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RISK FACTORS FOR EMERGENCY DEPARTMENT REVISIT OR HOSPITAL ADMISSION FOLLOWING ACUTE ASTHMA EXACERBATION IN CHILDREN: A SYSTEMATIC REVIEW AND META-ANALYSIS

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Abstract

Background: Acute asthma exacerbations are a leading cause of emergency department (ED) visits and hospital admissions in children. Recurrent episodes contribute to morbidity and healthcare burden and predict long-term impairment. Identifying risk factors for ED revisits and hospital admissions is essential to improve prevention and management. Methods: This systematic review followed PRISMA guidelines. MEDLINE, Embase, CINAHL, and PsycINFO were searched from inception to the final search date without language restrictions. Eligible studies included children and adolescents with physician-diagnosed asthma presenting with acute exacerbations and reporting outcomes of ED revisit or hospital admission. Data extraction and study selection were performed independently in duplicate. Results: Eight studies were included, including pediatric populations from the United States, Italy, Egypt, Saudi Arabia, and the United Kingdom, alongside adult comparator cohorts. Risk factors for ED revisits and admissions included younger age, female sex, minority ethnicity, socioeconomic deprivation, excessive short-acting β2-agonist use, poor adherence to controller therapy, environmental exposures (tobacco smoke, allergens, irritants), comorbidities such as obesity and depression, and seasonal variation. System-level contributors included inadequate discharge prescribing (low corticosteroid use), high absconding rates, and poor follow-up.

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Infection was the most common precipitant in pediatric cases. Despite most ED visits resulting in safe discharge, a substantial proportion of children experienced revisits or required admission, with 41% of children in one cohort returning within 12 months. Conclusions: Pediatric asthma exacerbations leading to ED revisits or admissions are driven by a combination of demographic, clinical, environmental, and system-level factors. Many of these determinants, medication adherence, controller therapy uses, exposure reduction, and follow-up, are modifiable. Addressing these factors through integrated, context-specific interventions is crucial to reducing recurrent acute care utilization in children with asthma.

Keywords: Asthma, Children, Emergency Department, Hospital Admission, Risk Factors, Exacerbations, Systematic Review.

INTRODUCTION

Asthma is the most common chronic respiratory condition in childhood and is a leading cause of emergency department (ED) visits and hospital admissions. Acute exacerbations contribute to morbidity, lost school days, caregiver stress, and escalating healthcare costs (Sarikloglou et al. 2024). Despite therapeutic advances, many children continue to experience recurrent exacerbations, which are not only burdensome but also predictive of further episodes and long-term impairment of lung function (Sarikloglou et al. 2024).

The risk of acute episodes is multifactorial. In addition to inadequate baseline control, exacerbations are influenced by genetic predisposition, allergic sensitization, viral respiratory infections, and environmental exposures (Puranik et al. 2017). Viral pathogens such as rhinovirus are among the most frequent precipitants of severe exacerbations and are associated with enhanced airway inflammation and reduced response to corticosteroids (Puranik et al. 2017). Furthermore, each severe episode independently increases the likelihood of subsequent events, underscoring the need to identify modifiable determinants (Bloomberg et al. 2020).

Socioeconomic and environmental factors play a significant role in shaping pediatric asthma outcomes. Children in lower-income or urban communities have disproportionately higher risks of sensitization, exacerbations, and hospital admissions (Conrad et al. 2018). Indoor exposures, including tobacco smoke, mold, and household allergens, are strongly associated with poor outcomes, and often coexist to amplify cumulative risk (Conrad et al. 2018). Outdoor air pollution and secondhand smoke exposure similarly intensify both the frequency and severity of exacerbations, disproportionately affecting disadvantaged and minority populations (Dougherty et al. 2009).

Recent advances have focused on predictive modeling to identify children at greatest risk for severe exacerbations. Clinical risk scores, biomarker-based approaches, and demographic predictors have been tested to stratify patients and enable early, personalized interventions. These models highlight the need to incorporate both biological and social determinants into preventive strategies, as structural inequities remain central drivers of asthma disparities (Conrad et al. 2018; Dougherty et al. 2009).

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Taken together, current evidence suggests that pediatric asthma exacerbations are driven by a complex interplay of clinical, environmental, and socioeconomic factors (Sarikloglou et al. 2024; Conrad et al. 2018; Puranik et al. 2017). This systematic review aims to discuss risk factors for ED revisit and hospital admission after acute asthma exacerbations in children, with the goal of informing prevention, guiding clinical decision-making, and identifying priorities for future research.

