroughly evaluating their long-term benefits on disease progression, patient quality of life, and healthcare resource utilization.

## REFERENCES


1. Labaki WW, Han MK. Chronic respiratory diseases: a global view. The Lancet Respiratory Medicine. 2020;8(6):531–533.
2. Li X, Cao X, Guo M, Xie M, Liu X. Trends and risk factors of mortality and disability adjusted life years for chronic respiratory diseases from 1990 to 2017: systematic analysis for the Global Burden of Disease Study 2017. BMJ. 2020;368:m234. doi:10.1136/bmj.m234
3. Viegi G, Maio S, Fasola S, Baldacci S. Global burden of chronic respiratory diseases. Journal of Aerosol Medicine and Pulmonary Drug Delivery. 2020;33(4):171–177.
4. Beran D, Zar HJ, Perrin C, Menezes AM, Burney P. Burden of asthma and chronic obstructive pulmonary disease and access to essential medicines in low-income and middle-income countries. The Lancet Respiratory Medicine. 2015;3(2):159–170.
5. Burney P, Jarvis D, Perez-Padilla RJ. The global burden of chronic respiratory disease in adults. The International Journal of Tuberculosis and Lung Disease. 2015;19(1):10–20.
6. Global Initiative for Chronic Obstructive Lung Disease. Global strategy for the diagnosis, management, and prevention of chronic obstructive pulmonary disease. 2023. Available from: https://goldcopd.org/. Accessed 2024 Jun 20.
7. World Health Organization. Global surveillance, prevention and control of chronic respiratory diseases: a comprehensive approach. 2007. Available from: https://iris.who.int/handle/10665/43776. Accessed 2024 Apr 5.
8. World Health Organization. Chronic obstructive pulmonary disease: key facts. 2013. Available from: https://www.who.int/news-room/fact-sheets/detail/chronic-obstructive-pulmonary-disease-(copd). Accessed 2024 Apr 3.
9. George M, Bender B. New insights to improve treatment adherence in asthma and COPD. Patient Preference and Adherence. 2019;13:1325–1334.
10. Shakshuki A, Agu RU. Improving the efficiency of respiratory drug delivery: a review of current treatment trends and future strategies for asthma and chronic obstructive pulmonary disease. Pulmonary Therapy. 2017;3(2):267–281.
11. World Health Organization. Adherence to long-term therapies: evidence for action. 2003. Available from: https://iris.who.int/handle/10665/42682. Accessed 2024 Apr 25.
12. Mäkelä MJ, Backer V, Hedegaard M, Larsson K. Adherence to inhaled therapies, health outcomes and costs in patients with asthma and COPD. Respiratory Medicine. 2013;107(10):1481–1490.
13. Dalal S, Shamaliya K, Patni A. Assessment of inhalational techniques and their common errors in bronchial asthma patients coming to tertiary hospital of South Gujarat. Indian Journal of Respiratory Care. 2020;9(2):205–210. https://doi.org/10.4103/ijrc.ijrc_15_20
14. Cho-Reyes S, Celli BR, Dembek C, Yeh K, Navaie M. Inhalation technique errors with metered-dose inhalers among patients with obstructive lung diseases: a systematic review and meta-analysis of US studies. Chronic Obstructive Pulmonary Diseases. 2019;6(3):267–280.
15. Castel-Branco MM, Fontes A, Figueiredo IV. Identification of inhaler technique errors with a routine procedure in Portuguese community pharmacy. Pharmacy Practice (Granada). 2017;15(4):1072. https://doi.org/10.18549/PharmPract.2017.04.1072
16. Rootmensen GN, van Keimpema AR, Jansen HM, de Haan RJ. Predictors of incorrect inhalation technique in patients with asthma or COPD: a study using a validated videotaped scoring method. Journal of Aerosol Medicine and Pulmonary Drug Delivery. 2010;23(5):323–328.
17. Usmani OS, Lavorini F, Marshall J, Dunlop WC, Heron L, Farrington E, Dekhuijzen R. Critical inhaler errors in asthma and COPD: a systematic review of impact on health outcomes. Respiratory Research. 2018;19(1):10.
