

# Caregivers' knowledge and practice of inhalation medications in asthmatic children in a tertiary center in Addis Ababa

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## Abstract

**Background:** Aerosol therapy is the cornerstone of treatment for childhood respiratory disorders, including asthma. Inhalation therapy and correct use of devices are not intuitive, and repeated training is essential. There is limited data on caregivers' inhalational knowledge and practice in asthmatic children in low-resource settings.

**Objectives:** The aim of this study was to assess caretakers' knowledge and practice of inhalation technique among asthmatic children at St. Paul's Hospital Millennium Medical College (SPHMMC).

**Methods:** Using a structured questionnaire, a hospital-based cross-sectional study was conducted among all caregivers of asthmatic children at SPHMMC chest clinic from April 2021 to August 2021. Data analysis was done by SPSS version 26. The chi-square test and logistic regression were applied as appropriate.

**Results:** The study included 86 caregivers of asthmatic children, 53 (61.6%) children were between 1-5 years, and 46 (53.6%) were female. Spacers were used only in 63.0 % of the children. The caregivers' knowledge on the proper use of inhalation medications was suboptimal, with good knowledge only for shaking metered dose inhalers (MDI) before use (90.0%), compared to less than 50.0% knowledge in most others. Inhalation practice was good in 53.0% of participants. The most common error was not completely exhaling before placing the apparatus in the mouth. The other common mistakes include failing to hold breath after inhaling and not waiting 30 to 60 seconds before the next dose. Only the duration of inhalation treatment was independent predictor of the practice of the inhalation technique.

**Conclusion:** This study revealed a low level of knowledge and practice towards inhalational medication use by caregivers of pediatric asthma patients, and the longer duration of inhalation use was directly related to the correct practice of inhalation. Pediatric asthma care providers should emphasize improving caregivers' inhalation techniques to optimize the delivery of asthma medications in the study setting.

**Keywords:** Aerosols, Asthma, Caregivers, Child, Inhaler devices

## Background

Aerosol therapy is the cornerstone of treatment for many respiratory disorders in children, including those with asthma, cystic fibrosis, croup, and bronchopulmonary dysplasia (1). An inhaled route provides a more rapid onset of action within the target organ than other administration methods, with a lower dose needed for an equivalent effect and the advantage of reducing systemic side effects (1).

Inhaled medications are delivered as aerosolized metered dose inhaler (MDI), dry powder inhaler (DPI), or via a nebulizer. Spacer devices, recommended for the administration of all MDI medications, are simple and inexpensive tools that (i) decrease the need for coordination, especially in young children, (ii) improve the delivery of the drug to the lower airways, and (iii) minimize the risk of oropharyngeal adverse effects (dysphonia and thrush) (2). The optimal inhalation technique for each puff of MDI-delivered medication is a slow (5 sec) inhalation, followed by a 5–10 sec breath hold. Since preschool children cannot perform this inhalation technique, MDI medications in this age group are delivered with a spacer and mask, using a different technique. Each puff is administered with regular breathing for up to 30 seconds, or 5–10 breaths, and a tight seal must be maintained (2). Correct use of current portable devices is not intuitive that repeated training is often essential for optimal use (1). Low-cost plastic bottle spacers and commercial spacers may produce equivalent clinical responses when appropriately used to deliver bronchodilators in young children with acute lower airway obstruction (3).

Incorrect inhaler technique is common, as high as 80 % among children, which results in suboptimal disease control, school absences, unnecessary increases in medication dosage, exacerbations requiring corticosteroid, and potential drug side effects (1,4). Evidence also shows that teaching children the proper use of inhalers during every consultation effectively improves technique (5).

Furthermore, if not repeatedly practiced, correct inhalation technique deteriorates over time (6). Most mistakes are committed by patients whose only source of information consists of the contents of the package insert. Patients on pressurized MDI (pMDI) without spacer devices are also more likely to make mistakes in the inhalation therapy than those using spacer devices (7-9).