METHODOLOGY

This systematic review was conducted according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines (Fig1), with methods specified a priori. The review aimed to synthesize evidence on risk factors associated with emergency department (ED) revisits and hospital admissions following acute asthma exacerbations in children. The review protocol was not registered but followed the Population, Intervention/Exposure, Comparator, Outcome, and Study design (PICOS) framework.

Eligible studies included children and adolescents, generally up to 18 years of age, with physician-diagnosed asthma presenting to the ED or hospital with an acute exacerbation. Studies involving mixed-age populations were considered if pediatric data were extractable or if findings were directly relevant to pediatric care. We included both randomized controlled trials and observational designs, such as cohort, case-cohort, cross-sectional, or database studies, provided that they reported outcomes related to ED revisit or hospital admission. Excluded were case series without denominators, reviews without primary data, and editorials. The primary outcomes of interest were repeat ED visits within common follow-up intervals (7, 14, or 30 days and up to 12 months) and hospital admission or readmission after acute care. Secondary outcomes, when available, included intensive care unit admission, adherence, quality of life, and time to disposition.

A search strategy was implemented in MEDLINE (PubMed), Embase, CINAHL, and PsycINFO, from database inception until the date of the final search. The strategy combined Medical Subject Headings and free-text terms for asthma, children, emergency department, admission, readmission, revisit, predictors, and risk factors. Equivalent terms were used across databases to maximize retrieval. No restrictions were applied to language or geographic setting. Reference lists of all included studies and relevant systematic reviews were hand-searched to identify additional eligible articles.

Titles and abstracts were screened by two reviewers, followed by full-text review of eligible studies. Discrepancies were resolved through discussion and, when necessary, by consultation with a third reviewer. Reasons for exclusion at the full-text stage were documented, and the overall process was summarized in a PRISMA flow diagram. Data extraction was performed independently and in duplicate using a standardized form. Extracted variables included study design, setting, sample size, age distribution, risk factors or exposures assessed, outcome definitions, and effect estimates.

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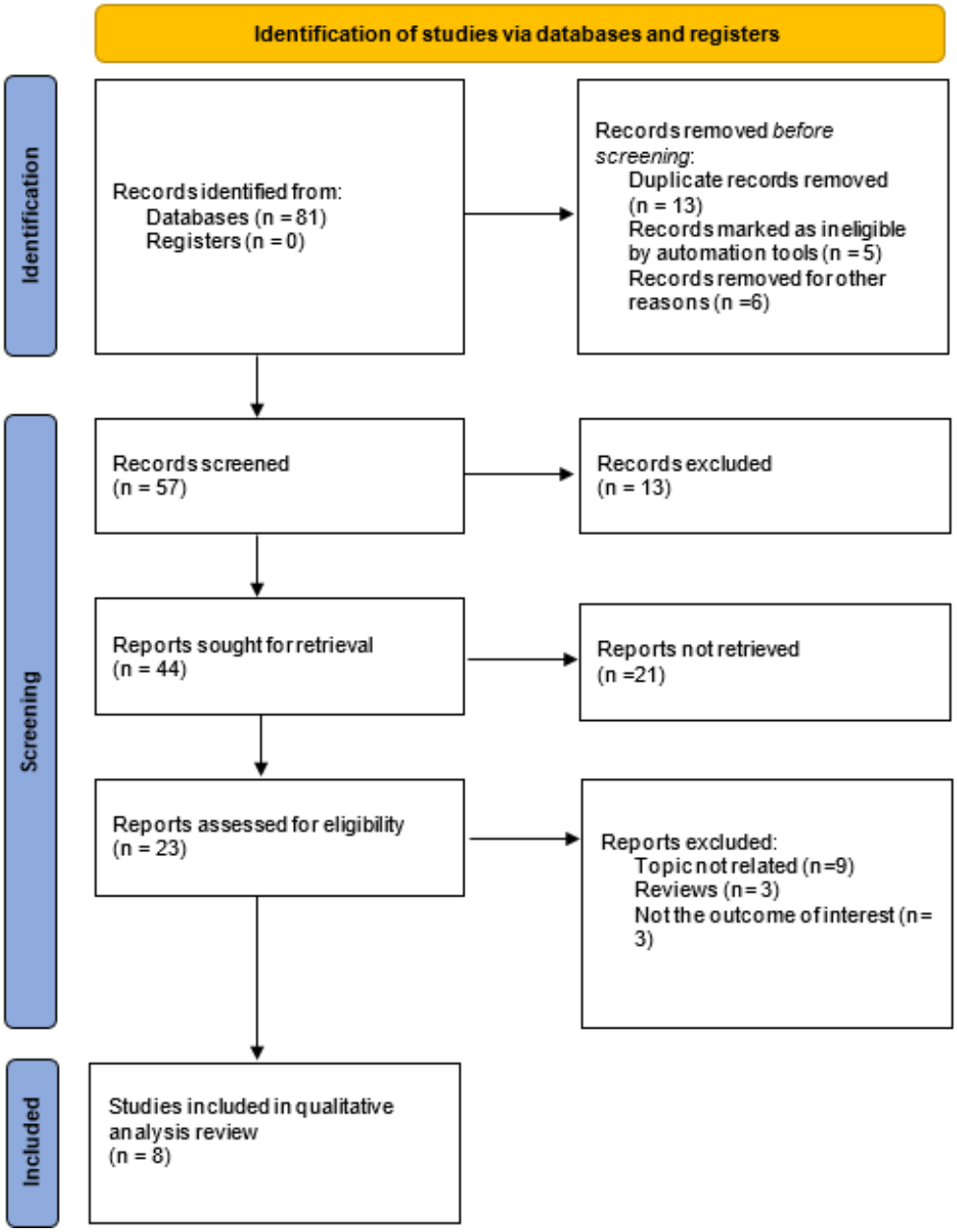

