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Factors Associated with Asthmatic Exacerbations in Pediatric Population at a Healthcare Institution in Medellín: an Analytical Cross-Sectional Study

Factores asociados con crisis asmática en población pediátrica en una IPS de Medellín: un estudio de corte transversal analítico

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Data availability
All data supporting the findings of this study are available within the article. For additional details, please contact the corresponding author.

Abstract

Introduction. Asthma is a heterogeneous respiratory disease characterized by chronic airway inflammation, frequently leading to pediatric consultations. It represents an important public health concern due to its impact on patients' quality of life.

Objective. To determine the factors associated with asthma exacerbations in pediatric patients aged 6 to 11 years treated at a healthcare institution in Medellín during 2024.

Methodology. An analytical cross-sectional study was conducted including 109 children aged 6 to 11 with a medical diagnosis of asthma who sought care in 2024. Associations between variables were determined using the chi-square test, and risk estimation was calculated using odds ratios (ORs). Multivariate adjustment was performed using binomial logistic regression.

Results. Nineteen percent of patients experienced at least one exacerbation in 2024, with mild exacerbations being most frequent. Males showed a higher proportion of exacerbations. Respiratory infections in the last year and treatment adherence were significantly associated with asthma exacerbations. In the multivariate model, previous respiratory infections remained significantly associated with exacerbations (OR = 13.97; 95% CI: 3.99-48.89; $p<0.001$). However, the wide confidence interval indicates limited precision of the estimate, and therefore this result should be interpreted with caution.

Conclusions. Previous respiratory infections constitute an important risk factor for asthma exacerbations in pediatric patients aged 6 to 11. Although treatment adherence did not maintain a significant association in multivariate model, its clinical relevance has been widely documented in the literature.

Author Contributions
Jeimy Katherine Rodríguez Ortiz: conceptualization, data curation, formal analysis, funding acquisition, investigation, methodology, project administration, resources, software, supervision, validation, visualization, writing – original draft.
Brethmen David Chavez Ortiz: conceptualization, funding acquisition, investigation, project administration, software, visualization, writing – original draft.
Silvia Patricia Betancur-Bedoya: conceptualization, investigation, supervision, validation, visualization, writing – review & editing.
Jesús David Forero Muñoz: formal analysis, methodology, resources, supervision, validation, visualization, writing – review & editing.

Generative AI declaration
During the preparation of this manuscript, the authors used ChatGPT as a generative artificial intelligence tool solely for language editing. The tool was not used to generate scientific content, interpret results, create figures, or perform data analyses. The authors reviewed and edited the manuscript and take full responsibility for the accuracy and integrity of the final content.

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Keywords

Asthma; asthma exacerbation; child; risk factors; respiratory tract infections.

Resumen

Introducción. El asma es una enfermedad respiratoria heterogénea caracterizada por inflamación crónica de la vía aérea, siendo motivo de consulta frecuente en población pediátrica. Se considera un problema relevante de salud pública debido al impacto que genera en la calidad de vida de los pacientes y sus familias.

Objetivo. Determinar los factores asociados con las crisis asmáticas en población pediátrica entre 6 y 11años en una Institución Prestadora de Servicios de Salud de Medellín durante el año 2024.

Metodología. Estudio analítico de corte transversal que incluyó 109 niños y niñas con edades entre 6 y11 años con diagnóstico médico de asma que consultaron durante el año 2024. La asociación entre variables se determinó mediante la prueba de chi-cuadrado y la estimación del riesgo se calculó empleando razón de odds. Se realizó ajuste multivariado mediante regresión logística binomial.

Resultados. El 19% de la población presentó al menos una exacerbación durante el año 2024, siendo las exacerbaciones leves las más frecuentes. El sexo masculino presentó una mayor proporción de estas crisis. Las infecciones respiratorias en el último año y la adherencia al tratamiento se asociaron de forma estadísticamente significativa con la ocurrencia de crisis asmáticas. En el modelo multivariado, las infecciones respiratorias previas mantuvieron una asociación significativa (OR = 13.97; IC 95%: 3.99-48.89; p<0.001). Sin embargo, el amplio intervalo de confianza indica baja precisión en la estimación, por lo que este resultado se debe interpretar con cautela.

Conclusiones. Las infecciones respiratorias previas constituyen un factor de riesgo importante para las crisis asmáticas en población pediátrica entre 6 y 11 años. Aunque la adherencia al tratamiento no mostró asociación en el modelo multivariado, su importancia clínica ha sido ampliamente documentada en la literatura.

