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Clinical Profile and Predictors of Asthma Control in Children Attending a Tertiary Care Centre

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Abstract

Background: Bronchial asthma is one of the most common chronic respiratory diseases affecting children and is a major cause of recurrent hospital visits, school absenteeism, and impaired quality of life. Despite the availability of effective treatment strategies, achieving optimal asthma control remains challenging due to multiple demographic, clinical, environmental, and treatment-related factors. Identifying predictors of poor asthma control is essential for improving disease management and preventing exacerbations.

Objectives:

1. To evaluate the clinical profile of children with bronchial asthma attending a tertiary care centre.
2. To assess the level of asthma control among these children.
3. To identify clinical and environmental predictors associated with poor asthma control.

Materials and Methods: This hospital-based cross-sectional observational study included 65 children aged 5–16 years with physician-diagnosed bronchial asthma attending the Department of Pediatrics and Department of Respiratory Medicine at a tertiary care centre. Detailed demographic data, clinical history, family

history of atopy, environmental exposures, asthma severity, comorbidities, medication adherence, inhaler technique, and spirometry findings (where age appropriate) were recorded using a structured proforma. Asthma control was assessed using the Childhood Asthma Control Test (C-ACT)/Asthma Control Test (ACT) and Global Initiative for Asthma (GINA) guidelines. Statistical analysis was performed using appropriate descriptive and inferential tests, with a p-value <0.05 considered statistically significant.

Results: Among the 65 children, 60.0% were males and 43.1% belonged to the 9–12-year age group. Allergic rhinitis was the most common comorbidity (47.7%), while a family history of asthma was present in 44.6% of participants. Dust (69.2%), seasonal variation (58.5%), and viral respiratory infections (52.3%) were the most common trigger factors. Based on GINA criteria, 41.5% of children had well-controlled asthma, whereas 35.4% had partly controlled asthma and 23.1% had uncontrolled asthma. Poor medication adherence (AOR 4.56; p=0.002), incorrect inhaler technique (AOR 3.29; p=0.018), passive tobacco smoke exposure (AOR 2.84; p=0.033), and severe persistent asthma (AOR 2.96; p=0.041) were identified as significant independent predictors of poor asthma control.

Conclusion: More than half of the children demonstrated suboptimal asthma control. Poor medication adherence, incorrect inhaler technique, passive smoke exposure, and severe disease severity were the major predictors of inadequate asthma control. Regular patient and caregiver education, reinforcement of correct inhaler technique, improved adherence to controller therapy, and reduction of environmental risk factors are essential to achieve better asthma outcomes in children.

Keywords: Clinical Profile, Predictors, Asthma, Children, AOR

Introduction

Bronchial asthma is one of the most common chronic inflammatory disorders of the airways in

Bronchial asthma is one of the most common chronic inflammatory diseases affecting children worldwide and remains a major cause of morbidity, emergency department visits, hospitalization, school absenteeism, and impaired quality of life [1,2]. It is characterized by chronic airway inflammation, variable respiratory symptoms, including wheezing, cough, breathlessness, and chest tightness, together with variable expiratory airflow limitation [1]. Asthma is a heterogeneous disease with different phenotypes and endotypes, reflecting variations in underlying inflammatory pathways and clinical presentation [3].

According to the Global Initiative for Asthma (GINA) 2025**,** asthma affects more than 260 million individuals globally and is among the leading chronic diseases of childhood[1]. Although advances in diagnosis and treatment have considerably reduced asthma-related mortality, the disease continues to impose a substantial burden on healthcare systems, particularly in low- and middle-income countries where access to specialized care and adherence to treatment guidelines remain suboptimal [1,4].

Childhood asthma has become increasingly prevalent over recent decades owing to rapid urbanization, industrialization, environmental pollution, changes in lifestyle, dietary habits, and increased exposure to indoor allergens [5,6]. The prevalence varies considerably across different geographical regions because of differences in genetic susceptibility, environmental exposures, socioeconomic status, healthcare accessibility, and

diagnostic practices [7]. In India, epidemiological studies have reported childhood asthma prevalence ranging from 3% to 15%, with higher rates observed in urban populations due to increased exposure to air pollutants, vehicular emissions, tobacco smoke, and indoor allergens [8,9].