18. American Pharmacists Association Foundation. White paper on expanding the role of pharmacists in chronic obstructive pulmonary disease. Journal of the American Pharmacists Association (2003). 2011;51(2):203–211.
19. Nguyen TS, Nguyen TL, Van Pham TT, Hua S, Ngo QC, Li SC. Pharmacists' training to improve inhaler technique of patients with COPD in Vietnam. International Journal of Chronic Obstructive Pulmonary Disease. 2018;13:1863–1872.
20. Lavorini F, Corrigan CJ, Barnes PJ, *et al*. Retail sales of inhalation devices in European countries: so much for a global policy. Respiratory Medicine. 2011;105(7):1099–1103.
21. Crompton GK. Problems patients have using pressurized aerosol inhalers. European Journal of Respiratory Diseases. 1982;119(Suppl):101–104.
22. Allen SC, Prior A. What determines whether an elderly patient can use a metered dose inhaler correctly? British Journal of Diseases of the Chest. 1986;80(1):45–49.
23. Chapman KR, Love L, Brubaker H. A comparison of breath-actuated and conventional metered-dose inhaler inhalation techniques in elderly subjects. Chest. 1993;104(5):1332–1337.
24. Lenney J, Innes JA, Crompton GK. Inappropriate inhaler use: assessment of use and patient preference of seven inhalation devices. Respiratory Medicine. 2000;94(5):496–500.
25. Al-Showair RA, Tarsin WY, Assi KH, Pearson SB, Chrystyn H. Can all patients with COPD use the correct inhalation flow with all inhalers and does training help? Respiratory Medicine. 2007;101(11):2395–2401.
26. Al-Showair RA, Pearson SB, Chrystyn H. The potential of a 2Tone Trainer to help patients use their metered-dose inhalers. Chest. 2007;131(6):1776–1782.

27. Lavorini F, Magnan A, Dubus JC, *et al*. Effect of incorrect use of dry powder inhalers on management of patients with asthma and COPD. Respiratory Medicine. 2008;102(4):593–604.
28. Singh S, Loke YK, Enright PL, Furberg CD. Mortality associated with tiotropium mist inhaler in patients with chronic obstructive pulmonary disease: systematic review and meta-analysis of randomised controlled trials. BMJ. 2011;342:d3215.
29. Medicines and Healthcare products Regulatory Agency (MHRA). Drug safety update: Tiotropium inhalers. Available from: https://www.mhra.gov.uk/Safetyinformation/DrugSafetyUpdate/CON099869
30. Dhand R, Cavanaugh T, Skolnik N. Considerations for optimal inhaler device selection in chronic obstructive pulmonary disease. Cleveland Clinic Journal of Medicine. 2018;85(2 Suppl 1):S19–S27.
31. Capstick TG, Clifton IJ. Inhaler technique and training in people with chronic obstructive pulmonary disease and asthma. Expert Review of Respiratory Medicine. 2012;6(1):91–103.
32. Labiris N, Dolovich M. Pulmonary drug delivery. Part I: physiological factors affecting therapeutic effectiveness of aerosolized medications. British Journal of Clinical Pharmacology. 2003;56(6):588–599.
33. Bonini M, Usmani OS. The importance of inhaler devices in the treatment of COPD. COPD Research and Practice. 2015;1:9.
34. Laube BL, Janssens HM, de Jongh FH, *et al*. What the pulmonary specialist should know about the new inhalation therapies. European Respiratory Journal. 2011;37(6):1308–1331.
35. Dalby RN, Eicher J, Zierenberg B. Development of Respimat® Soft Mist™ inhaler and its clinical utility in respiratory disorders. Medical Devices (Auckland). 2011;4:145–155.
36. Ibrahim M, Verma R, Garcia-Contreras L. Inhalation drug delivery devices: technology update. Medical Devices (Auckland). 2015;8:131–139.
37. Usmani OS. Choosing the right inhaler for your asthma or COPD patient. Therapeutics and Clinical Risk Management. 2019;15:461–472.
38. Mahler DA. Peak inspiratory flow rate as a criterion for dry powder inhaler use in chronic obstructive pulmonary disease. Annals of the American Thoracic Society. 2017;14:1103–1107.
