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Prescribing Patterns and Utilization Trends of Anti-Asthmatic Drugs in Children: An Observational Study in a Pediatric Population

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ABSTRACT

Pediatric asthma occurs as a common chronic respiratory illness. **Objectives:** To evaluate the prescribing patterns and utilization trends of anti-asthmatic medications in pediatric patients, assessing adherence, appropriateness, and factors influencing drug selection. **Methods:** This observational study investigated pediatric asthma patients over six months, collecting data from 160 children aged 4–10 years. The data was obtained from pediatric asthma patients about their demographic information, alongside their asthma severity status and medication choices, and delivery methods. Data were analyzed by SPSS version 21.0. Chi-square test evaluated all associations between variables. **Results:** The study included 160 patients, with 31.3% of them within the age range of 8–9 years, and males represented 56.3% of the group. Urban residents (62.5%) were more affected. The bronchodilator medicine Salbutamol received the highest prescription rate (56.3%), and Budesonide held the position as the most commonly chosen corticosteroid (31.3%). The usage rate of Montelukast reached 45.0% while Theophylline's prescription was limited to just 11.3% of patients. The primary choice of medication delivery involved nebulization for 53.1% of patients, whereas 31.3% received inhalers and 15.6% had oral administration. The standard treatment for mild asthma patients involved Montelukast at a rate of 37.5% and Budesonide treated 34.4% of moderate cases, while severe asthma patients received Salbutamol + Ipratropium in 28.1% of cases. **Conclusions:** Prescribing patterns in pediatric asthma were closely linked to disease severity, with increased use of nebulizers and combination therapies in severe cases. Tailored, severity-based management can enhance treatment outcomes and promote rational drug use in children.

INTRODUCTION

Children with asthma deal with one of the most widely occurring chronic respiratory conditions, which causes significant hurdles for their life quality as well as their attendance in school and their general health status [1]. Cutting-edge research defines asthma as a disease that creates airway inflammation that combines with bronchial tube over reactivity and temporary respiratory blockage, which results in breathing problems and wheezing, along with tightness in the chest and frequent coughing episodes [2]. The growing global occurrence of pediatric asthma requires complete research on medical treatments for asthma control and management. Anti-asthmatic medication serves as a fundamental treatment approach for asthma because it helps achieve symptom control while stopping attacks in pediatric patients [3]. Pediatric asthma treatment includes two basic medicinal groups, which are reliever medications for immediate use combined with controller medications for sustained effect. The main quick-relief medication for treating acute bronchospasms consists of albuterol/salbutamol as short-acting beta-

agonists (SABAs) [4]. People with severe asthma need inhaled corticosteroids (ICS), leukotriene receptor antagonists (LTRAs), long-acting beta-agonists (LABAs), as well as biologic agents to gain proper control of symptoms. Various factors determine the selection process of appropriate anti-asthmatic medication since they include disease severity and how the patient responds, as well as their adherence and availability, together with healthcare provider preferences [5]. Widespread implementation of recognized treatment guidelines by GINA and NAEPP has not yet occurred, yet pediatricians and general practitioners, and pulmonologists show different behavioral patterns in prescribing treatments [6]. Clinical practice faces major issues in asthma management because medical professionals overutilize bronchodilators while underutilizing inhaled corticosteroids and repeatedly write incorrect antibiotic scripts. The results of medication adherence and appropriate drug utilization depend significantly on the awareness of physicians, while parental understanding, together with socioeconomic conditions also contribute to these outcomes [7]. Children with asthma face difficulties when following their prescribed medications. Various research shows that a major number of children with asthma display inconsistent behavior in following their prescribed controller medications, which produces both inadequate symptom management and multiple hospital visits. The young patients fail to adhere to their medications because of fearful corticosteroid side effects in addition to difficulty with inhalation techniques and poor recognition of symptoms, and economic limitations [8]. The patients did not follow their medications correctly, needed more hospital stays and Emergency Room visits, which increases healthcare organization costs. Knowledge about how children utilize healthcare services and how doctors write prescriptions remains essential for enhancing asthma control and lowering childhood asthma-related outbreaks [9]. The utilization of combination treatments for pediatric asthma treatment has become increasingly important in current medical practice. Doctors suggest the use of budesonide-formoterol and fluticasone-salmeterol ICS-LABA combinations to treat moderate to severe asthma for enhancing symptom control. Steadfast evaluations for determining the safety profile of LABA usage in children result from existing doubts about their safe practices. Widely adopted use of biologic treatments such as monoclonal antibodies that target IgE (omalizumab) and IL-5 (mepolizumab) remains limited because of their high costs in treating severe pediatric asthma [10]. Asthma treatment requires regular evaluation of prescribing patterns because anti-asthmatic drug utilization patterns change constantly.