Asthma is primarily characterized by chronic inflammation involving eosinophils, mast cells, dendritic cells, macrophages, and T-helper type-2 lymphocytes, resulting in excessive production of cytokines such as interleukin-4, interleukin-5, and interleukin-13 [10,11]. These inflammatory mediators contribute to airway edema, mucus hypersecretion, smooth muscle hypertrophy, airway remodeling, and bronchial hyperresponsiveness, leading to recurrent episodes of airflow obstruction that are largely reversible either spontaneously or following bronchodilator therapy [10–12].

The development of childhood asthma is multifactorial and results from complex interactions between genetic predisposition and environmental influences[13]. Children with a family history of asthma, allergic rhinitis, eczema, or other atopic diseases are at significantly greater risk of developing asthma than those without such a history [13,14]. Early-life viral respiratory infections, particularly respiratory syncytial virus and rhinovirus infections, have also been implicated in the development and progression of asthma [15]. Environmental risk factors including passive tobacco smoke exposure, biomass fuel combustion, indoor dampness, dust mites, pet dander, cockroach allergens, molds, pollen, and outdoor air pollution contribute substantially to disease initiation and exacerbation [6,14,16].

The clinical manifestations of childhood asthma vary according to age, disease severity, phenotype, and exposure to precipitating factors [1]. Children commonly present with recurrent wheezing, persistent cough, shortness of breath, chest tightness, nocturnal symptoms, exercise-induced respiratory symptoms, and recurrent episodes of acute exacerbations [17]. Symptoms may worsen following viral respiratory infections, exercise, exposure to allergens, seasonal changes, cold air, emotional stress, or environmental pollutants [1,17]. Younger children often present diagnostic challenges because recurrent wheezing may also occur in viral bronchiolitis and other respiratory illnesses [18].

Accurate diagnosis of asthma relies on careful clinical assessment supported by objective evidence of variable airflow limitation whenever feasible[1]. Spirometry remains the gold standard investigation in children capable of performing acceptable pulmonary function tests and helps assess disease severity, reversibility, and response to bronchodilator therapy [19]. Assessment of asthma control has become the primary goal of management because symptom control correlates strongly with quality of life, healthcare utilization, and future risk of exacerbations [1].

Current GINA recommendations emphasize achieving and maintaining optimal asthma control rather than merely classifying disease severity [1]. Asthma control encompasses both current symptom control and future risk reduction. Validated tools such as the Childhood Asthma Control Test (C-ACT), Asthma Control Test (ACT), and GINA symptom assessment are widely used to evaluate treatment response and guide therapeutic decisions [1,20].

Despite effective controller medications, a considerable proportion of children continue to experience poorly controlled asthma because of multiple modifiable factors. Poor adherence to inhaled corticosteroids, incorrect inhaler technique, inadequate caregiver

knowledge, passive smoking, obesity, allergic rhinitis, recurrent respiratory infections, psychosocial stress, and environmental pollution have all been associated with poor asthma control [6,14,16,20]. Numerous studies have shown that improving medication adherence and inhaler technique significantly reduces asthma exacerbations and improves long-term disease outcomes [20].

Identification of predictors associated with poor asthma control is therefore essential for implementing targeted interventions, improving adherence, reducing exacerbations, and enhancing quality of life among affected children. Although several international studies have evaluated determinants of asthma control, there remains limited region-specific evidence from tertiary care centres in India. Therefore, the present study was undertaken to evaluate the clinical profile and predictors of asthma control in children attending a tertiary care centre**,** with the aim of identifying important demographic, clinical, environmental, and treatment-related factors influencing asthma control.

Materials and Methods

Study Design

This was a hospital-based cross-sectional observational study conducted in the Department of Pediatrics and the Department of Respiratory Medicine at a tertiary care teaching hospital.

Study Duration

The study was conducted over a period of 12 months.