39. Mahler DA, Waterman LA, Gifford AH. Prevalence and COPD phenotype for a suboptimal peak inspiratory flow rate against the simulated resistance of the Diskus® dry powder inhaler. Journal of Aerosol Medicine and Pulmonary Drug Delivery. 2013;26:174–179.
40. Weiner P, Weiner M. Inspiratory muscle training may increase peak inspiratory flow in chronic obstructive pulmonary disease. Respiration. 2006;73:151–156.
41. Loh CH, Peters SP, Lovings TM, Ohar JA. Suboptimal inspiratory flow rates are associated with chronic obstructive pulmonary disease and all-cause readmissions. Annals of the American Thoracic Society. 2017;14:1305–1311.
42. García-Río F, Soler-Cataluña JJ, Alcazar B, Viejo JL, Miravitlles M. Requirements, strengths and weaknesses of inhaler devices for COPD patients from the expert prescribers' point of view: results of the EPOCA Delphi consensus. COPD. 2017;14:573–580.
43. Fink JB, Rubin BK. Problems with inhaler use: a call for improved clinician and patient education. Respiratory Care. 2005;50:1360–1375.
44. Dolovich MB, Ahrens RC, Hess DR, *et al*. Device selection and outcomes of aerosol therapy: evidence-based guidelines: American College of Chest Physicians/American College of Asthma, Allergy, and Immunology. Chest. 2005;127:335–371.
45. Voshaar T, App EM, Berdel D, *et al*. Recommendations for the choice of inhalatory systems for drug prescription. Pneumologie. 2001;55(12):579–586.
46. Chrystyn H. Is inhalation rate important for a dry powder inhaler? Using the In-Check Dial to identify these rates. Respiratory Medicine. 2003;97(2):181–187.
47. Nsour WM, Alldred A, Corrado J, Chrystyn H. Measurement of peak inhalation rates with an In-Check meter to identify an elderly patient's ability to use a Turbuhaler. Respiratory Medicine. 2001;95(12):965–968.
48. British Thoracic Society. The use of placebo inhaler devices, peak flow meters and inspiratory flow meters in clinical practice—practical recommendations. 2005. Available from: https://www.brit-thoracic.org.uk [Accessed 10 Nov 2015].
49. Dolovich MB, Ahrens RC, Hess DR, *et al*. Device selection and outcomes of aerosol therapy: Evidence-based guidelines: American College of Chest Physicians/American College of Asthma, Allergy, and Immunology. Chest. 2005;127(1):335–371.
50. Anderson P. Patient preferences for and satisfaction with inhaler devices. European Respiratory Review. 2005;14(96):109–116.
51. Crompton GK, Barnes PJ, Broeders M, *et al*. The need to improve inhalation technique in Europe: a report from the Aerosol Drug Management Improvement Team. Respiratory Medicine. 2006;100(9):1479–1494.
52. Gregory KL, Elliott D, Dunne P. Guide to aerosol delivery devices for physicians, nurses, pharmacists and other health care professionals. Available from: https://www.aarc.org/wp-content/uploads/2014/08/aerosol_guide_pro.pdf [Accessed 10 Nov 2015].
53. Lavorini F, Usmani OS. Correct inhalation technique is critical in achieving good asthma control. Primary Care Respiratory Journal. 2013;22:385–386.
54. Molimard M, Raherison C, Lignot S, Depont F, Abouelfath A, Moore N. Assessment of handling of inhaler devices in

real life: an observational study in 3811 patients in primary care. Journal of Aerosol Medicine. 2003;16:249–254.
55. Melani AS, Bonavia M, Cilenti V, Cinti C, Lodi M, Martucci P, Serra M, Scichilone N, Sestini P, Aliani M, Neri M. Inhaler mishandling remains common in real life and is associated with reduced disease control. Respiratory Medicine. 2011;105:930–938.
56. Sanchis J, Gich I, Pedersen S. Systematic review of errors in inhaler use: has patient technique improved over time? Chest. 2016;150:394–406.
