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Original Research Article

ASTHMA CONTROL AND INHALER TECHNIQUE ASSESSMENT IN CHILDREN ATTENDING A TERTIARY CARE HOSPITAL

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ABSTRACT

Background: Poor asthma control in children is frequently associated with incorrect inhaler technique, leading to increased morbidity and healthcare utilization. Despite availability of effective medications, improper device use remains a major barrier to optimal asthma management. The objective is to assess the level of asthma control and evaluate inhaler technique among children with bronchial asthma attending a tertiary care hospital, and to determine the association between inhaler technique and asthma control.

Materials and Methods: A cross-sectional observational study was conducted over 12 months in the pediatric outpatient department of a tertiary care hospital. Children aged 5–15 years with physician-diagnosed asthma on inhaler therapy for at least 3 months were enrolled. Asthma control was assessed using the Childhood Asthma Control Test (C-ACT/ACT). Inhaler technique was evaluated using a standardized stepwise checklist. Associations were analyzed using chi-square test and logistic regression.

Results: A total of 120 children were included. Well-controlled asthma was observed in 38.3%, partially controlled in 34.2%, and poorly controlled in 27.5% of children. Incorrect inhaler technique was identified in 46.7% of participants. Poor asthma control was significantly associated with incorrect inhaler technique ($p<0.001$). On multivariate analysis, incorrect inhaler technique (Adjusted OR 3.6; 95% CI 1.8–7.2) and irregular follow-up (Adjusted OR 2.4; 95% CI 1.1–5.1) were independent predictors of poor control.

Conclusion: Nearly half of asthmatic children demonstrated incorrect inhaler technique, which was significantly associated with poor asthma control. Regular assessment and reinforcement of inhaler technique should be an integral part of pediatric asthma management.

Keywords: Pediatric asthma, Asthma control, Inhaler technique, C-ACT, Metered dose inhaler.

INTRODUCTION

Bronchial asthma is one of the most common chronic respiratory diseases in children and represents a significant cause of morbidity worldwide. It is characterized by chronic airway inflammation, reversible airflow limitation, and recurrent episodes of wheezing, breathlessness, chest tightness, and cough.[1] Globally, asthma affects an estimated 339 million people, with a substantial proportion being children, and its prevalence continues to rise in urban and developing regions.[2] In India, the burden of pediatric asthma contributes significantly to school absenteeism, emergency department visits, and impaired quality of life.[3]

Effective asthma management relies on long-term anti-inflammatory therapy and appropriate use of inhaled medications. Inhaled corticosteroids and bronchodilators delivered via metered-dose inhalers (MDIs) or dry powder inhalers (DPIs) form the cornerstone of treatment 1.[4] However, optimal therapeutic response depends heavily on correct inhaler technique. Improper inhaler use leads to

inadequate drug deposition in the lower airways and poor symptom control.[5]

Multiple studies have demonstrated that incorrect inhaler technique is common among children and their caregivers, even among those receiving regular treatment.[6,7] Errors such as failure to shake the inhaler, improper coordination between actuation and inhalation, inadequate breath holding, and poor spacer seal significantly reduce medication delivery.[8] Despite repeated instructions, technique errors persist, suggesting a need for regular reassessment and reinforcement.

Asthma control refers to the degree to which symptoms are minimized and normal activity is maintained. The Childhood Asthma Control Test (C-ACT) and Asthma Control Test (ACT) are validated, widely used tools for assessing control status in children.[9] Poor asthma control has been associated with incorrect inhaler technique, poor adherence, irregular follow-up, and lack of structured education.[10]

International guidelines, including the Global Initiative for Asthma (GINA), emphasize periodic assessment of inhaler technique as a fundamental component of asthma management.[4] However, real-world data from tertiary care centers in developing countries suggest that inhaler technique assessment is often overlooked during routine outpatient visits.

Given the potential impact of inhaler misuse on disease control, the present study was undertaken to assess asthma control status and evaluate inhaler technique among children with bronchial asthma attending a tertiary care hospital, and to determine the association between inhaler technique and level of asthma control.