Fig 1: PRISMA consort chart of selected studies

RESULTS

Eight studies were included (Table 1), spanning pediatric and adult populations in multiple settings (emergency departments, primary care, and national administrative datasets). Pediatric cohorts included a U.S. hospital-based prospective cohort of 671 children (Johnson et al. 2017), an Italian pediatric ED audit of 603 visits (Dondi et al. 2017), an Egyptian pediatric ED series of 170 patients (Ahmed et al. 2023), a Saudi primary-care

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cross-sectional survey of 124 children (Al Ghadeer et al. 2024), and a large UK cohort using linked primary and secondary care data (Simms-Williams et al. 2024). Adult-focused emergency cohorts were conducted in Egypt (Mohamed et al. 2022) and Malaysia (Nik Muhamad et al. 2016), while U.S. all-age data were analyzed from the Nationwide Emergency Department Sample (Qin et al. 2024). Admission and utilization patterns varied. In the U.S. national NEDS analysis, 88.5% of asthma-related ED visits were treated and released, while =9.8% resulted in hospital admission overall; among children, 10.4% of visits ended in admission or transfer (Qin et al. 2024). In the Italian pediatric ED, 19% of presentations were admitted, with infection being the leading precipitant (Dondi et al. 2017). In Cairo, 96.5% of children were stabilized and discharged, while 3.5% required ICU care and no deaths were reported (Ahmed et al. 2023). In Malaysia, 13.9% of adults revisited within two weeks of discharge, and 9.1% of revisit episodes required admission (Nik Muhamad et al. 2016).

Risk factor profiles showed consistent sociodemographic and clinical associations. In the UK cohort, females, younger age groups, ethnic minorities, and socioeconomically deprived patients had higher risks of hospital or ICU admission. Excessive short-acting β2-agonist (SABA) use, obesity, depression, anxiety, and gastro-oesophageal reflux disease also significantly contributed to risk, with obesity alone accounting for =23% of admissions in adults (Simms-Williams et al. 2024). Similarly, in the U.S. dataset, children under 12 years, females, and those discharged in winter or late autumn were more likely to be admitted, while Black and Hispanic patients had lower odds of admission compared with White patients (Qin et al. 2024).