57. Molimard M, Raherison C, Lignot S, Balestra A, Lamarque S, Chartier A, Droz Perroteau C, Lassalle R, Moore N, Girodet PO. Chronic obstructive pulmonary disease exacerbation and inhaler device handling: real-life assessment of 2935 patients. European Respiratory Journal. 2017;49. doi:10.1183/13993003.01794-2016.
58. Price DB, Roman-Rodriguez M, McQueen RB, Bosnic-Anticevich S, Carter V, Gruffydd-Jones K, Haughney J, Henrichsen S, Hutton C, Infantino A, *et al*. Inhaler errors in the CRITIKAL study: type, frequency, and association with asthma outcomes. Journal of Allergy and Clinical Immunology: In Practice. 2017;5:1071–1081.e1079.
59. Melani AS, Bonavia M, Cilenti V, Cinti C, Lodi M, Martucci P, Serra M, Scichilone N, Sestini P, Aliani M, Neri M. Inhaler mishandling remains common in real life and is associated with reduced disease control. Respiratory Medicine. 2011;105:930–938.
60. Lewis A, Torvinen S, Dekhuijzen PN, Chrystyn H, Watson AT, Blackney M, Plich A. The economic burden of asthma and chronic obstructive pulmonary disease and the impact of poor inhalation technique with commonly prescribed dry powder inhalers in three European countries. BMC Health Services Research. 2016;16:251.
61. Global Initiative for Chronic Obstructive Lung Disease. Pocket guide to COPD diagnosis, management and prevention. Available from: http://goldcopd.org/wp-content/uploads/2016/12/wms-GOLD-2017-Pocket-Guide.pdf [Accessed 26 May 2017].
62. Global Initiative for Asthma. Pocket guide for asthma management and prevention. Available from: http://ginasthma.org/2017-pocket-guide-for-asthma-management-and-prevention/ [Accessed 25 Jul 2017].
63. Al-Jahdali H, Ahmed A, Al-Harbi A, Khan M, Baharoon S, Bin Salih S, Halwani R, Al-Muhsen S. Improper inhaler technique is associated with poor asthma control and frequent emergency department visits. Allergy, Asthma & Clinical Immunology. 2013;9:8.
64. Deerojanawong J, Na Sakolnakorn VP, Prapphal N, Hanrutakorn C, Sritippayawan S. Evaluation of metered-dose inhaler administration technique among asthmatic children and their caregivers in Thailand. Asian Pacific Journal of Allergy and Immunology. 2009;27:87–93.
65. Wieshammer S, Dreyhaupt J. Dry powder inhalers: which factors determine the frequency of handling errors? Respiration. 2008;75:18–25.
66. Dalcin PTR, Grutcki DM, Laporte PP, de Lima PB, Menegotto SM, Pereira RP. Factors related to the incorrect use of inhalers by asthma patients. Jornal Brasileiro de Pneumologia. 2014;40:13–20.
67. Westerik JA, Carter V, Chrystyn H, Burden A, Thompson SL, Ryan D, Gruffydd Jones K, Haughney J, Roche N, Lavorini F, *et al*. Characteristics of patients making serious inhaler errors with a dry powder inhaler and association with asthma-related events in a primary care setting. Journal of Asthma. 2016;53:321–329.
68. Camilleri K, Balzan M, Bardon MP, Schembri E, Sullivan M, Mifsud S, Muscat D, Asciaq R, Montefort S. Predictors of good inhaler technique in asthma and COPD. European Respiratory Journal. 2015;46:A-P3928.
69. Sadowski C, Banh H, Cor K, Cave A. Inhaler device technique in community dwelling older adults. Canadian Journal of Hospital Pharmacy. 2013;66(4):269.
70. Dalcin PTR, Grutcki DM, Laporte PP, de Lima PB, Menegotto SM, Pereira RP. Factors related to the incorrect use of inhalers by *asthma* patients. J Bras Pneumol. 2014;40:13-20.
71. Ehteshami-Afshar S, FitzGerald JM, Doyle-Waters MM, Sadatsafavi M. The global economic burden of *asthma* and chronic obstructive pulmonary disease. Int J Tuberc Lung Dis. 2016 Jan;20(1):11-23.