MATERIALS AND METHODS

This cross-sectional observational study was conducted in the pediatric outpatient department of a tertiary care teaching hospital over a period of 12 months. Children aged 5–15 years with physician-diagnosed bronchial asthma and receiving inhaler therapy for at least three months were included. Children with other chronic respiratory illnesses, congenital heart disease, or acute severe exacerbation requiring hospitalization were excluded.

After obtaining written informed consent from parents or guardians, demographic details including age, sex, duration of asthma, family history, and follow-up status were recorded. Asthma control was assessed using the Childhood Asthma Control Test (C-ACT) for children aged 5–11 years and ACT for those aged ≥12 years. Scores ≥20 were considered well-controlled, 16–19 partially controlled, and ≤15 poorly controlled.

Inhaler technique was assessed by direct observation using a standardized checklist based on recommended steps for metered-dose inhaler (with spacer) or dry powder inhaler use. Each correct step was scored as 1 and incorrect as 0. Technique was classified as correct if all critical steps were performed properly. Errors in critical steps such as shaking the inhaler, proper seal, timing of actuation and inhalation, and breath holding were particularly noted.

Data were entered into Microsoft Excel and analyzed using SPSS version 22. Categorical variables were expressed as frequency and percentage. Association between inhaler technique and asthma control was analyzed using chi-square test. Multivariate logistic regression was performed to identify independent predictors of poor asthma control. A p-value <0.05 was considered statistically significant.

The study was approved by the Institutional Ethics Committee, and confidentiality of patient information was maintained.

RESULTS

The demographic and clinical characteristics of the study population are summarized in [Table 1]. Of the 120 participants, 72 (60%) were male and 48 (40%) were female, demonstrating a male predominance. The majority of children (56.7%) were in the 5–10 year age group, while 43.3% were aged 11–15 years. More than half of the participants (53.3%) had a disease duration exceeding three years, indicating a substantial proportion with long-standing asthma.

These findings suggest that asthma in our cohort predominantly affected younger school-aged children, with a considerable burden of chronic disease.

Table 1: Demographic Profile (n=120)

Variable	Frequency	Percentage
Male	72	60%
Female	48	40%
Age 5–10 years	68	56.7%
Age 11–15 years	52	43.3%
Duration >3 years	64	53.3%

Asthma control status assessed using C-ACT/ACT scores is presented in [Table 2]. Overall, 46 children (38.3%) had well-controlled asthma, 41 (34.2%) were partially controlled, and 33 (27.5%) had poorly controlled asthma.

Thus, nearly one-third of children demonstrated inadequate asthma control despite ongoing inhaler therapy. When partially and poorly controlled categories were combined, 61.7% of children did not achieve optimal control, highlighting a significant gap in effective disease management.

Table 2: Level of Asthma Control

Control Status	n	%
Well-controlled	46	38.3%
Partially controlled	41	34.2%
Poorly controlled	33	27.5%

Incorrect inhaler technique was observed in 56 children (46.7%). [Table 3] outlines the distribution of specific technique errors. The most frequently observed error was inadequate breath holding (36.7%), followed by incorrect timing of actuation and inhalation (31.7%). Failure to shake the inhaler prior to use was noted in 26.7%, while improper spacer seal was observed in 17.5% of children.

Coordination-related errors and inadequate breath-holding were the predominant technical deficiencies, both of which are known to significantly reduce effective drug delivery to the lower airways.

Table 3: Common Errors in Inhaler Technique

Error	n (%)
Failure to shake inhaler	32 (26.7%)
Incorrect timing of actuation	38 (31.7%)
Inadequate breath holding	44 (36.7%)
Improper spacer seal	21 (17.5%)

The relationship between inhaler technique and asthma control is shown in [Table 4]. Among children demonstrating correct inhaler technique, 34 had well-controlled asthma compared to only 8 with poor control. In contrast, among those with incorrect technique, 25 children had poorly controlled asthma while only 12 achieved good control.