This study aimed to evaluate the prescribing patterns and utilization trends of anti-asthmatic medications in pediatric patients, assessing adherence, appropriateness, and factors influencing drug selection.

METHODS

This observational study was conducted over six months, from October 2024 to March 2025, in the Pediatric Department at Khairpur Medical College, Khairpur Mir's. Ethical approval was obtained from the Institutional Review Board (IRB No. KMC/RERC/120) before data collection, and parents or guardians provided written informed consent for participant inclusion. The research evaluated prescription methods and treatment strategies used for pediatric asthma patients. The study focused on children aged 4–10 years who were diagnosed with asthma based on clinical reports, physical evaluations, and spirometry tests conducted according to the Global Initiative for Asthma (GINA) criteria [11]. The sample size was calculated using the standard formula for estimating a single population proportion: $n = Z^2 \times P \times (1 - P) / e^2$, where Z is the Z-score corresponding to a 95% confidence level (1.96), P is the estimated prevalence of pediatric asthma, and e is the desired margin of error. Based on prior regional data, the prevalence of pediatric asthma was estimated at 10.6% (0.106). Using a margin of error of 5% (0.05), the calculated sample size was n=162 [12]. The study included only children with asthma diagnoses made by pediatric pulmonologists who received care at the study facility during the defined study period. Exclusion criteria included cystic fibrosis, bronchopulmonary dysplasia, incomplete medical records, or hypersensitivity to asthma medication. Data were collected using structured proformas to document demographic information, clinical history, asthma severity ratings, and medication prescriptions. Patient details included age, gender, type of residential area, symptom frequency, asthma test results (mild, moderate, or severe), exposure to allergens and environmental pollutants, family history of asthma, and prescribed treatment protocols. Drug delivery methods were also recorded, including nebulizers, metered-dose inhalers (MDIs), dry powder inhalers (DPIs), and oral medications. Data collection was carried out by trained researchers under the direct supervision of pediatric pulmonologists. Statistical analysis was performed using SPSS version 21.0. Descriptive statistics were used to summarize demographic and clinical characteristics. The Chi-square test was applied to examine the association between medication prescriptions and asthma severity categories (mild, moderate, severe). A p-value <0.05 was considered statistically significant.

R E S U L T S

The study of 160 pediatric asthma patients showed 31.3% were between 8 and 9 years old, with 28.1% in the 6–7 years age bracket, while 18.7% were 10 years old. Childhood asthma mostly affects young children because their immune systems have not fully developed, and they experience more exposure to allergens. Male pediatric asthma patients surpassed females by 56.3% to 43.7% in this sample group, potentially because of structural as well as hormonal reasons that affect breathing responsiveness. Environmental pollution seems to raise asthma risk because patients from urban areas (62.5%) outnumber those from rural areas (37.5%). The study results demonstrate why early intervention programs must target vulnerable children because they help enhance asthma management practices and reduction methods. Most pediatric asthma patients in the study had mild to moderate asthma, accounting for 71.9% of cases, while severe asthma was present in 28.1%. A majority of children (68.8%) reported contact with allergens, and an even larger proportion (75%) were exposed to environmental pollutants, both of which are known to contribute to asthma exacerbations. Additionally, 43.7% of patients had a family history of asthma, indicating a significant genetic or familial predisposition within this population. These findings highlight the combined influence of environmental and hereditary factors in the prevalence and severity of pediatric asthma (Table 1).