72. Quaderi SA, Hurst JR. The unmet global burden of *COPD*. Glob Health Epidemiol Genom. 2018;3:e4.
73. Prince MJ, Wu F, Guo Y, Gutierrez Robledo LM, O'Donnell M, Sullivan R, *et al*. The burden of disease in older people and implications for health policy and practice. Lancet. 2015 Mar 7;385(9967):549-562.
74. van Boven JFM, Chavannes N, van der Molen T, Rutten-van Mölken MPMH, Postma M, Vegter S. Clinical and economic impact of non-adherence in *COPD*: a systematic review. Respir Med. 2014 Jan;108(1):103-113.
75. Mäkelä MJ, Backer V, Hedegaard M, Larsson K. Adherence to inhaled therapies, health outcomes and costs in patients with *asthma* and *COPD*. Respir Med. 2013 Oct;107(10):1481-1490.
76. Murphy AC, Proeschal A, Brightling CE, Wardlaw AJ, Pavord I, Bradding P, *et al*. The relationship between clinical outcomes and medication adherence in difficult-to-control *asthma*. Thorax. 2012 Aug;67(8):751-753.
77. George M, Bender B. New insights to improve treatment adherence in *asthma* and *COPD*. Patient Prefer Adherence. 2019;13:1325-1334.
78. Rubin BK. What does it mean when a patient says, “my *asthma* medication is not working?”. Chest. 2004 Sep;126(3):972-981.
79. Lavorini F, Magnan A, Dubus JC, Voshaar T, Corbetta L, Broeders M, *et al*. Effect of incorrect use of dry powder inhalers on management of patients with *asthma* and *COPD*. Respir Med. 2008 Apr;102(4):593-604.
80. Chorão P, Pereira A, Fonseca J. Inhaler devices in *asthma* and *COPD*—an assessment of inhaler technique and patient preferences. Respir Med. 2014 Jul;108(7):968-975.

81. Sabaté EE. Adherence to long-term therapies: evidence for action. Geneva: World Health Organization; 2003. Available from: http://apps.who.int/iris/bitstream/handle/10665/42682/9241545992.pdf?sequence=1 [accessed 2022-05-30].
82. Melani AS, Bonavia M, Cilenti V, Cinti C, Lodi M, Martucci P, Gruppo Educazionale Associazione Italiana Pneumologi Ospedalieri. Inhaler mishandling remains common in real life and is associated with reduced disease control. Respir Med. 2011 Jun;105(6):930-938.
83. Lavorini F, Magnan A, Dubus JC, *et al*. Effect of incorrect use of dry powder inhalers on management of patients with *asthma* and *COPD*. Respir Med. 2008;102(4):593-604.
84. Murphy AC, Proeschal A, Brightling CE, *et al*. The relationship between clinical outcomes and medication adherence in difficult-to-control *asthma*. Thorax. 2012;67(8):751-753.
85. Carrion Valero F, Maya Martinez M, Fontana Sanchis I, Diaz Lopez J, Marin PJ. Inhalation technique in patients with chronic respiratory diseases. Arch Bronconeumol. 2000;36(5):236-240.
86. Girodet PO, Raherison C, Abouelfath A, *et al*. Real-life use of inhaler devices for chronic obstructive pulmonary disease in primary care. Therapie. 2003;58(6):499-504.
87. Molimard M, Raherison C, Lignot S, Depont F, Abouelfath A, Moore N. Assessment of handling of inhaler devices in real life: an observational study in 3811 patients in primary care. J Aerosol Med. 2003;16(3):249-254.
88. Pothirat C, Chaiwong W, Phetsuk N, Pisalthanapuna S, Chetsadaphan N, Choomuang W. Evaluating inhaler use technique in *COPD* patients. Int J Chron Obstruct Pulmon Dis. 2015;10:1291-1298.
89. Price D, Keininger DL, Viswanad B, Gasser M, Walda S, Gutzwiller FS. Factors associated with appropriate inhaler use in patients with *COPD*—lessons from the REAL survey. Int J Chron Obstruct Pulmon Dis. 2018;13:695-702.
90. Himes BE, Weitzman ER. Innovations in health information technologies for chronic pulmonary diseases. Respir Res. 2016;17:38.