Despite a handful of data on the knowledge and practice of inhalation therapy in asthmatic children from the rest of the world (10–12), there are limited studies assessing caregivers' knowledge and practice in Ethiopia (13). A recent review and meta-analysis from Ethiopia documented poor inhalation technique as one of the limiting factors for optimal asthma control (14). However, the review included only studies in adult asthmatics with no data on pediatric asthma inhalation and control. The pediatric inhalation technique is different from adults. It is important to study the determinants and practice in those age groups specifically (5-9).

Asthma is the most common chronic disease in children affecting 12 % of children worldwide and 9.1 % in Ethiopia. Thus, the impact of optimal asthma control is of paramount importance for all stakeholders that we aimed to assess caregivers' knowledge and practice of inhalational technique among asthmatic children in Addis Ababa to identify knowledge and practice gaps to help improve asthma control (15-17).

## Methods and materials

### Study setting, design, period, and population

The study was conducted in Saint Paul's Hospital Millennium Medical College (SPHMMC) outpatient pediatric chest clinic. The pediatric department has more than 100 beds, and there is twice-weekly follow-up for pediatric pulmonary patients, including asthma. The clinics are run by a team of clinicians, including two pulmonary and critical care specialists, assisted by senior pediatric residents, nursing and other staffs. A total of 80-100 asthmatic children are seen in the clinic monthly. Most are followed every 2-4 months' interval based on their asthma control level. The study site was selected for the presence of an organized clinic dedicated to follow asthmatic children under the guidance of pediatric pulmonologists.

A hospital-based cross-sectional study was conducted over a five-month period (April 1, -2021 to August 30, 2021). The study population was all caregivers of pediatric patients (1–16 years) attending follow-up chest clinics with physician-diagnosed asthma on follow-up with prescribed inhaler medication. All parents/caregivers of children aged 1–16 who were on prescribed inhaler medications for asthma for at least 3 months and visited the chest clinics of SPHMMC were eligible

for inclusion. Patients with other cardiorespiratory comorbidities, those with an unclear diagnosis despite a trial of treatment, and children brought by attendants not directly involved in the child's daily care were excluded from the study. All parents/caregivers of children who fulfill the eligibility criteria and attended the clinic during the study period were enrolled consecutively.

## Data collection and tools

Data was collected by interviewing caretakers by using a validated questionnaire and standard tools to assess their knowledge, and a standardized tool was used to assess their practice of inhalation (18). The practice was assessed by observation of the caregivers while they demonstrate the inhalation skills. The questionnaire was prepared in English and Amharic and was modified based on pretest results before the study. The investigator rechecked the data collection to ensure completeness and accuracy. As the study was observational, no instructions were given to the study subjects prior to the assessment.

Data collectors were 2nd year pediatric residents who were trained on the questionnaire and tool. The study used a tool called the Inhaler Device Assessment Tool (IDAT) to assess practice, which is used to train nurses, respiratory therapists, and children and their families (18). Empty medications with plastic spacers and a mask or mouthpiece were used for demonstration of the technique by patients or caregivers as used regularly by the child. Seven specific questions assessed knowledge of inhalational technique according to American Thoracic Society specifications on MDI use (19).

## Study variables and operational definitions

Knowledge and practice of inhalation were the dependent variables, while the independent variables were patients' or caregivers': age, sex, education status, socioeconomic status, place of residence, duration of illness, duration of inhaler use, person administering the medication, spacer used or not, previous training, checking technique during every follow-up.

**Spacer** is an add-on device used to increase the ease of administering aerosolized medication from an MDI. Spacers can be conventional or made from plastic bottles.

**Knowledge** refers to the caregivers' general understanding or familiarity with inhalational techniques.

**Good knowledge** refers to understanding and being familiar with the specific steps of the technique. Those who responded to the knowledge questions correctly are classified to have good knowledge.