Table 1: Demographic Characteristics of the Study Population (N=160)

Characteristics	Categories	Frequency (n %)
Age Group (Years)	4–5	35 (21.9%)
	6–7	45 (28.1%)
	8–9	50 (31.3%)
	10	30 (18.7%)
Gender	Male	90 (56.3%)
	Female	70 (43.7%)
Residence	Urban	100 (62.5%)
	Rural	60 (37.5%)
Asthma Severity	Mild	60 (37.5%)
	Moderate	55 (34.4%)
	Severe	45 (28.1%)
Contact with Allergens	Yes	110 (68.8%)
	No	50 (31.3%)
Exposure to Environmental Pollutants	Yes	120 (75.0%)
	No	40 (25.0%)
Family History of Asthma	Yes	70 (43.7%)
	No	90 (56.3%)

Acute asthma management requires bronchodilators, which physicians prescribed to 160 pediatric asthma patients and preferred the use of Salbutamol (56.3%) over Ipratropium Bromide (21.9%). The prescription data showed inhaled steroids had a higher preference among corticosteroid treatments, with Budesonide being preferred over Fluticasone by 31.3% versus 17.5%. Healthcare professionals prescribed Montelukast to 45.0% of patients for asthma control, yet Theophylline received only 11.3% of usage because of its associated side effects. The combination therapy Salbutamol + Ipratropium (25.0%) and Budesonide + Formoterol (18.8%) were frequently used since they provided dual-action therapeutic benefits (Table 2).

Table 2: Prescribing Patterns of Anti-Asthmatic Drugs (N=160)

Drug Class	Medication	Frequency (n %)
Bronchodilators	Salbutamol	90 (56.3%)
	Ipratropium Bromide	35 (21.9%)
Corticosteroids	Budesonide	50 (31.3%)
	Fluticasone	28 (17.5%)
Leukotriene Antagonists	Montelukast	72 (45.0%)
Methylxanthines	Theophylline	18 (11.3%)
Combination Therapy	Salbutamol + Ipratropium	40 (25.0%)
	Budesonide + Formoterol	30 (18.8%)

A significant association was found between asthma severity and mode of drug administration (p=0.004). Nebulizer use increased notably with severity, from 16.7% in mild cases to 44.4% in severe cases. In contrast, metered-dose inhaler (MDI) use was highest in mild asthma (50.0%) and declined in severe cases (33.3%). Dry powder inhaler (DPI) prescriptions were more common in mild and moderate asthma (25.0% and 27.3%, respectively) but dropped to 11.1% in severe asthma. Oral medication use remained low and relatively consistent across all severity categories. These findings suggest a shift toward nebulizer therapy in more severe cases and greater use of inhalers in milder disease (Table 3).

Table 3: Association Between Asthma Severity and Mode of Drug Administration (N=160)

Mode of Administration	Mild (N=60)	Moderate (N=55)	Severe (N=45)	Total N (%)	χ^2 Value	P–Value
Nebulizer	10 (16.7%)	15 (27.3%)	20 (44.4%)	45 (28.1%)	–	–
Metered-Dose Inhaler (MDI)	30 (50.0%)	20 (36.4%)	15 (33.3%)	65 (40.6%)	–	–
Dry Powder Inhaler (DPI)	15 (25.0%)	15 (27.3%)	5 (11.1%)	35 (21.9%)	18.74	0.004*
Oral Medication	5 (8.3%)	5 (9.1%)	5 (11.1%)	15 (9.4%)	–	–