The association between incorrect inhaler technique and poor asthma control was statistically significant (χ^2 test, $p<0.001$). Children with improper inhaler technique were significantly more likely to have poor asthma control compared to those performing the technique correctly.

Table 4: Inhaler Technique vs Asthma Control

Inhaler Technique	Well Controlled	Poorly Controlled	p-value
Correct	34	8	<0.001
Incorrect	12	25	

Multivariate logistic regression analysis was performed to identify independent predictors of poor asthma control [Table 5]. Incorrect inhaler technique emerged as the strongest independent predictor (Adjusted OR 3.6; 95% CI: 1.8–7.2; $p<0.001$), indicating that children with improper technique were more than three times as likely to have poorly controlled asthma.

Irregular follow-up was also independently associated with poor control (Adjusted OR 2.4; 95% CI: 1.1–5.1; $p=0.02$). Duration of asthma greater than three years did not demonstrate a statistically significant association with poor control after adjustment ($p=0.18$).

These findings suggest that modifiable behavioral factors, particularly inhaler technique and adherence to follow-up, play a more critical role in asthma control than duration of disease alone.

Table 5: Predictors of Poor Asthma Control

Variable	Adjusted OR	95% CI	p-value
Incorrect inhaler technique	3.6	1.8–7.2	<0.001
Irregular follow-up	2.4	1.1–5.1	0.02
Duration >3 years	1.1	0.3-1.9	0.18

DISCUSSION

The present study demonstrates that nearly half of children with bronchial asthma exhibited incorrect inhaler technique (46.7%), and more than one-quarter had poorly controlled asthma (27.5%). These findings highlight that suboptimal asthma control remains common even in tertiary care settings.

The prevalence of incorrect inhaler technique observed in our study is consistent with previous reports indicating high rates of device misuse among pediatric patients. Sanchis et al[6], in a systematic review, reported persistent inhaler errors over decades despite advances in device design. Similarly, Melani et al,[10] demonstrated that

incorrect inhaler handling was significantly associated with poor disease control. These findings reinforce the observation that improper technique continues to be a major barrier to optimal asthma management.

The most common errors identified in our study were inadequate breath holding and poor coordination between actuation and inhalation. These findings are in agreement with earlier aerosol therapy studies, which have emphasized that coordination errors significantly reduce pulmonary drug deposition and therapeutic efficacy.[5,8] In pediatric populations, improper spacer seal and failure to inhale slowly and deeply are additional contributing factors.

Approximately 27.5% of children in our cohort had poorly controlled asthma. This is comparable to global and regional data suggesting that a substantial proportion of children remain inadequately controlled despite guideline-based therapy[2]. According to GINA recommendations1, poor control is often related to modifiable factors such as incorrect inhaler technique and poor adherence rather than treatment failure alone.

A significant association was observed between incorrect inhaler technique and poor asthma control ($p<0.001$). On multivariate analysis, incorrect technique increased the likelihood of poor control by more than threefold. Similar associations have been documented in previous studies, where educational interventions targeting inhaler technique resulted in improved asthma outcomes.[7] These findings underscore the importance of routine inhaler technique assessment during outpatient visits, as recommended by international guidelines.[1,4]

Irregular follow-up was also independently associated with poor asthma control. Reduced follow-up frequency limits opportunities for reinforcement of inhaler technique, medication adjustment, and patient education. Prior literature suggests that structured education and repeated demonstration of inhaler use significantly improve control scores and reduce exacerbations.[6,7]

Overall, the findings of this study reaffirm that asthma control in children is strongly influenced by correct inhaler technique, a modifiable factor. Incorporating systematic inhaler technique assessment and demonstration into routine pediatric practice may significantly enhance therapeutic outcomes and reduce disease burden.

CONCLUSION

A significant proportion of children with bronchial asthma demonstrate incorrect inhaler technique, which is strongly associated with poor asthma control. Regular evaluation and reinforcement of inhaler technique, along with structured follow-up, are essential to optimize disease management and reduce morbidity.

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