**Poor knowledge** refers to not understanding and not being familiar with the specific steps of the technique. Those who responded to the knowledge questions incorrectly are classified to have poor knowledge.

**Practice** refers to the caregivers' skill of properly applying all the required steps in the inhalational technique.

**Caregivers** are defined as parents or family members who are primarily responsible in the care of the child

IDAT lists five critical steps applicable to several inhaler devices used by children. These steps involve preparing and priming the device (for example, removing the cap and shaking the inhaler) and the actions required from the patient (exhaling, inhaling, and holding breath). It has specific scoring criteria for each of the five critical steps. These five steps are critical for both the assessment of the patient's technique and for teaching optimal inhaler technique. Each of the five steps for all forms of the IDAT is scored as 1 or 0.

A step is scored as "1" if no errors are made for that step. A step is scored as "0" if there is at least one error in performing that step.

The scores for the five steps are then added, for a total possible maximum score of 5, and a minimum score of 0.

The IDAT can be used for the following devices: a metered dose inhaler (MDI) alone, a MDI with spacer, or a MDI with spacer plus mask, depending on their age group. All forms include the same five critical steps, and the specific criteria for whether to score the step as 1 or 0 differ depending on the device and the child's age, as indicated in the forms.

**Scoring system:** The mean score was calculated for the practical skill, and if scored above the mean, it was labeled as good practice, and below the mean, it was labeled as poor practice. However, we did not calculate a composite score for the knowledge variables.

## Data Processing and Analysis

After data collection, it was checked for completeness and entered into SPSS Version 26. Descriptive statistics were used to describe the independent variables. If outliers and missed values were found

during exploration, causes were determined, and if not, variables with missing value(s) and outliers were dropped from analysis. A bivariate and multivariable analysis was done to see the association between dependent and independent variables. A confidence limit of 95% and a p-value less than 0.05 were used as the cutoff to see the presence of statistical significance. Stepwise multiple logistic regression analysis was done to control the effect of confounding variables, and adjusted odds ratios (AORs) were used to explore the real association.

Sensitivity, specificity, positive and negative predictive values of the screening test were compared with the gold standard laboratory PCR test results using two by two matrix of measure of diagnostic validity (15).

## Results

### Socio-demographic characteristics of participants

Caregivers are the main providers of the inhalation technique. Caregivers of 86 children (46, 53.6 % females) were included; fifty-three (61.6%) children were between 1-5 years. In 42 cases (48.8%), parental education was completed in primary school. Seventy-seven (90.7%) were urban dwellers (see table 1 below).

Table1: Socio-demographic characteristics of patients and caregivers at SPHMMC, April 1-2021 to August 30-2021.

Variables	Response category	Frequency(n)	Percentage (%)
Child Age	1-5 years	53	61.6
	6-10years	28	32.6
	11-16 years	5	5.8
Child Sex	Male	40	46.5
	Female	46	53.5
Educational level of caregivers	No formal education	13	15.1
	Primary education	42	48.8
	Secondary education	18	20.9
	Higher education	13	15.1
Residence	Urban	78	90.7
	Rural	8	9.3
Caregivers Monthly Income	500-2000ETB	37	43
	2000-3500 ETB	13	15.1
	>3500 ETB	36	41.9

### Characteristics related to the use of inhalers

Thirty-eight (44.2%) had both diagnoses for asthma and used inhaler medication for 3–12 months. However, only 54 (62.8%) of the children used spacers. Caregivers administered inhaler medications in 68 (79.1%), and 83 (96.5%) are trained or educated on inhaler use. Of those who are trained, 75 (90.3%) and 81 (97.5%) were taught by physicians and obtained the education through demonstration, respectively. Among those who did not take training, 2 (67.0%)

learned through relatives using inhaler medications. Fifty (58.6%) responded that their technique was checked during every follow-up appointment (Table 2).

Table 2: Characteristics related to the use of inhalers by caregivers of asthmatic children at SPHMMC, April 1, 2021, to August 30, 2021.