Study Setting

The study was carried out in the Pediatric Outpatient Department (OPD), Pediatric Inpatient Department (IPD), and Pediatric Pulmonology Clinic of the tertiary care centre.

Study Population

Children diagnosed with bronchial asthma attending the Department of Pediatrics during the study period were screened for eligibility. A total of 65 children fulfilling the inclusion criteria were enrolled consecutively after obtaining written informed consent from their parents or legal guardians and assent from older children whenever applicable.

Sample Size

A total of 65 children with physician-diagnosed bronchial asthma were included in the study using consecutive sampling during the study period.

Sampling Technique

Consecutive sampling technique.

Inclusion Criteria

1. Children aged 5–16 years**.**
2. Children with physician-diagnosed bronchial asthma according to Global Initiative for Asthma (GINA) 2025 guidelines.
3. Children attending the Pediatric OPD or admitted to the Pediatric ward for asthma evaluation or follow-up.
4. Children whose parents or legal guardians provided written informed consent.
5. Children who were able to perform spirometry, where age and clinical condition permitted.

Exclusion Criteria

1. Children younger than 5 years or older than 16 years**.**
2. Children with congenital heart disease, cystic fibrosis, bronchopulmonary dysplasia, primary ciliary dyskinesia, pulmonary tuberculosis, bronchiectasis, or other chronic lung diseases.

3. Children with significant neurological or neuromuscular disorders affecting respiratory function.
4. Children with immunodeficiency disorders or chronic systemic illnesses likely to influence respiratory symptoms.
5. Children presenting with acute respiratory infections without established asthma.
6. Parents or guardians who refused to provide written informed consent.
7. Children with incomplete clinical records or inability to complete study assessments.

Study Procedure

After obtaining Institutional Ethics Committee approval and written informed consent, eligible children were enrolled in the study. A detailed history was obtained using a structured case record form. Information regarding age, sex, residence, socioeconomic status, age at onset of asthma, duration of illness, family history of asthma or atopy, environmental exposures, passive tobacco smoke exposure, trigger factors, previous hospitalizations, intensive care admissions, medication history, adherence to treatment, and inhaler technique was recorded.

A complete general physical examination and detailed respiratory system examination were performed. Anthropometric measurements, including height and weight, were recorded and body mass index was calculated according to age.

Asthma severity was classified according to the GINA 2025 recommendations. Asthma control was assessed using the Childhood Asthma Control Test (C-ACT) for children aged 5–11 years and the Asthma Control Test (ACT) for children aged ≥12 years together with GINA symptom control criteria.

Spirometry was performed in children able to cooperate according to the American Thoracic Society/European Respiratory Society (ATS/ERS) recommendations. Forced expiratory volume in one second (FEV_1), forced vital capacity (FVC), FEV_1/FVC ratio, and peak expiratory flow rate (PEFR) were recorded. Bronchodilator reversibility testing was performed whenever indicated.

Medication adherence was assessed by caregiver interview and review of prescription records. Inhaler technique was evaluated using a standardized checklist. Environmental exposures, including tobacco smoke, biomass fuel, household dust, pets, and seasonal triggers, were documented.

Outcome Measures

Primary Outcome

- Level of asthma control (well controlled, partly controlled, and uncontrolled).

Secondary Outcomes

- Clinical profile of children with asthma.
- Distribution of asthma severity.
- Frequency of environmental trigger factors.
- Medication adherence.
- Correct inhaler technique.
- Spirometry findings.
- Predictors associated with poor asthma control.

Data Collection Tool

Data were collected using a predesigned, pretested structured case record proforma.

Statistical Analysis

Data were entered into Microsoft Excel and analyzed using Statistical Package for the Social Sciences (SPSS) version 26.0 (IBM Corp., Armonk, NY, USA). Continuous variables were expressed as mean ± standard deviation (SD) or median with interquartile range,

depending on data distribution. Categorical variables were expressed as frequencies and percentages.

Associations between categorical variables were assessed using the Chi-square test or Fisher's exact test**,** whereas continuous variables were compared using the Student's independent t-test or Mann–Whitney U test**,** as appropriate. Variables showing statistical significance in univariate analysis were entered into a multivariate logistic regression model to identify independent predictors of poor asthma control. A p-value <0.05 was considered statistically significant.