Adult ED cohorts emphasized physiologic and disease-control measures. In Egypt, baseline oxygen saturation <90%, low 1-hour peak expiratory flow rate (PEFR), and uncontrolled asthma were predictors of severe exacerbations, while hospitalization was more likely with older age, poor control, low PEFR, and hypoxemia (Mohamed et al. 2022). Patients with severe or life-threatening attacks also had more prior ED visits, hospitalizations, mechanical ventilation, comorbid depression and anxiety, and higher eosinophil and IgE levels (Mohamed et al. 2022). Post-discharge outcomes underscored system gaps. In Malaysia, high absconding rates (25.1%) and low oral corticosteroid prescribing at discharge (24.9%) contributed to early revisits, with infection and absconding independently associated with return (Nik Muhamad et al. 2016). In the U.S. prospective cohort, 41% of children revisited the ED within 12 months after hospitalization; revisit risk was higher among younger and Black children, and among those with prior inhaled steroid use, whereas socioeconomic markers and traffic exposure were not predictive (Johnson et al. 2017). Triggers and modifiable care factors were highlighted in pediatric cohorts. In Italy, infections predominated across all age groups, while allergic triggers were more common in school-aged children, and absence of controller therapy was associated with more severe attacks (Dondi et al. 2017). In Cairo, ER attendance correlated with non-compliance, irritant exposure, and exercise, with non-adherence linked to family negligence, illiteracy, and financial constraints (Ahmed et al. 2023). In Saudi Arabia, poor follow-up, frequent SABA use, smoke and pet exposure, and poor asthma control were linked to more hospitalizations and ER visits (Al Ghadeer et al.

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2024). Seasonal patterns were evident across datasets, with peaks in autumn and winter for preschool children and spring/autumn for school-aged children in Italy (Dondi et al. 2017), and increased admission risk in winter months in the U.S. NEDS data (Qin et al. 2024). Results indicate that while many asthmas ED visits end in safe discharge, a substantial proportion of patients, children, socioeconomically disadvantaged groups, and those with uncontrolled disease, experience revisits or admissions. Across studies, consistent modifiable risk factors were identified, including poor treatment adherence, SABA overuse, gaps in post-discharge corticosteroid prescribing, lack of follow-up, and preventable exposures such as smoke and allergens (Table 2).

Table 1: studies summary table

Citation	Study Design	Population Characteristics	Sample Size	Methodology	Study Aim
Nik Muhamad & Kwong, 2016	Retrospective cohort	Patients ≥ 12 years with acute asthma, discharged from ED, Sarawak, Malaysia	397	Reviewed records of patients treated for acute asthma and discharged from ED; outcomes assessed within 2 weeks	To identify factors associated with early ED revisits and hospitalization after acute asthma discharge
Johnson et al., 2017	Prospective observational cohort	Children aged 2–16 years, hospitalized for asthma at an urban pediatric facility (USA)	671	Followed children ≥12 months post-discharge; collected demographic, socioeconomic, environmental, and clinical data	To identify factors related to asthma-related ED revisits within 12 months after hospitalization
Qin et al., 2024	Cross-sectional (nationwide database analysis)	Children (0–17 yrs) and adults (≥18 yrs) in the U.S. with asthma-related ED visits (NEDS 2020 data)	National dataset (=28M ED visits, weighted to 123M)	Analyzed ED discharge data with logistic regression to identify factors linked to admission after asthma ED visits	To examine risk factors for hospital admission following ED visits for asthma in U.S. children and adults
Ahmed et al., 2023	Cross-sectional observational	Children aged 2–12 years with asthma presenting to ER, Cairo, Egypt	170	Collected personal, anthropometric, SES, clinical, and risk factor data using questionnaire; assessed treatment compliance and outcomes	To assess precipitating factors and outcomes of acute asthma attacks in pediatric ER patients

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Mohamed et al., 2022	Prospective observational	Adult asthma patients (18–70 yrs) with acute exacerbations presenting to ED, Assiut, Egypt	40	Clinical history, lab tests, ABG, IgE, PEFR, adherence, comorbidities, and psychological assessment; followed outcomes	To evaluate clinical characteristics, risk factors, and predictors for poor outcomes in severe asthma exacerbations
Dondi et al., 2017	Retrospective chart review	Children aged 0–14 yrs with acute asthma in Pediatric ED, Bologna, Italy	603	Reviewed ED records for demographics, triggers, severity, and seasonal patterns of exacerbations	To analyze triggers, seasonality, and risk of severe exacerbations in pediatric asthma patients
Al Ghadeer et al., 2024	Cross-sectional descriptive	Children with asthma attending primary health centers, Eastern Saudi Arabia (2022–2023)	124	Used Childhood Asthma Control Test (C-ACT), collected clinical, sociodemographic, and environmental exposure data	To evaluate predictive variables of hospitalization and ER visits in asthmatic children
Simms-Williams et al., 2024	Cohort study using linked primary and secondary care data	Children (5–11 yrs), adolescents (12–17 yrs), adults (≥18 yrs) with asthma, UK	1,385,326 (children: 90,989; adolescents: 114,927; adults: 1,179,410)	Analyzed CPRD Aurum + HES data; negative binomial models for risk factors; estimated PAF for modifiable factors	To estimate contributions of demographic, clinical, and modifiable risk factors to asthma-related hospital/ICU admissions