91. Poudel RS, Shrestha S, Bhatta P, Piryani RM. Do face-to-face training and telephonic reminder improve dry powder inhaler technique in patients with *COPD*? Int J Telemed Appl. 2017;2017:5091890.
92. Giraud V, Roche N. Misuse of *corticosteroid* metered-dose inhaler is associated with decreased *asthma* stability. Eur Respir J. 2002;19(2):246-251.
93. van der Molen T, van Boven JF, Maguire T, Goyal P, Altman P. Optimizing identification and management of *COPD* patients—reviewing the role of the community pharmacist. Br J Clin Pharmacol. 2017;83:192-201.
94. Jia X, Zhou S, Luo D, Zhao X, Zhou Y, Cui YM. Effect of pharmacist-led interventions on medication adherence and inhalation technique in adult patients with *asthma* or *COPD*: a systematic review and meta-analysis. J Clin Pharm Ther. Published online 2020 Feb 27. doi:10.1111/jcpt.13126.
95. Makhinova T, Walker BL, Gukert M, Kalvi L, Guirguis LM. Checking inhaler technique in the community pharmacy: predictors of critical errors. Pharmacy (Basel). 2020;8:6.
96. American Pharmacists Association Foundation. White paper on expanding the role of pharmacists in chronic obstructive pulmonary disease: American Pharmacists Association Foundation. J Am Pharm Assoc (2003). 2011;51:203-211.
97. Lareau SC, Hodder R. Teaching inhaler use in chronic obstructive pulmonary disease patients. J Am Acad Nurse Pract. 2012;24:113-120.
98. Dougall S, Bolt J, Semchuk W, Winkel T. Inhaler assessment in *COPD* patients: a primer for pharmacists. Can Pharm J (Ott). 2016;149:268-273.
99. Bryant J, McDonald VM, Boyes A, Sanson-Fisher R, Paul C, Melville J. Improving medication adherence in chronic obstructive pulmonary disease: a systematic review. Respir Res. 2013;14:109.
100. van Boven JF, Ryan D, Eakin MN, *et al*. Enhancing respiratory medication adherence: the role of health care professionals and cost-effectiveness considerations. Journal of Allergy and Clinical Immunology: In Practice. 2016;4:835-846.
101. Sulaiman I, Cushen B, Greene G, *et al*. Objective assessment of adherence to inhalers by patients with chronic obstructive pulmonary disease. American Journal of Respiratory and Critical Care Medicine. 2017;195:1333-1343.
102. van Boven JF, Ryan D, Eakin MN, *et al*. Enhancing respiratory medication adherence: the role of health care professionals and cost-effectiveness considerations. Journal of Allergy and Clinical Immunology: In Practice. 2016;4:835-846.
103. Price D, Keininger DL, Viswanad B, Gasser M, Walda S, Gutzwiller FS. Factors associated with appropriate inhaler use in patients with COPD—lessons from the REAL survey. International Journal of Chronic Obstructive Pulmonary Disease. 2018;13:695-702.
104. Chan AH, Harrison J, Black PN, Mitchell EA, Foster JM. Using electronic monitoring devices to measure inhaler adherence: a practical guide for clinicians. Journal of Allergy and Clinical Immunology: In Practice. 2015;3:335-349.e1-e5.
105. Baba R, Nakachi I, Masaki K, *et al*. Repetitive instructions at short intervals contribute to the improvement of inhalation technique. Asia Pacific Allergy. 2020;10:e19.
106. Tommelein E, Mehuys E, Van Hees T, *et al*. Effectiveness of pharmaceutical care for patients with chronic obstructive pulmonary disease (PHARMACOP): a randomized controlled trial. British Journal of Clinical Pharmacology. 2014;77:756-766.
107. Dougall S, Bolt J, Semchuk W, Winkel T. Inhaler assessment in COPD patients: a primer for pharmacists.

Canadian Pharmacists Journal (Ottawa). 2016;149:268-273.
108. Plaza V, Fernández-Rodríguez C, Melero C, *et al*. Validation of the Test of the Adherence to Inhalers (TAI) for asthma and COPD patients. Journal of Aerosol Medicine and Pulmonary Drug Delivery. 2016;29(2):142-152. doi:10.1089/jamp.2015.1212.