Results

A total of 65 children with physician-diagnosed bronchial asthma attending the Department of Pediatrics at a tertiary care centre were included in the study. The demographic profile, clinical characteristics, asthma severity, asthma control status, environmental trigger factors, medication adherence, inhaler technique, spirometry findings, and predictors of asthma control were analyzed.

Table 1: Demographic Characteristics of Study Participants (n = 65)

Variable	Frequency (n)	Percentage (%)
Age Group (years)		
5–8	20	30.8
9–12	28	43.1
13–16	17	26.1
Gender		
Male	39	60.0
Female	26	40.0
Residence		
Urban	41	63.1
Rural	24	36.9

Among the 65 children included in the study, the majority (43.1%) belonged to the 9–12 years age group, followed by 30.8% in the 5–8 years age group and 26.1% in the 13–16 years age group. Male children constituted 60.0% of the study population, while females accounted for 40.0%, indicating a male predominance. Most participants (63.1%) were from urban areas.

Table 2: Clinical Profile of Children with Asthma (n = 65)

Clinical Variable	Frequency (n)	Percentage (%)
Duration of symptoms >2 years	37	56.9
Family history of asthma	29	44.6
Allergic rhinitis	31	47.7
Atopic dermatitis	10	15.4
Previous hospitalization	18	27.7

ICU admission	4	6.2
Passive smoke exposure	26	40.0
Pet exposure	12	18.5

More than half (56.9%) of the children had asthma symptoms for over two years. Nearly half (47.7%) had allergic rhinitis, while 44.6% reported a family history of asthma. Passive tobacco smoke exposure was present in 40.0% of the participants. Previous hospitalization due to asthma was reported in 27.7%, whereas only 6.2% had required ICU admission.

Table 3: Asthma Severity According to GINA Classification

Severity	Frequency (n)	Percentage (%)
Mild intermittent	18	27.7
Mild persistent	20	30.8
Moderate persistent	19	29.2
Severe persistent	8	12.3

Mild persistent asthma was the most common severity category (30.8%), followed closely by moderate persistent asthma (29.2%). Mild intermittent asthma accounted for 27.7% of cases, while severe persistent asthma was observed in 12.3% of children.

Table 4: Common Trigger Factors

Trigger	Frequency (n)	Percentage (%)
Dust	45	69.2
Seasonal change	38	58.5
Viral infection	34	52.3
Exercise	22	33.8
Cold air	20	30.8
Strong odors/smoke	18	27.7
Pets	10	15.4

Dust was the most frequently reported trigger (69.2%), followed by seasonal variation (58.5%) and viral respiratory infections (52.3%). Exercise and cold air were also common triggers, whereas pet exposure was the least common precipitating factor.

Table 5: Asthma Control Status (GINA/Childhood ACT)

Asthma Control	Frequency (n)	Percentage (%)
Well controlled	27	41.5
Partly controlled	23	35.4
Uncontrolled	15	23.1

Only 41.5% of children achieved well-controlled asthma. More than half (58.5%) had suboptimal asthma control, including 35.4% with partly controlled asthma and 23.1% with uncontrolled disease.