Palabras clave

Asma; exacerbación asmática; niño; factores de riesgo; infecciones del sistema respiratorio.

Introduction

Asthma is a chronic respiratory disease that affects millions of children worldwide. Breathing difficulties, commonly referred to asthma attacks, represent one of the main acute manifestations of the disease and may require urgent medical attention [1,2].

Although significant medical advances have been made in the treatment of asthma from an early age, exacerbations in this population remain frequent. In this context, it is important to consider the anatomical and physiological characteristics of the pediatric airway, which contribute significantly to the severity of asthma attacks [3,4]. It is worth noting that asthma represents not only a problem for individual health but

also a relevant public health concern, as it is one of the leading causes of pediatric hospital visits, thereby generating costs for the healthcare system and affecting the quality of life of children and their families [5].

The prevalence of asthma varies widely across the world; global estimates range between 1% and 18%. According to the World Health Organization (WHO), 262 million people had asthma in 2019, causing at least 455,000 deaths. Most of these deaths occur in low- and middle-income countries, where diagnosis and treatment rates are generally lower. Likewise, scientific evidence shows that the prevalence of this disease has tended to remain stable in developed countries; however, in low- and middle-income countries there is evidence of an increasing trend in asthma cases [6-8].

In Colombia, epidemiological studies have been conducted since 1992, indicating an increase in the prevalence of asthma among individuals aged 5 to 17 years. Likewise, national prevalence data by region and age group between 2015 and 2019 show a rate of 20.15% in Bogotá and 16.84% in the department of Antioquia, representing the highest prevalence rates in the country particularly among children under 11 years of age, who represent a large proportion of the pediatric population affected by the disease. However, updated epidemiological reports following the COVID-19 pandemic remain limited [6,9,10].

Consequently, the primary objective of the Global Initiative for Asthma (GINA) is to prevent asthma-related fatalities while alleviating the burden on individuals, families, communities, the healthcare system, and the environment. In alignment with this goal, various studies have sought to identify the factors associated with asthma exacerbations, revealing that previous respiratory infections, tobacco exposure, contact with pets, prior hospitalizations, and poor treatment adherence are significant risk factors for future crises [11,12]. Viral respiratory infections have been recognized as one of the most common triggers of asthma exacerbations in children, due to their ability to induce airway inflammation and bronchial hyperreactivity [12,13].

Despite the available evidence, the factors associated with asthma exacerbations may vary among different populations according to socioeconomic, clinical, and environmental conditions [1]. The healthcare institution where this study was conducted has no previous analyses describing the behavior of these variables in its pediatric asthma population, revealing an opportunity to generate local evidence to guide prevention and management strategies. Therefore, the objective of this study was to determine the factors associated with asthma exacerbations in pediatric patients aged 6 to 11 years treated at a healthcare institution in Medellín during 2024.

Method

An analytical cross-sectional observational study was conducted in pediatric patients with a confirmed medical diagnosis of asthma who attended the Military Medical Dispensary of Medellín during 2024. Eligible participants were children aged between 6 and 11 years with diagnosis of asthma confirmed by a pediatric specialist and documented in the medical record, who has at least one medical consultation at the institution during the study period. Patients with incomplete medical records regarding the main outcome variable or those who were not permanent residents of the department of Antioquia were excluded.

An a priori sample size calculation was performed based on expected associations reported in the literature. However, the database did not contain enough patients to meet the initially calculated sample size; therefore, a non-probabilistic convenience sample was used for the

analysis. The outcome variable was asthma exacerbation, defined as episodes of progressive worsening of respiratory symptoms in patients with a previous diagnosis of asthma, characterized by increased dyspnea, wheezing, chest tightness, and/or cough, requiring intensification of usual therapy or unplanned medical care, documented in medical history in the year 2024.

Independent variables included sociodemographic and clinical characteristics, such as sex, age, family and clinical history, body mass index, documented respiratory infections during the previous year, adherence to pharmacological treatment based on information provided by the patient and recorded by the treating physician, and dietary pattern. Dietary pattern was classified as balanced or unbalanced according to nutritional assessments documental by healthcare professionals.

Data were collected through a retrospective review of electronic medical records and entered into a pre-coded database. Data extractors were previously trained to ensure standardized data collection. All records were anonymized using unique identification codes, and data confidentiality was ensured through storage on a secure institutional server.