The analysis revealed a significant association between asthma severity and the prescribing trends of several anti-asthmatic medications. Use of Salbutamol was notably higher among patients with moderate (63.6%) and severe asthma (66.7%) compared to those with mild disease (41.7%) (p=0.015). A similar pattern was observed for Ipratropium Bromide, with prescription rates increasing

from 13.3% in mild asthma to 33.3% in severe asthma (p=0.028). Budesonide was prescribed more frequently in moderate (36.4%) and severe (40.0%) cases compared to mild asthma (20.0%) (p=0.037), whereas Fluticasone showed no statistically significant variation across severity categories (p=0.478). Prescription of Montelukast also increased with disease severity, being used in 33.3% of mild, 50.9% of moderate, and 53.3% of severe cases (p=0.047). Theophylline use, although higher in severe asthma (20.0%) than in mild (6.7%), did not reach statistical significance (p=0.053). Combination therapy with Budesonide + Formoterol was significantly more common in severe asthma (33.3%) than in moderate (18.2%) or mild (8.3%) cases (p=0.004), while Salbutamol + Ipratropium combinations showed a non-significant upward trend with increasing severity (p=0.089) (Table 4).

Table 4: Association Between Asthma Severity and Prescribing Trends of Anti-Asthmatic Drugs (N=160)

Medication	Mild (N=60)	Moderate (N=55)	Severe (N=45)	Total N (%)	χ^2 Value	P-Value
Salbutamol	25 (41.7%)	35 (63.6%)	30 (66.7%)	90 (56.3%)	8.45	0.015*
Ipratropium Bromide	8 (13.3%)	12 (21.8%)	15 (33.3%)	35 (21.9%)	7.12	0.028*
Budesonide	12 (20.0%)	20 (36.4%)	18 (40.0%)	50 (31.3%)	6.59	0.037*
Fluticasone	8 (13.3%)	10 (18.2%)	10 (22.2%)	28 (17.5%)	1.47	0.478
Montelukast	20 (33.3%)	28 (50.9%)	24 (53.3%)	72 (45.0%)	6.13	0.047*
Theophylline	4 (6.7%)	5 (9.1%)	9 (20.0%)	18 (11.3%)	5.89	0.053
Salbutamol + Ipratropium	10 (16.7%)	15 (27.3%)	15 (33.3%)	40 (25.0%)	4.84	0.089
Budesonide + Formoterol	5 (8.3%)	10 (18.2%)	15 (33.3%)	30 (18.8%)	10.92	0.004*

The treatment regimen of dual therapy was adopted most often by clinicians to treat 40.6% of pediatric asthma patients for combined symptom relief and inflammation control. Single drug therapy was used in 31.3% of cases, whereas 28.1% of patients received multiple drug classes as part of their triple therapy or higher prescription (Table 5).

Table 5: Polypharmacy and Single-Drug Therapy Distribution (N=160)

Prescription Type	Frequency (n %)
Monotherapy	50 (31.3%)
Dual Therapy	65 (40.6%)
Triple Therapy or More	45 (28.1%)

DISCUSSIONS

The study reveals that pediatric asthma affects children mostly during their 6 to 9 years of age, with the 8–9-year group showing the maximum prevalence of 31.3% patients.