Table 6: Medication Adherence and Inhaler Technique

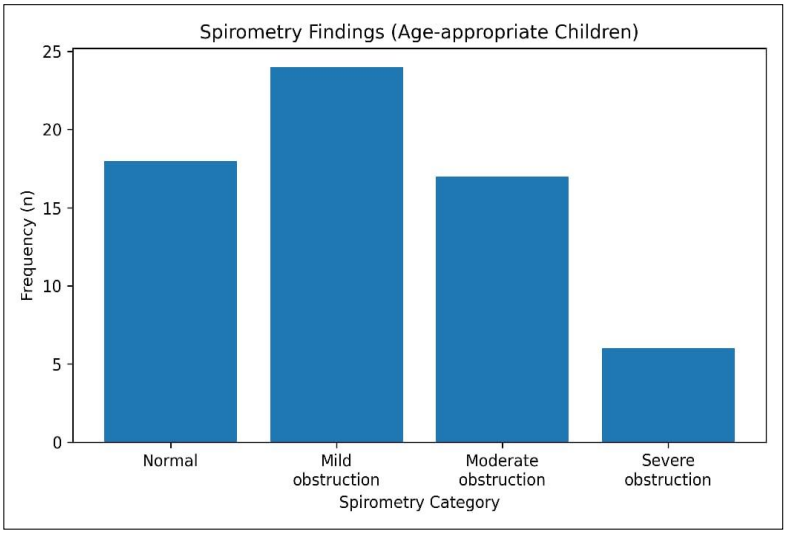
Variable	Frequency (n)	Percentage (%)
Good adherence	38	58.5
Poor adherence	27	41.5
Correct inhaler technique	42	64.6
Incorrect inhaler technique	23	35.4

Good medication adherence was observed in 58.5% of children, while 41.5% demonstrated poor adherence. Correct inhaler technique was present in 64.6% of participants, whereas approximately one-third used their inhalers incorrectly.

Table 7: Spirometry Findings (Age-appropriate children)

Spirometry	Frequency (n)	Percentage (%)
Normal	18	27.7
Mild obstruction	24	36.9
Moderate obstruction	17	26.2
Severe obstruction	6	9.2

Mild obstructive airway disease was the most common spirometric abnormality (36.9%). Normal spirometry was observed in 27.7% of children, while severe obstruction was found in only 9.2% of cases.



Graph 1: Spirometry Findings (Age-appropriate children)

Table 8: Predictors of Poor Asthma Control

Predictor	Well Controlled (n=27)	Partly/Uncontrolled (n=38)	p-value
Passive smoke exposure	6	20	0.012
Poor medication adherence	4	23	<0.001
Incorrect inhaler technique	5	18	0.008

Allergic rhinitis	8	23	0.041
Severe persistent asthma	1	7	0.029
Family history of asthma	9	20	0.284

Children with poor medication adherence, incorrect inhaler technique, passive smoke exposure, allergic rhinitis, and severe persistent asthma were significantly more likely to have poorly controlled asthma. Family history of asthma did not show a statistically significant association with asthma control.

Table 9: Multivariate Logistic Regression for Predictors of Poor Asthma Control

Variable	Adjusted Odds Ratio (AOR)	95% CI	p-value
Poor medication adherence	4.56	1.71–12.18	0.002
Incorrect inhaler technique	3.29	1.22–8.86	0.018
Passive smoke exposure	2.84	1.09–7.43	0.033
Allergic rhinitis	2.18	0.89–5.37	0.087
Severe persistent asthma	2.96	1.04–8.39	0.041

Multivariate analysis demonstrated that poor medication adherence was the strongest independent predictor of poor asthma control, followed by incorrect inhaler technique, passive tobacco smoke exposure, and severe persistent asthma. Allergic rhinitis showed an increased risk but did not remain statistically significant after adjustment. These findings highlight the importance of improving treatment adherence, inhaler technique, and reducing environmental smoke exposure to achieve optimal asthma control.

Among 65 children, 41.5% had well-controlled asthma, while 58.5% had partly controlled or uncontrolled asthma. Poor medication adherence, incorrect inhaler technique, passive smoke exposure, and severe persistent asthma were significant independent predictors of poor asthma control.

The study demonstrated that more than half of the enrolled children had suboptimal asthma control. Dust exposure, seasonal variation, and viral respiratory infections were the predominant trigger factors. Poor medication adherence, incorrect inhaler technique, passive tobacco smoke exposure, and severe persistent asthma emerged as the most important predictors of poor asthma control. These findings highlight the need for regular patient education, reinforcement of inhaler technique, adherence counseling, and reduction of environmental risk factors to improve asthma outcomes in children.