Descriptive analyses included frequencies and proportions for categorical variables and measures of central tendency and dispersion for quantitative variables. The normality of continuous variables was assessed using the Kolmogorov–Smirnov test. For the evaluation of associations between categorical variables, the chi-square (χ^2) test was used. Prior to its application, the assumptions required for this test were verified, particularly that at least 80% of the cells had expected frequencies equal to or greater than five and that no cell had an expected frequency below one. When these criteria were not met, Fisher's exact test was used.

Both tests were applied in an exploratory manner to assess the robustness of the results. Comparison of the p-values obtained from the chi-square and Fisher's exact tests showed no meaningful differences between methods, indicating stability in the estimation of statistical significance regardless of the test used. The magnitude of associations was estimated using odds ratios (OR) with their corresponding 95% confidence intervals. Variables with a p-value < 0.05 in the bivariate analysis were included in a multivariate binomial logistic regression model. Model fit was evaluated using the Akaike Information Criterion (AIC), McFadden's pseudo-R^2, the Omnibus likelihood ratio test, and multicollinearity was assessed using the variance inflation factor (VIF). Statistical analyses were performed using Jamovi software.

To control for selection and information bias, inclusion and exclusion criteria were clearly defined a priori. Variables with more than 10% missing data were excluded from the analysis. Variables with missing data ≤10% were handled using multiple imputation by iterative regression, under the assumption that data were missing at random.

The imputation model included all variables used in the primary analysis. Following imputation, a sensitivity analysis was conducted comparing results from the imputed datasets with those obtained from a complete-case analysis. The direction and magnitude of the associations remained consistent across all analyses.

The study complied with national and international ethical standards. According to Colombian Resolution 8430 of 1993, the study was classified as minimal risk. Approval was obtained from the Ethics Committee of the Fundación Universitaria del Area Andina, and the study adhered to Law 1581 of 2012 regarding the protection of personal data. Given the retrospective nature of the study and the use of anonymized data, the requirement for informed consent was waived.

Results

Table 1 summarizes the characteristics of the study population. A total of 109 children aged 6–11 years were analyzed, including boys and girls with a medical diagnosis of asthma who are part of the follow-up database of the Military Medical Dispensary in the city of Medellín. Overall, 19% of the study population experienced at least one asthma exacerbation in 2024. Among these cases, 61% corresponded to male patients. Regarding asthma severity, the most frequently reported category was mild, followed by moderate severity, while severe asthma was uncommon and was represented by only one case in the study population.

Table 1. Characteristics of the study population.

Variables	Category	n	%
Asthma Exacerbation	No	88	81%
	Yes	21	19%
Sociodemographic variables			
Sex	Male	66	61%
	Female	43	39%
Age (years)	6	11	10%
	7	22	20%
	8	19	17%
	9	20	18%
	10	17	16%
	11	20	18%
Clinical variables			
Family history of asthma	No	88	81%
	Yes	21	19%
History of preterm birth	No	94	86%
	Yes	15	14%
History of atopy	No	58	53%
	Yes	51	47%
Severity of asthma exacerbation	Mild	18	85.7%
	Moderate	2	9.5%
	Severe	1	4.8%
Adenoid hypertrophy	No	89	82%
	Yes	20	18%
Body Mass Index	Underweight	9	8.3%
	Healthy weight	66	61%
	Overweight	17	16%
	Obesity	17	16%
Respiratory infection (last year)	No	75	69%
	Yes	34	31%
Home medical management (last year)	No	80	73%
	Yes	29	27%
Adherence to medical treatment	No	51	47%
	Yes	58	53%
Diet	Balanced	92	84%
	Unbalanced	17	16%

Participants ranged in age from 6 to 11 years; the age distribution was non-normal ($p < 0.05$); with a median age of 9 years and an interquartile range (IQR) of 3. The most frequent age was 7 years, representing 20% of the study population, followed by ages 9 and 11, each accounting for 18%. Children aged 6 years showed the lowest representation, with 11 cases, corresponding to 10% of the total population.

Regarding clinical characteristics, 19% of participants reported a first-degree family history of asthma, 15% had a history of prematurity, and 51% presented with atopy, with allergic rhinitis being the most frequently reported condition. Additionally, 20% of the population had a medical diagnosis of adenoid hypertrophy. Based on Body Mass Index (BMI), 66% of the children had a healthy weight, followed by overweight and obesity, while malnutrition was recorded in a smaller proportion (9%).