Variables	Response category	Frequency(n=86)	Percentage (%)
Duration of asthma since diagnosis	3-12 months	38	44.2
	12-24 months	22	25.6
	>24 months	26	30.2
Duration of inhaler use	3-12 months	38	44.2
	12-24 months	22	25.6
	>24 months	26	30.2
Use of spacer	Yes	54	62.8
	No	32	37.2
Person administering inhaler medication	Child (Self)	18	20.9
	Caregiver	68	79.1
Trained/educated of inhaler use	Yes	83	96.5
	No	3	3.5
Inhalation taught by	Nurse	1	1.2
	Physician	75	90.4
	Both	7	8.4
Way of inhalation training	Demonstration	81	97.6
	Leaflets	2	2.4
No formal training of inhalation but learnt how to use inhaler	Common sense	1	33.3
	Relatives using inhaler medications	2	66.7
Inhalational technique checked at follow up	Yes	50	58.1
	No	36	41.9

### Knowledge about inhalational techniques

Seventy-seven (89.5%) participants responded that shaking the inhaler before use should be done. Inhalation should be done through both the mouth and the nose, according to 52 (60.5%) of those polled. From those using mouthpieces, 34 (39.5%) responded that the mouthpiece should be placed in the mouth. Among those using a mask, 45 (52.3%) responded that the mask should be placed both on the nose and mouth. Moreover, 45 (52.3%), 48 (55.8%), 54 (62.8%), and 40 (46.5%) of the participants responded that the mask should fit the face, the mouth should not be rinsed after inhaling, the inhaler/spacer has to be cleaned, and shaking is the method of checking the remaining doses of the inhaler, respectively (Supplement Table 1).

### The practice of inhalational medication

The mean practice score was 3.38 (SD = 1.33). Forty-six (53.5%) had good practice of use of inhalational medication (Supplement Table 2). The most common error was failing to completely exhale before inserting the apparatus into the mouth, followed by failing to hold breathe after inhaling and failing to wait 30-60 seconds before repeating the next dose.

## Factors associated with poor inhalation practice and knowledge

For the evaluation of associated factors, bivariate and multivariable logistic regression (LR) were used. Four variables were found to have a p-value of less than 0.25 in the bivariate LR analysis and were included in the multivariable model. Finally, only one variable in the final model had a P value of 0.05 and showed a statistically significant association with poor practice. Patients who had been using the inhaler medication for 3-12 months as compared to those who used it for >24 months had a 4.38-fold increased odds of poor practice [AOR, 4.38, 95% CI, (1.34, 14.14)] (Table 3). Factors associated with caregivers' knowledge was not evaluated as a composite score; however, taking the single variables of knowledge, only knowledge of shaking the MDI (AOR 7.00(CI 1.53, 31.87.), and regular checking of the inhalation technique (AOR 6.12 (CI 1.06, 35.05)) were associated with level of caregiver education.

## Discussion

This study assessed the knowledge and practice of inhalation techniques among caregivers of children with asthma and associated factors. The study demonstrated both insufficient knowledge of inhalation and common practice techniques. When compared to children with more than 2 years of aerosol therapy and/or asthma diagnosis, patients who had used aerosol medications for a shorter period had more than four times the odds of poor practice [AOR, 4.38, 95% CI, (1.34, 14.14)]. This is consistent with repeated use improving device technique accuracy and most likely regular provider training at each visit (5-9). The most commonly observed error by patients and caregivers in our study, not exhaling completely before putting on the apparatus and no good mask fitting, was also similar to a research

from Portugal on the assessment of asthmatic children's inhalation technique (6), but differed from a study in children from Gondar, Ethiopia. Because the majority of (53 (61.6%)) asthmatic children in our study were under-five, and the caregivers administering inhalation medications in 68 (79.1%), the decision to use spacer devices and the involvement of caregivers with clear and straightforward instructions on when and how to use inhaler medications is critical (1,4). The finding of our study on good practice (54%) was slightly higher than a study from Kenya (45% good practice), and a clear explanation is difficult (20), but both are generally much below the new target of asthma control (21, 22). This low level of knowledge and practice of inhalation compromises asthma control in patients (14, 15, 21). Asthma providers must emphasize on optimal training and demonstration of proper inhalation technique of caregivers of pediatric asthma patients (14, 21, 22).