Discussion

The present hospital-based cross-sectional study evaluated the clinical profile and predictors of asthma control among 65 children attending a tertiary care centre. Childhood asthma remains one of the most prevalent chronic respiratory disorders worldwide and continues to contribute substantially to pediatric morbidity, healthcare utilization, school absenteeism, and reduced quality of life. Despite significant advances in asthma management, achieving optimal asthma control remains a challenge because of multiple demographic, environmental, behavioral, and treatment-related factors [1–6].

In the present study, the majority of participants (43.1%) belonged to the 9–12-year age group**,** while 30.8% were aged 5–8 years and 26.1% were aged 13–16 years. This

age distribution is comparable with previous studies, which reported that school-aged children constitute the largest proportion of pediatric asthma patients because increasing exposure to allergens, outdoor pollution, respiratory infections, and physical activity during these years leads to greater recognition of asthma symptoms [3,4,7,8]. Similar observations have been reported in recent international studies published during 2024–2026, which continue to identify school-aged children as the group most frequently requiring long-term asthma follow-up and controller therapy.

Male children constituted 60.0% of the study population, demonstrating a male predominance. This finding is consistent with numerous epidemiological studies showing that asthma is more common among boys during childhood because of relatively smaller airway diameter, hormonal influences, increased airway responsiveness, and genetic susceptibility [3,4,10]. The higher prevalence among boys has been consistently reported in Indian as well as international literature, although the gender difference tends to diminish after puberty [7–10].

Nearly two-thirds (63.1%) of the participants were from urban areas. Urban residence has repeatedly been associated with increased asthma prevalence due to higher exposure to vehicular pollution, industrial emissions, indoor allergens, overcrowding, reduced green spaces, and changing lifestyles [4,6,15]. Similar findings have been reported in Indian epidemiological studies, where urban children experience a greater burden of allergic respiratory diseases than their rural counterparts [8,9]. Recent environmental studies published in 2025–2026 further emphasize the contribution of ambient air pollution and neighborhood characteristics to childhood asthma exacerbations.

The present study observed that 56.9% of children had asthma symptoms for more than two years, indicating that asthma is a chronic condition requiring continuous monitoring and long-term controller therapy. Chronic airway inflammation contributes to progressive airway remodeling, recurrent symptoms, and increased healthcare utilization if treatment is inadequate [1,3,6]. Early diagnosis and regular follow-up are therefore essential to prevent long-term deterioration in lung function.

A positive family history of asthma was present in 44.6% of children. Genetic predisposition plays an important role in asthma development, with multiple susceptibility genes interacting with environmental exposures to influence disease onset and severity [10,13]. Although family history was common in our study, it was not an independent predictor of poor asthma control, suggesting that environmental and treatment-related factors may exert a greater influence on current disease control than hereditary predisposition alone. Similar findings have been described in previous observational studies [10,13].

Nearly half of the children **(**47.7%**)** had allergic rhinitis**,** making it the most common associated comorbidity. The coexistence of allergic rhinitis and asthma supports the concept of "one airway, one disease," whereby inflammation simultaneously affects both the upper and lower respiratory tract [1,6,17]. Children with allergic rhinitis frequently experience increased airway inflammation, recurrent symptoms, sleep disturbance, and reduced asthma control. Although allergic rhinitis showed a significant association with poor asthma control in univariate analysis, it did not remain an independent predictor after multivariate adjustment.

Similar observations have been reported in both earlier studies and more recent pediatric asthma research.

Passive tobacco smoke exposure was documented in 40.0% of children, highlighting the continued importance of household environmental risk factors. Exposure to environmental tobacco smoke promotes airway inflammation, oxidative stress, impaired mucociliary clearance, increased bronchial hyperresponsiveness, and recurrent asthma exacerbations [6,15]. The significant association observed in our study between passive smoking and poor asthma control agrees with GINA recommendations and several recent investigations that emphasize avoidance of tobacco smoke as an essential component of asthma management.

Overall, the demographic and clinical characteristics observed in the present study are consistent with previously published national and international literature. They reinforce the multifactorial nature of childhood asthma, where genetic susceptibility interacts with environmental exposures and modifiable behavioral factors to determine disease expression and clinical outcomes. These findings also support the need for comprehensive asthma education, environmental control measures, and individualized long-term follow-up for children with asthma.