With respect to healthcare utilization and treatment-related variables, 31% of the study population sought medical care due to acute respiratory infection in 2024. At-home pharmacological management for asthma was reported in 29% of cases, of whom 58% were adherent to the prescribed treatment. Finally, dietary information indicated that 84% of participants reported having a balanced diet.

Table 2 presents the results of the bivariate analysis. The chi-square (χ^2) test identified statistically significant associations ($p < 0.05$) for the variables *respiratory infection in the past year* and *treatment adherence*. Both variables were therefore considered for inclusion in the multivariate analysis.

Table 2. Bivariate Analysis.

Independent variables	0	1	Statistical test
	(n=88)	(n=21)	X^2
Sex	34/88	9/21	X^2=0.13, *p*=0.72
Age			X^2=0.50, *p*=0.99
6	9/88	2/21	
7	18/88	4/21	
8	15/88	4/21	
9	17/88	3/21	
10	13/88	4/21	
11	16/88	4/21	
Family history of asthma	20/88	1/21	X^2=3.52, *p*=0.06
History of preterm birth	11/88	4/21	X^2=0.61, *p*=0.43
History of atopy	39/88	12/21	X^2=1.12, *p*=0.29
Adenoid hypertrophy	16/88	4/21	X^2=0.01, *p*=0.93
Body Mass Index			X^2=2.26, *p*=0.52
Underweight	6/88	3/21	
Healthy weight	56/88	10/21	
Overweight	13/88	4/21	
Obesity	13/88	4/21	
Respiratory infection (last year)	17/88	17/21	X^2=30.01, *p*=<0.01*

Home medical management (last year)	21/88	8/21	X^2=1.76, *p*=0.18
Adherence to medical treatment	41/88	17/21	X^2=8.04, *p*=<0.01*
Diet	12/88	5/21	X^2=1.33, *p*=0.25

Note. * Statistically significant p-value (p < 0.05).

Tables 3 and 4 show the construction of the binomial logistic regression model, which included treatment adherence and previous respiratory infection, as independent variables, given their statistical significance in the bivariate analysis.

Table 3. Model Fit Measures.

				Global Model Test		
Model	**Deviance**	**AIC**	**McFadden´s R^2**	**X^2**	**df**	**p-value**
1	98.21	102.21	0.08	8.62	1	0.003
2	76.89	82.89	0.28	29.94	2	<0.001

Note. Akaike Information Criterion (AIC), McFadden´s Pseudo-R^2 (R^2 MCF), Chi-square (X^2), degress of freedom (df), probability (p-value).

Table 4. Model Coefficients.

						Confidence Interval	
Predictor	**Estimate**	**SE**	**Z**	**p**	**Odds Ratio**	**Lower CI**	**Upper CI**
Constant	-0.16	0.37	-0.44	0.662	0.85	0.41	1.76
Treatment adherence 0-1	0.81	0.68	1.19	0.232	2.24	0.60	8.44
Previous respiratory infection 0-1	2.64	0.64	4.12	<0.001*	13.97	3.99	48.89

Model 1 included only one variable (treatment adherence), whereas Model 2 was adjusted to include both variables (treatment adherence and previous respiratory infection).

Assumptions for logistic regression were verified, and no evidence of multicollinearity was observed (VIF = 1). Model 2 was selected as the best-fitting model based on a lower Akaike Information Criterion (AIC = 82.89 vs. 102.21), a higher McFadden's pseudo-R^2 (0.28 vs. 0.08), a statistically significant Omnibus likelihood ratio test (p < 0.001), and superior performance, with a specificity of 0.67 and a sensitivity of 0.85.

In the adjusted analysis, previous respiratory infection was strongly associated with asthma exacerbation. Children with a documented respiratory infection were more likely to experience an asthma exacerbation compared with those without a prior infection (OR = 13.97; 95% CI: 3.99–48.89; p < 0.001). Although this association was statistically significant, the

wide confidence interval suggests limited precision, and the magnitude of the association should therefore be interpreted with caution.

Conversely, after adjustment, treatment adherence showed an OR = 2.29 with a p-value = 0.232 and a confidence interval crossing the null value (0.60–8.44), indicating that the associations was not statistically significant (See Figure 1).