Table 2: Main Findings by Study

Citation	Outcome Measured	Risk Factors ↑ (Higher Risk)	Protective / Lower Risk ↓	Notable Rates / Magnitudes	Notes / Context
Simms-Williams N, et al. BMJ Open Respir Res. 2024;11: e001746 (UK cohort)	Asthma-related hospital & ICU admissions	Younger age groups; females; ethnic minority status; socioeconomic deprivation; high medication burden incl. excessive SABA; comorbidities (obesity, depression, GORD, anxiety, chronic rhinosinusitis;	—	Population attributable fraction (adults): obesity =23%; depression =11%; smoking: adolescents =6.8%, adults =4.3%	Highest incidence in children & adolescents; similar risk factors for ICU as for hospital admissions

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		age-specific smoking in adolescents/adults)			
Qin X, Pate C, Zahran H. J Asthma. 2024 (NEDS, USA)	Hospital admission following ED visit for asthma	Children: female sex; <12 years; Q1 & Q4 discharges (Jan–Mar, Oct–Dec). Adults: female sex; ≥35 years; Medicare; Q1 discharges; metropolitan teaching hospitals	Lower odds in Black/Hispanic /Other race; self-pay/other payers; non-teaching metropolitan or non-metropolit an hospitals; lower ZIP-code income quartiles (adults)	≈10% of asthma ED visits resulted in hospital admission (children + adults combined)	Sociodemograp hic & system factors strongly associated with admission
Johnson LH, et al. Ann Emerg Med. 2017	Asthma-relat ed ED revisit within 12 months after hospitalizati on (children 2–16y)	Younger age; Black race; excellent reported access to primary care; history of inhaled steroid use	Low income; detectable cotinine; traffic exposure did not independently predict revisit	41% had ≥1 asthma-related ED revisit within 12 months	Prospective cohort; urban pediatric facility
Ahmed AM, et al. Egyptian Pediatric Associatio n Gazette. 2023	Frequent ER attendance (past 6 months) among pediatric asthma	Non-compliance with asthma treatment; caregiver factors (family negligence/illiterac y) and financial disability frequently reported among non-compliant	—	—	Urban residence common; study aimed to correlate precipitating factors with outcomes
Mohamed AZE, et al. Egyptian J Broncholo gy. 2022	Severe exacerbation s & hospitalizati on (ED cohort)	Predictors of severe exacerbations: baseline SpO_2 <90%; low PEFR at 1h; uncontrolled asthma. Predictors of hospitalization: older age; uncontrolled asthma; low PEFR at 1h; baseline SpO_2 <90%	—	—	Also associated: overuse of SABA; moderate-to-sev ere depression; eosinophilia
Dondi A, et al. BioMed Res Int. 2017	Triggers & severity of pediatric ED asthma	Infections = main trigger at all ages; in school-aged children, allergic triggers (≈33%)	—	ED asthma visits: 603/23,197 (2.6%); 76% <6y	Seasonality: preschool peaks in autumn/winter; school-aged

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	exacerbations	common; lack of controller therapy associated with higher risk of moderate-to-severe exacerbation			peaks spring/early autumn
Al Ghadeer H, et al. Cureus. 2024	ER visits & hospitalizations among children with asthma	Not following up with physicians; frequent SABA use; exposure to smoke; household pets; poor asthma control	—	—	Cross-sectional PHC sample; C-ACT used (score <19 = uncontrolled)
Nik Muhamad NA, Kwong LJ. Med & Health. 2016	Early ED revisit (≤2 weeks) and admission among adult AEBA discharges	Absconding before assessment; concurrent infection associated with early revisit	— (protective not reported)	Revisit rate 13.9%; among revisits, 9.1% admitted; oral corticosteroid on discharge low (24.9%)	Authors recommend increasing OCS prescribing on discharge; address high absconding

DISCUSSION

This systematic review of nine studies provides detailed insights into the risk factors influencing repeat emergency department (ED) visits and hospital admissions among children with acute asthma exacerbations. The collective evidence shows that both intrinsic disease factors and modifiable determinants contribute to recurrent acute care utilization.