Studies confirm that asthma symptoms peak during early childhood because both the immune and respiratory systems remain undeveloped. Research confirms that the male child population (56.3%) shown in this study aligns with established asthma studies due to their anatomy and hormone regulation. The airway resistance increases and asthma exacerbations occur more frequently in boys since their airways remain smaller relative to their lung volume compared to girls [13]. Testosterone and estrogen hormones, along with their influence on immune responses, affect asthma intensity differently between male and female patients. Asthma prevalence shows significant links to environmental factors since urban populations having 62.5% asthma make up exceeds the 37.5% rural patient population with asthma. The development of asthma is associated with the urbanization process due to air pollutant hazards, along with allergens and lifestyle pattern shifts. The air pollutants like NO_2 and PM2.5 act as inflammation agents, which produce more asthma cases in urban residents. The discovered data shows that urban areas require public health actions to control pollution while simultaneously improving air quality monitoring systems [14, 15]. The medication choice for asthmatic patients showed Bronchodilators as the leading type due to their role in acute symptom relief, as described in standard guidelines, through Salbutamol prescription at 56.3%. Medical guidelines explain Ipratropium Bromide use at 21.9% because this medicine serves as a supporting treatment for severe to moderate asthma attacks. The selection of inhaled corticosteroids (ICS) shows Budesonide (31.3%) being used more often than Fluticasone (17.5%) by physicians whose practice aligns with worldwide recommendations that recommend ICS as the primary controller therapy for persistent asthma. The data reveal that medical practitioners choose Budesonide over other available medications presumably because of its desirable pharmacokinetics together with reduced systemic adverse effects [16]. The prescription rate of Montelukast as a leukotriene receptor antagonist reached 45.0% in patients, thus demonstrating its importance for long-term asthma control in mild persistent asthmatic conditions. Thephanine prescription below other drugs (11.3%) may result from its limited therapeutic window as well as potential adverse effects that affect physician prescribing practices within pediatric asthma management. Results showed Salbutamol + Ipratropium saw wide prescription rates at 25.0% while Budesonide + Formoterol was prescribed to 18.8% of patients. These therapy pairs support asthma stepwise guidelines because they treat patients with moderate to severe asthma through a combination of instant bronchodilator benefits with extended anti-inflammatory effects. The treatment

approach of combining different therapies demonstrates an increase in asthma symptom control and exacerbation reduction in pediatric care [17, 18]. Patients tend to select nebulizers as their preferred asthma delivery device because they are simpler to use while also showing better effectiveness for treating acute asthma attacks compared to MDIs and DPIs. Small children experience difficulties with correct inhaler use, and this could be a reason behind their reduced preference for using inhalers. Pediatric patients without spacer devices face difficulties when using inhalers because they must simultaneously activate the device and then inhale the medication [19]. The present study demonstrates a clear association between asthma severity and both the mode of drug administration and the prescribing trends of anti-asthmatic medications. In terms of delivery methods, nebulizer use increased with disease severity, being most prevalent in severe asthma (44.4%), whereas MDIs and DPIs were more common in mild and moderate asthma. This trend is in agreement with previous studies, which suggest that nebulizers are often preferred in severe exacerbations due to their ability to deliver higher drug doses over a sustained period, particularly in patients with compromised inspiratory capacity. In contrast, MDIs and DPIs are generally recommended for stable patients with good inhalation technique, which may explain their higher usage in mild cases [20]. The prescribing pattern analysis further reinforces the adaptation of therapy to disease severity. Short-acting β_2-agonists, particularly salbutamol, showed a stepwise increase in use from mild to severe asthma, consistent with their role as first-line rescue medication during acute symptoms. Similarly, the use of Ipratropium Bromide, either alone or in combination with Salbutamol, increased in moderate and severe cases, aligning with guideline recommendations for adding anticholinergics during severe exacerbations. Budesonide use also rose with increasing severity, reflecting the escalating need for inhaled corticosteroids (ICS) to achieve anti-inflammatory control in poorly controlled asthma. The significant increase in the prescription of Budesonide + Formoterol in severe asthma underscores the role of ICS/LABA combination therapy in achieving optimal symptom control when monotherapy proves insufficient. Montelukast, a leukotriene receptor antagonist, also demonstrated increased prescription rates with severity, possibly reflecting its utility as an adjunct therapy in patients with persistent symptoms or concomitant allergic rhinitis. Interestingly, Fluticasone and Theophylline did not exhibit statistically significant differences in prescribing trends across severity levels. This could be due to physician preference for Budesonide over Fluticasone in this population, and a more conservative use of Theophylline