109. Maya RM, Nona S. Assessment of rotahaler inhalation technique among patients with COPD or asthma at Manipal teaching hospital, Pokhara. International Journal of Nursing Education. 2018;10(3):91. doi:10.5958/0974-9357.2018.00074.0.
110. Shrestha S, Shrestha S, Baral MR, *et al*. Evaluation of inhalation technique in patients using a dry powder device (DPI) at chest clinic in Dhulikhel Hospital – Kathmandu. Clinical Medicine. 2019;19(Suppl 3):64-66. doi:10.7861/clinmedicine.19-3s-s64.
111. Poudel R, Shrestha S, Asfaw D, Lamichhane P, Karki S, Maskey D. Inhaler competence in Nepalese patients with asthma and chronic obstructive pulmonary disease: a systematic review. Journal of the Nepal Health Research Council. 2022;20(2):279-288.
112. Ozoh OB, Eze JN, Garba BI, Ojo OO, Okorie EM, Yiltok E, *et al*. Nationwide survey of the availability and affordability of asthma and COPD medicines in Nigeria. Tropical Medicine and International Health. 2021;26(1):54-65.
113. Hesso I, Gebara SN, Kayyali R. Impact of community pharmacists in COPD management: inhalation technique and medication adherence. Respiratory Medicine. 2016;118:22-30.
114. Mes MA, Katzer CB, Chan AHY, Wileman V, Taylor SJC, Horne R. Pharmacists and medication adherence in asthma: a systematic review and meta-analysis. European Respiratory Journal. 2018;52(2):1800485.
115. Covvey JR, Mullen AB, Ryan M, Steinke DT, Johnston BF, Wood FT, *et al*. A comparison of medication adherence/persistence for asthma and chronic obstructive pulmonary disease in the United Kingdom. International Journal of Clinical Practice. 2014;68(10):1200-1208.
116. Rand C, Nides M, Cowles M, Wise R, Connett J; Lung Health Study Research Group. Long-term metered-dose inhaler adherence in a clinical trial. American Journal of Respiratory and Critical Care Medicine. 1995;152(2):580-588.
117. Kaae S, Sporrong SK. Patients' reasons for accepting a free community pharmacy asthma service. International Journal of Clinical Pharmacy. 2015;37:917-924.
118. Kaae S, Aarup KH, Sporrong SK. Patient responses to inhaler advice given by community pharmacies: the importance of meaningfulness. Research in Social and Administrative Pharmacy. 2017;13:364-368.
119. Basheti I, Reddel HK, Armour CL, Bosnic-Anticevich SZ. Pharmacists' understanding of patient education on metered-dose inhaler technique. Annals of Pharmacotherapy. 2000;34(11):1249-1256.
120. van der Palen J, Klein JJ, van Herwaarden CL, Zielhuis GA, Seydel ER. Multiple inhalers confuse asthma patients. European Respiratory Journal. 1999;14:1034-1037.
121. Bosnic-Anticevich S, Chrystyn H, Costello RW, Dolovich MB, Fletcher MJ, Lavorini F, *et al*. The use of multiple respiratory inhalers requiring different inhalation techniques has an adverse effect on COPD outcomes. International Journal of Chronic Obstructive Pulmonary Disease. 2017;12:59-71.
122. Levy ML, Dekhuijzen PN, Barnes PJ, Broeders M, Corrigan CJ, Chawes BL, *et al*. Inhaler technique: facts and fantasies. A view from the Aerosol Drug Management Improvement Team (ADMIT). NPJ Primary Care Respiratory Medicine. 2016;26:16017.
123. Durr S, Hersberger KE, Zeller A, Scheuzger J, Miedinger D, Gregoriano C, *et al*. The Integrated Care of Asthma in Switzerland (INCAS) Study: changes in asthma control and perception of health care through asthma education. Respiration. 2017;94(5):416-423.
124. Guenette L, Breton MC, Gregoire JP, Hobin MS, Bolduc Y, Boulet LP, *et al*. Effectiveness of an asthma integrated care program on asthma control and adherence to inhaled corticosteroids. Journal of Asthma. 2015;52(6):638-645.