Demographic and Clinical Predictors

Several studies highlighted the importance of demographic and clinical characteristics. Ardura-García et al. (2018) show that younger age, African-American ethnicity, female sex, and low socioeconomic status were significant predictors of repeated hospital or ED admissions. Walsh-Kelly et al. (2008) similarly identified younger than two years of age, persistent asthma severity, and public insurance status as independent risk factors for revisits within seven days. Aguilar et al. (2024) expanded on these findings, showing that prior ED visits, history of pneumonia, and concurrent febrile illness increased the odds of revisits within 14 days. These findings are consistent with Johnson et al. (2017) and Qin et al. (2024), where younger age groups and comorbidities were linked to higher admission and revisit rates.

Environmental and Adherence-Related Predictors

Environmental exposures and treatment adherence were strongly associated with adverse outcomes. Butz et al. (2019) showed that second-hand smoke exposure and allergen sensitization predicted recurrent ED visits, despite targeted environmental control interventions. Al Ghadeer et al. (2024) reported that poor follow-up, frequent SABA use, smoke exposure, and pet ownership were strongly linked to increased

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hospitalizations and ER visits among children in Saudi Arabia. Rodriguez-Martinez et al. (2008) emphasized the role of parental knowledge, reporting that misconceptions about medication use, believing drugs should only be administered when symptomatic, were significantly associated with recurrent ED visits in Colombia. Ahmed et al. (2023) provided further evidence, showing that non-compliance with treatment, irritant exposure, and socioeconomic barriers, family negligence and illiteracy were leading contributors to ER attendance in Egyptian children. Collectively, these findings reinforce the importance of caregiver education, adherence monitoring, and environmental control.

Health System and Treatment-Related Factors

System-level barriers and treatment strategies also played important roles. To et al. (2008) show that drug insurance coverage reduced repeat ED visits and acute asthma episodes, highlighting the protective role of financial access to medications.

Dexheimer et al. (2013) evaluated an ED-based computerized asthma detection and management system but found no significant impact on admission rates or length of stay, suggesting that digital tools alone are insufficient without robust implementation. Paniagua et al. (2017) compared two corticosteroid regimens and found that two doses of dexamethasone were as effective as a five-day course of prednisone, with higher adherence in the dexamethasone group, supporting simplified regimens to improve compliance.

Implications for Prevention and Management

Evidence shows that while disease severity remains central, modifiable determinants substantially shape outcomes. Ensuring affordable access to controller medications (To et al. 2008), reinforcing treatment adherence (Ahmed et al. 2023; Rodriguez-Martinez et al. 2008), addressing environmental exposures such as smoke and allergens (Butz et al. 2019; Al Ghadeer et al. 2024), and caregiver education (Rodriguez-Martinez et al. 2008) are critical.

Streamlined pharmacologic strategies (Paniagua et al. 2017) and targeted follow-up care (Walsh-Kelly et al. 2008; Aguilar et al. 2024) further provide opportunities to reduce recurrence risk. Although informatics-based approaches (Dexheimer et al. 2013) did not show immediate benefits, integration with clinical workflows remains a promising avenue.

Comparison with Current Review Findings

Our results in this review are consistent with previous studies, younger age, persistent asthma severity, prior acute care utilization, poor adherence, environmental exposures, and socioeconomic disadvantage were repeatedly identified as risk factors.

These findings spanned diverse healthcare systems, including North America (To et al. 2008; Walsh-Kelly et al. 2008; Aguilar et al. 2024; Butz et al. 2019), Europe (Paniagua et al. 2017; Ardura-García et al. 2018), the Middle East (Ahmed et al. 2023; Al Ghadeer et al. 2024; Dexheimer et al. 2013), and Latin America (Rodriguez-Martinez et al. 2008).

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CONCLUSION

This systematic review show that emergency department revisits and hospital admissions after acute asthma exacerbations in children are shaped by a combination of demographic, clinical, environmental, and health system factors. Younger age, female sex, socioeconomic disadvantage, minority status, comorbidities, and seasonal variation increased risk. Poor adherence to controller therapy, excessive use of short-acting β2-agonists, exposure to tobacco smoke, allergens, and inadequate follow-up were major contributors. System gaps, low discharge corticosteroid prescribing and high absconding rates, also worsened outcomes. As many determinants are modifiable, targeted interventions addressing adherence, exposures, and continuity of care reduce recurrent acute utilization.

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