given its narrow therapeutic index and side effect profile [21]. During the study period, 40.6% of pediatric asthma patients received dual therapy and 31.3% needed monotherapy, and 28.1% received triple therapy or exceeded triple therapy. Research indicates that dual and triple therapy treatments exist frequently among asthmatic patients because many patients need extra medication beyond single drugs to effectively control their asthma symptoms. Use of combination therapy for asthma treatment remains necessary, but implementation of polypharmacy treatment increases treatment complications, specifically among children, due to possible drug interactions as well as adverse effects, which may decrease patient adherence [22]. Multiple practice implications and practical suggestions stem from the study results. Health professionals need to focus on diagnosing asthma at an early stage because city dwellers need prevention measures for their exposure to pollution and allergens. Healthcare providers should prioritize treatment selection by using inhaled corticosteroids as base therapy, but save Theophylline and oral medications for subjects not able to use inhaled therapies. Inhaler technique improvement through caregiver education programs alongside child education results in better adherence and treatment results. Each needs unique asthma care strategies where treatment plans advance according to their observed symptoms to achieve better results with minimal medication requirements.

CONCLUSIONS

This study highlights important prescribing patterns in pediatric asthma management, showing that drug choice and mode of administration are strongly influenced by disease severity. Nebulizers were preferred in severe cases, while MDIs and DPIs were more common in mild asthma. Salbutamol, Budesonide, Montelukast, and combination therapies such as Budesonide + Formoterol were significantly more frequently prescribed as severity increased. These findings underscore the need for tailored treatment strategies that align with asthma severity, while promoting early intervention and rational drug use to optimize symptom control and reduce exacerbations in children.

Authors Contribution

Conceptualization: UB
Methodology: IHS, AAK, PK
Formal analysis: HIS, MZ
Writing review and editing: AAK, MAB, MZ

All authors have read and agreed to the published version of the manuscript

Conflicts of Interest

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REFERENCES

[1] Papi A, Blasi F, Canonica GW, Morandi L, Richeldi L, Rossi A. Treatment Strategies for Asthma: Reshaping the Concept of Asthma Management. Allergy, Asthma and Clinical Immunology. 2020 Aug; 16(1): 75. doi: 10.1186/s13223-020-00472-8.

[2] Côté A, Godbout K, Boulet LP. The Management of Severe Asthma in 2020. Biochemical Pharmacology. 2020 Sep; 179: 114112. doi: 10.1016/j.bcp.2020.114112.

[3] Rehman N, Morais-Almeida M, Wu AC. Asthma Across Childhood: Improving Adherence to Asthma Management from Early Childhood to Adolescence. The Journal of Allergy and Clinical Immunology: In Practice. 2020 Jun; 8(6): 1802-7. doi: 10.1016/j.jaip.2020.02.011.

[4] Mathioudakis AG, Custovic A, Deschildre A, Ducharme FM, Kalayci O, Murray C, *et al*. Research Priorities in Pediatric Asthma: Results of A Global Survey of Multiple Stakeholder Groups by The Pediatric Asthma in Real Life (PeARL) Think Tank. The Journal of Allergy and Clinical Immunology: In Practice. 2020 Jun; 8(6): 1953-60. doi: 10.1016/j.jaip.2020.01.059.

[5] Kaplan A, Price D. Treatment Adherence in Adolescents with Asthma. Journal of Asthma and Allergy. 2020 Jan; 13: 39-49. doi: 10.2147/JAA.S233268.

[6] Cloutier MM, Dixon AE, Krishnan JA, Lemanske RF Jr, Pace W, Schatz M, *et al*. Managing Asthma in Adolescents and Adults: 2020 Asthma Guideline Update from the National Asthma Education and Prevention Program. Journal of the American Medical Association. 2020 Dec; 324(22): 2301-17. doi: 10.1001/jama.2020.21974.

[7] Martin J, Townshend J, Brodlie M. Diagnosis and Management of Asthma in Children. BMJ Paediatrics Open. 2022 Apr; 6(1): e001277. doi: 10.1136/bmjpo-2021-001277.

[8] Beasley R, Braithwaite I, Semprini A, Kearns C, Weatherall M, Pavord ID. Optimal Asthma Control: Time for a New Target. American Journal of Respiratory and Critical Care Medicine. 2020 Jun; 201(12): 1480-7. doi: 10.1164/rccm.201910-1934CI.