The present study demonstrated that mild persistent asthma (30.8%) was the most common severity category, followed by moderate persistent asthma (29.2%)**,** while 12.3% of children had severe persistent asthma. These findings are comparable with previous studies that have shown mild-to-moderate persistent asthma to be the predominant clinical presentation among children attending tertiary care hospitals [1–4,7]. The increasing prevalence of persistent asthma may be attributed to prolonged exposure to environmental allergens, delayed diagnosis, poor adherence to controller therapy, and inadequate environmental control measures 5,6. Similar observations have been reported in recent pediatric asthma studies published during 2024–2026, where persistent asthma constituted the majority of outpatient cases.

Asthma severity is closely associated with the degree of airway inflammation and bronchial hyperresponsiveness. Children with severe persistent asthma experience more frequent symptoms, recurrent exacerbations, impaired lung function, increased emergency visits, and greater dependence on inhaled corticosteroids and combination therapy [3,6,10]. In the present study, severe persistent asthma was significantly associated with poor asthma control, emphasizing the importance of early identification and intensive follow-up of these high-risk patients. Similar findings have been reported by GINA and other international studies [1,3,12].

Environmental trigger factors play an important role in precipitating asthma symptoms and exacerbations. In the present study, dust exposure (69.2%) was the most common trigger, followed by seasonal variation (58.5%)**,** viral respiratory infections (52.3%)**,** exercise (33.8%)**,** and cold air exposure (30.8%)**.** These findings are in agreement with earlier studies demonstrating that exposure to house dust mites, pollens, molds, respiratory viral infections, and climatic changes significantly increases airway inflammation and bronchial hyperresponsiveness [4,6,15–17]. Similar trigger patterns have also been observed among Indian children with asthma [8,9].

Dust exposure remains particularly important in developing countries because of overcrowding, poor indoor ventilation, accumulation of household allergens,

and increased environmental pollution. Seasonal fluctuations in pollen concentration, humidity, temperature, and viral respiratory infections further contribute to recurrent asthma exacerbations throughout the year [6,15]. Recent studies from 2024–2026 have reaffirmed the major contribution of environmental pollutants and allergen exposure to poor asthma outcomes in children.

One of the most important findings of the present study was that only 41.5% of children achieved well-controlled asthma**,** whereas 58.5% had partly controlled or uncontrolled disease. These observations indicate that optimal asthma control remains difficult to achieve despite the availability of effective controller medications. Similar rates of inadequate asthma control have been reported in both Indian and international pediatric studies [1–6,12].

Poor asthma control is usually multifactorial. Inadequate adherence to inhaled corticosteroids, incorrect inhaler technique, persistent allergen exposure, poor caregiver awareness, socioeconomic limitations, recurrent respiratory infections, and delayed follow-up collectively contribute to persistent symptoms and recurrent exacerbations [5,6,17–20]. Recent longitudinal studies published during 2024 and 2025 have similarly demonstrated that inadequate adherence and improper inhaler use remain among the strongest determinants of poor asthma control in children.

Medication adherence represents one of the cornerstones of successful asthma management. In the present study, 58.5% of children demonstrated good medication adherence, whereas 41.5% showed poor adherence. This finding is comparable with previous studies reporting that approximately one-third to one-half of pediatric asthma patients fail to use controller medications regularly [17–20].

Recent randomized and observational studies published in 2024 and 2025 have evaluated several interventions to improve adherence, including electronic reminder systems, smartphone applications, digital inhalers, caregiver education programs, and telemedicine-based follow-up. These studies consistently demonstrated improvements in medication adherence, asthma control scores, and quality of life while reducing emergency visits and hospitalization [25–27]. Such interventions may be particularly valuable in resource-limited settings where regular specialist follow-up is difficult.

Recent randomized and observational studies published in 2024 and 2025 have evaluated several interventions to improve adherence, including electronic reminder systems, smartphone applications, digital inhalers, caregiver education programs, and telemedicine-based follow-up. These studies consistently demonstrated improvements in medication adherence, asthma control scores, and quality of life while reducing emergency visits and hospitalization [25–27]. Such interventions may be particularly valuable in resource-limited settings where regular specialist follow-up is difficult.