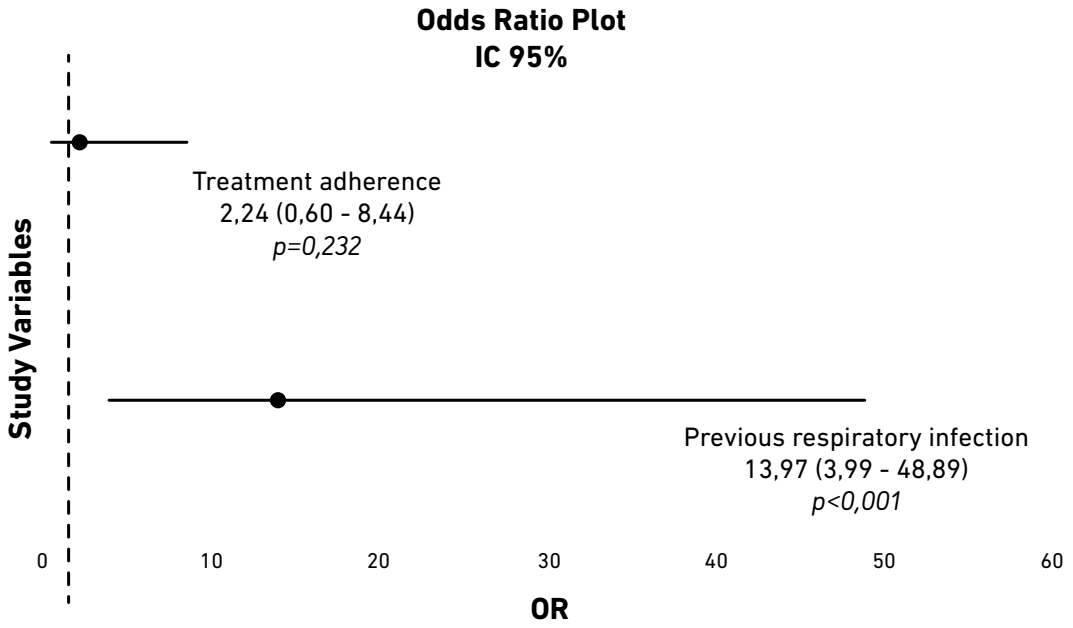

Figure 1. Odds Ratio Plot.

Source: Prepared by the authors.

Discussion

Asthma is a chronic, noncommunicable, and heterogeneous inflammatory disease that affects millions of people worldwide and is one of the most prevalent respiratory diseases in childhood [1]. In Colombia, it is estimated that around 5 million people may have asthma; however, only about 285,000 cases are treated each year [14]. This suggests possible underdiagnosis, which may be influenced by mild or intermittent cases that go unreported, stigma or lack of awareness, and limited access to specialized healthcare services.

In the present study, a total of 109 boys and girls with a medical diagnosis of asthma, aged between 6 and 11 years, were identified from a database of 473 individuals across all age groups, estimating a prevalence of 23% in the study population. Although this value is relatively high, it remains below the national report, in which 45.4% of cases correspond to children under 11 years of age [9]. This difference may be partially explained by the exclusion of children younger than five years in the present study. Additionally, the prevalence observed was lower than that reported in other studies conducted in similar age groups, such as a previous investigation that reported a prevalence of 31.5% in a sample of 120 children [15]. These discrepancies highlight the variability in asthma prevalence estimates according to differences in population characteristics and study design.

During 2024, 19% of the studied population reported experiencing an asthma crisis, with mild exacerbations being the most frequently observed, which is consistent with other published studies [16]. However, this aspect is relevant considering that asthma exacerbations, regardless of their intensity, are significantly associated with morbidity and mortality during childhood [17,18]. For this reason, continuous clinical monitoring of all pediatric patients who experience exacerbations is recommended [19,20]. These findings may also be influenced by the characteristics of the sample, as the study was conducted at a healthcare institution with a relatively low level of complexity.

Asthma severity was not assessed in the present study due to insufficient detail in medical records. Nonetheless, it is acknowledged as a clinically relevant variable, as disease severity guides treatment decisions and helps evaluate future risk of exacerbations. Evidence from the literature shows that even mild asthma can result in severe exacerbations; thus, identifying and controlling risk factors remains essential, given their potential to significantly affect a child's academic and social functioning. This highlights the importance of including this variable in future research [17].

Moreover, asthma exacerbations were more frequent among male participants (61%) which is consistent with several studies reporting a higher prevalence and greater severity of asthma in males during childhood. This sex-related difference has been attributed to hormonal factors [21-23]. However, other studies in pediatric populations have reported a higher prevalence in females, a finding that may be explained by differences in the age ranges included in those analyses [15,24].