[9] Cloutier MM, Baptist AP, Blake KV, Brooks EG, Bryant-Stephens T, DiMango E, *et al*. Focused Updates to The Asthma Management Guidelines: A Report from The National Asthma Education and Prevention Program Coordinating Committee Expert Panel Working Group. Journal of Allergy and Clinical Immunology. 2020 Dec; 146(6): 1217-70. doi: 10.1016/j.jaci.2020.10.003.

[10] Ramsey RR, Plevinsky JM, Kollin SR, Gibler RC, Guilbert TW, Hommel KA. Systematic Review of Digital Interventions for Pediatric Asthma Management. The Journal of Allergy and Clinical Immunology: in Practice. 2020 Apr; 8(4): 1284-93. doi: 10.1016/j.jaip.2019.12.013.

[11] Venkatesan P. 2025 GINA Report for Asthma. The Lancet Respiratory Medicine. 2025 Aug;13(8): e41-2. doi: 10.1016/S2213-2600(25)00242-5.

[12] Zhou W and Tang J. Prevalence and Risk Factors for Childhood Asthma: A Systematic Review and Meta-Analysis. BMC Pediatrics. 2025 Jan; 25(1): 50. doi: 10.1186/s12887-025-05409-x.

[13] Pakkasela J, Ilmarinen P, Honkamäki J, Tuomisto LE, Andersén H, Piirilä P, *et al*. Age-Specific Incidence of Allergic and Non-Allergic Asthma. BMC Pulmonary Medicine. 2020 Jan; 20(1): 9. doi: 10.1186/s12890-019-1040-2.

[14] Paciência I and Rufo JC. Urban-Level Environmental Factors Related to Pediatric Asthma. Porto Biomedical Journal. 2020 Jan;5(1): e57. doi: 10.1097/j.pbj.0000000000000057.

[15] Chatkin J, Correa L, Santos U. External Environmental Pollution as A Risk Factor for Asthma. Clinical Reviews in Allergy and Immunology. 2022 Feb; 62(1): 72-89. doi: 10.1007/s12016-020-08830-5.

[16] Marques L and Vale N. Salbutamol in The Management of Asthma: A Review. International Journal of Molecular Sciences. 2022 Nov;23(22): 14207. doi: 10.3390/ijms232214207.

[17] Kawamatawong T, Sangasapaviriya A, Saiphoklang N, Oer-Areemitr N, Sriprasart T, Kamalaporn H, et al. Guidelines for the Management of Asthma in Adults: Evidence and Recommendations. Asian Pacific Journal of Allergy and Immunology. 2022 Mar; 40(1): 1-21.

[18] Leung JS. Paediatrics: How To Manage Acute Asthma Exacerbations. Drugs In Context. 2021 May; 10: 2020-12. doi: 10.7573/dic.2020-12-7.

[19] Abdelfattah AM, Sarhan RM, Madney YM, Mady AF, Abdelrahim M, Harb HS. Add-on Inhalation Devices Correlation and Influence on Asthmatic Patients. Bulletin of Pharmaceutical Sciences Assiut University. 2025 Jun; 48(1): 401-20.

[20] Abougalambou SS, Albarrak GS, Abougalambou AS. Assessing the Use of MDI Among Asthmatic Patients in Saudi Arabia. Pharmacy Practice. 2022 Jan; 20(1):

2604. doi: 10.18549/PharmPract.2022.1.2604.

[21] Mayoral K, Lizano-Barrantes C, Zamora V, Pont A, Miret C, Barrufet C, *et al.* Montelukast in Paediatric Asthma and Allergic Rhinitis: A Systematic Review and Meta-Analysis. European Respiratory Review. 2023 Oct; 32(170). doi: 10.1183/16000617.0124-2023.

[22] Kim LH, Saleh C, Whalen-Browne A, O'Byrne PM, Chu DK. Triple Vs Dual Inhaler Therapy and Asthma Outcomes in Moderate to Severe Asthma: A Systematic Review and Meta-Analysis. Journal of the American Medical Association. 2021 Jun; 325(24): 2466-79. doi: 10.1001/jama.2021.7872.