## Limitations of the study

This study has several limitations. First, it was a cross-sectional study conducted partly with interviews of caregivers, indicating that recall bias is possible. Second, it was a single tertiary center study with a small sample size, although higher than previous local studies. Third, generalizability is also limited as the setting and patient population may not be the same with most Ethiopian children with asthma, who are from rural areas and are mainly cared for by primary providers. Despite those limitations, the study alerts and helps guide pediatric asthma practitioners to optimize inhalation technique, and may alert other stakeholders at different levels on the need of interventions to optimize knowledge and practice of pediatric asthma caregivers' inhalation technique. Further large scale studies evaluating effective interventions to improve caregivers' knowledge and practice of inhalation therapy are warranted.

Table 3: Bivariate and multivariable LR analyses of factors associated with poor inhalation practice at SPHMMC pediatric chest clinic, April-August 2021.

Variables	Practice Category		COR (95%CI)	AOR (95%CI)	P-value
	Poor, n (%)	Good, n (%)			
Age of the patient					
1-5 years	28 (70%)	25 (54.3%)	4.480 (0.469,42.791)	10.2 (862,120.241)	0.193
Care taker/parents level of education					
No formal education	8 (20%)	5 (10.9%)	3.6 (0.710,18.254)	5.772 (0.889,37.467)	0.122
primary education	23 (57.5%)	19 (41.3%)	2.724 (0.724, 10.25)	2.468 (0.597,10.202)	0.138
Duration of inhaler medication use					
3-11months	23 (57.5%)	15 (36.2%)	4.162 (1.408, 2.299)	4.348 (1.337,14.138)**	0.01*
12-24months	10 (25%)	12 (26.1%)	2.262 (0.677,7.557)	1.947 (0.520,7.288)	0.185
>24 months	7 (17.5%)	19 (41.3%)	1	1	1

\*p-value <0.05, \*\* Variables statistically significantly associated with poor practice

## Conclusion

In conclusion, the knowledge and practice of inhalation therapy among caregivers of asthmatic children is suboptimal in our setting, and require optimal evaluation and interventions to improve their knowledge and practice. Pediatricians and primary care physicians taking care of asthmatic children should assess the inhalation technique of children prescribed with inhaler devices to guarantee its correct use, which is essential for optimal asthma control.

## Abbreviations

DPI: Dry Powder Inhaler

IDAT: Inhaler device assessment tool

MDI: Metered Dose Inhaler

pMDI: Pressurized Metered Dose Inhaler without Spacer

SPHMMC: Saint Paul's Hospital Millennium Medical College

## Declarations

### Consent for publication

Participants consented for unanimous sharing of compiled data as approved by the IRB of the college at SPHMMC.

### Ethical declaration

The study was approved by SPHMMC's Institutional Review Board (IRB). Informed written consent was obtained from parents/primary caregivers, and assent was obtained verbally from older children over 10 years of age and practicing inhalation under supervision by their caregiver. The study was conducted based on the approved protocol following the Helsinki Declaration principles.

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### Authors' contributions

EW conceptualized the research problem, designed the study, conducted fieldwork, collected and data analyzed, and drafted the manuscript. AYW was involved in conceptualization, preparing the research proposal, and revising the final manuscript. All authors of the manuscript have read and agreed to its content.

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## Competing interest

All authors read and approved the final manuscript. The authors declare that they have no competing interests.

## Availability of Data and Materials

The datasets used in the current study or data collection tool are available from the corresponding author with a reasonable request.

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