Bivariate analysis in the present study revealed a statistically significant association between treatment adherence, respiratory infection within the previous year, and asthma exacerbations. Nevertheless, in the binomial logistic regression model, treatment adherence lost statistical significance ($p > 0.05$), whereas respiratory infections remained a significant risk factor for asthma exacerbations in the pediatric population. The discrepancy between bivariate and multivariate analyses may be explained by the absence of relevant mediating variables, such as correct inhaler technique or patient education delivered by healthcare professionals. It should be emphasized that, due to the cross-sectional design of this study, it is not possible to confirm or rule out adherence as a factor associated with asthma exacerbations. Nonetheless, evidence from cohort studies supports the importance of adherence in asthma control, identifying it as a protective factor [25,26].

Therefore, the absence of statistical significance for variables such as atopy, treatment adherence, diet, and body mass index should not be interpreted as evidence of lack of clinical relevance. Instead, it highlights the need for more robust research designs capable of capturing mediating variables and incorporating longitudinal follow-up to better establish causal relationships.

In the binomial logistic regression model, prior respiratory infection was significantly associated with an increased probability of experiencing asthma exacerbation. However, the wide confidence interval indicates limited precision of the estimate, even after adjustment for treatment adherence. Similar results have been reported in other investigations, such as the case–control study by Recabarren et al., which found an OR of 27.61 (95% CI: 12.34–61.75). The loss of precision may be attributed to small sample sizes and a low number of events in one of the comparison groups. Nonetheless, the wide confidence interval may also reflect underlying pathophysiological mechanisms, such as early viral sensitization, underscoring the potential value of including immunological variables in future research [27-29].

The prevention of respiratory infections in pediatric patients with asthma has been shown to reduce emergency department visits and hospital admissions. This was evidenced in countries such as the United States during the pandemic, where enhanced self-care and respiratory virus prevention measures contributed to a substantial reduction in emergency consultations for asthma exacerbations, particularly among children [30]. This finding is particularly relevant, as some of these measures may be incorporated as strategies for asthma control, especially during the winter months when the circulation of respiratory viruses tends to increase [31].

These findings should be interpreted with caution, given the methodological limitations. As a cross-sectional design was used, causal relationships and temporal sequences between variables and asthma exacerbations could not be established. Moreover, the convenience sampling approach limits the generalizability of the findings, and the relatively small sample size further constrains the ability to explore the outcome of interest.

Additionally, data were collected through the review of medical records from 2024. However, due to incomplete information, several clinically relevant variables could not be considered, including socioeconomic status, parental education level, vaccination history, spirometric measurements, and other diagnostic tests. Similarly, environmental triggering factors such as exposure to tobacco smoke, pets, or pollen were not documented. These limitations highlight the importance of incorporating alternative data collection strategies in future research, such as structured questionnaires and direct observation.

Despite the limitations described, this study presents several strengths that reinforce the validity and applicability of its findings. Methodological rigor was ensured through clearly defined inclusion and exclusion criteria, along with an analytical plan consistent with the study objectives. Although non-probabilistic sampling was employed, the findings offer valuable evidence that can inform future longitudinal research with larger sample sizes and greater statistical power. Accordingly, these findings will be highly valuable for the reference institution, allowing it to strengthen evaluation and intervention strategies aimed at this pediatric population. Finally, the importance of accurate and timely diagnosis is emphasized [32], considering that children who receive appropriate care have fewer emergency visits and hospitalizations, which translates into an improved quality of life [15,33].

Conclusions

This study identified factors associated with asthma exacerbations in pediatric patients aged 6 to 11 years who were treated at a low-complexity healthcare institution in Medellín during 2024. Nineteen percent of the population experienced at least one exacerbation, with mild exacerbations being the most frequent, and male patients representing the highest proportion of cases.

Bivariate analysis revealed a statistically significant association between prior respiratory infections and treatment adherence with the occurrence of asthma exacerbations. In the binomial logistic regression model, only prior respiratory infections retained statistical significance. However, the wide confidence interval indicates limited precision of the estimate, and therefore this result should be interpreted with caution. Treatment adherence lost its significant association, suggesting that this relationship may be mediated by unmeasured variables.

In conclusion, prior respiratory infections represent a relevant risk factor for asthma exacerbations in the pediatric population studied. Although treatment adherence did not show an association in the multivariate model, its clinical importance is acknowledged and supported by previous literature.

The findings of this study provide locally relevant evidence that may inform clinical monitoring and preventive strategies within the reference institution. Future longitudinal studies are recommended to establish causal relationships and further clarify the role of treatment adherence and other related variables.

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