Similarly, the importance of correct inhaler technique cannot be overemphasized. Incorrect inhaler use substantially decreases pulmonary drug deposition and therapeutic efficacy despite adequate prescription of inhaled medications. International guidelines recommend assessment and correction of inhaler technique during every outpatient visit [1,12]. Recent studies from 2025–2026 have demonstrated that repeated practical demonstrations, caregiver training, and use of audiovisual educational tools significantly improve inhaler technique and long-term asthma control [27–29].

The present study has important implications for pediatric clinical practice. Regular assessment of asthma control using validated instruments such as the Childhood Asthma Control Test (C-ACT) or Asthma Control Test (ACT), periodic spirometry, reinforcement of medication adherence, environmental counseling, smoking cessation advice for family members, and repeated inhaler education should become routine components of asthma follow-up clinics. Such comprehensive management strategies are expected to reduce exacerbations, improve school attendance, enhance quality of life, and decrease healthcare expenditure.

The strengths of the present study include the use of standardized GINA 2025 diagnostic criteria, objective assessment of asthma control, evaluation of medication adherence and inhaler technique, assessment of environmental exposures, and multivariate logistic regression analysis to identify independent predictors of poor asthma control. These methodological strengths increase the clinical relevance of the findings and provide useful information for pediatricians involved in asthma management.

However, the study was conducted in a single tertiary care centre with a relatively small sample size, which may limit the generalizability of the findings. Furthermore, because of the cross-sectional design, causal relationships between predictors and asthma control could not be established. Future multicentric prospective cohort studies involving larger populations and longer follow-up periods are recommended to validate these findings and evaluate long-term clinical outcomes.

Overall, the present study confirms that childhood asthma control depends upon multiple interacting demographic, environmental, behavioral, and clinical factors. Among these, poor medication adherence, incorrect inhaler technique, passive tobacco smoke exposure, and severe persistent asthma represent the most important modifiable determinants of poor disease control. Addressing these factors through structured asthma education, caregiver counseling, individualized treatment plans, and regular follow-up has the potential to substantially improve asthma outcomes and reduce the long-term burden of childhood asthma.

Conclusion

The present hospital-based cross-sectional study evaluated the clinical profile and predictors of asthma control among 65 children with bronchial asthma attending a tertiary care centre. The study demonstrated that childhood asthma predominantly affected school-aged children, with a higher prevalence among males and urban residents. Mild persistent asthma was the most common disease severity, while dust exposure, seasonal variation, and viral respiratory infections were identified as the leading trigger factors for asthma exacerbations.

Although effective treatment options are available, more than half of the study participants had partly controlled or uncontrolled asthma, indicating that achieving optimal asthma control remains a significant clinical challenge. Poor medication adherence, incorrect inhaler technique, passive tobacco smoke exposure, and severe persistent asthma were identified as significant predictors of poor asthma control. These findings emphasize that modifiable behavioral and environmental factors play a crucial role in determining asthma outcomes.

The study highlights the importance of regular assessment of asthma control using standardized tools, reinforcement of correct inhaler technique, promotion of

adherence to inhaled controller medications, and reduction of exposure to environmental triggers, particularly passive tobacco smoke and household allergens. Early recognition and appropriate management of associated allergic conditions, such as allergic rhinitis, may further contribute to improved disease control.

In conclusion, comprehensive asthma management should extend beyond pharmacological treatment and include patient and caregiver education, regular follow-up, individualized treatment plans, environmental control measures, and continuous monitoring of treatment adherence. Implementation of these strategies can improve asthma control, reduce exacerbations and hospitalizations, enhance quality of life, and decrease the long-term burden of childhood asthma.

Limitations

The present study was conducted at a single tertiary care centre with a relatively small sample size of 65 children, which may limit the generalizability of the findings to the wider pediatric population.

In addition, the cross-sectional study design precluded assessment of long-term asthma outcomes, temporal changes in asthma control, and causal relationships between the identified predictors and asthma control.

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