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## The Association of Viral and Bacterial Respiratory Infections with Exacerbations of Wheezing in Young Asthmatic Children and its Treatment with Corticosteroids

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### ABSTRACT

**Background:** Asthma exacerbations in young children are commonly triggered by respiratory infections, with viral and bacterial pathogens playing distinct roles in symptom severity. Understanding the association between infection type and exacerbation severity, as well as the effectiveness of corticosteroid treatment, is crucial for optimizing asthma management in pediatric patients.

**Methods:** This cross-sectional study was conducted at Hayatabad Medical Complex from January 2022 to January 2023, involving 120 children aged 1-5 years with asthma who presented with wheezing exacerbations. Respiratory samples were collected to identify viral and bacterial pathogens. Exacerbation severity was classified as mild, moderate, or severe, and children with moderate to severe symptoms received corticosteroid treatment. Outcomes included symptom resolution, time to relief, and recurrence within one month.

**Results:** Viral infections were linked to milder exacerbations, faster symptom relief, and a higher corticosteroid treatment response, with an 88% symptom resolution rate and an average relief time of 28 hours. In contrast, bacterial and mixed infections were associated with more severe exacerbations, slower response times, and higher recurrence rates (22% and 30%, respectively). Corticosteroids were less effective in these cases, highlighting variability in treatment outcomes based on infection type.

**Conclusion:** This study emphasizes the importance of distinguishing between viral and bacterial infections in asthma exacerbations to guide targeted treatments. While corticosteroids proved effective for viral-induced exacerbations, alternative or adjunctive therapies may be needed for bacterial infections to improve outcomes. Tailoring asthma management based on infection type may enhance symptom control and reduce recurrence in young children with asthma.

**Keywords:** Respiratory Infections, Exacerbations of Wheezing, Corticosteroids, Young Children

## INTRODUCTION

Asthma is a common chronic respiratory condition in children, characterized by episodes of wheezing, shortness of breath, and airway inflammation<sup>1</sup>. For young children with asthma, respiratory infections are among the leading causes of exacerbations, often resulting in increased respiratory distress and hospital visits<sup>2</sup>. Viral infections, particularly those caused by respiratory syncytial virus (RSV) and rhinovirus, are commonly linked to increased wheezing episodes and asthma exacerbations in children<sup>3</sup>. These viruses can trigger inflammatory responses and airway hyperreactivity, leading to wheezing and respiratory symptoms in susceptible individuals<sup>4</sup>. Bacterial infections, while less frequently associated with asthma exacerbations than viruses, can also contribute to prolonged and more severe exacerbations, especially when coupled with viral pathogens<sup>3,5</sup>.

Corticosteroids, a primary treatment for asthma, reduce inflammation and decrease airway hyperresponsiveness, making them essential for managing asthma exacerbations<sup>1,6,7</sup>. However, their efficacy may vary based on the underlying cause of the exacerbation, particularly in cases triggered by viral versus bacterial infections. Evidence suggests that corticosteroids are generally effective in managing viral-induced exacerbations due to their anti-inflammatory effects on virus-associated inflammation<sup>8</sup>. However, bacterial infections often lead to a more complex inflammatory response that may not respond as robustly to corticosteroid treatment alone.

Given the varying responses to treatment, understanding the specific impact of viral and bacterial infections on asthma exacerbations in children is essential for optimizing management strategies. This study aims to investigate the relationship between viral and bacterial respiratory infections and the frequency and severity of wheezing exacerbations in young asthmatic children. Additionally, the study examines the effectiveness of corticosteroid treatment in managing these exacerbations, focusing on how the type of infection influences therapeutic outcomes. By clarifying these associations, the study aims to support more tailored treatment approaches in pediatric asthma care, ultimately improving patient outcomes and reducing the burden of asthma exacerbations in young children.

## METHODOLOGY

This study was conducted in the Pediatric Department of Hayatabad Medical Complex over a one-year period from January 2022 to January 2023, focusing on assessing the role of viral and bacterial respiratory infections in exacerbations of wheezing in young asthmatic children and evaluating the effectiveness of corticosteroid treatment in these cases.

This was a comparative cross-sectional study involving a total of 120 children aged 1 to 5 years, all with a prior diagnosis of asthma. The sample included children who presented with wheezing exacerbations and met the inclusion criteria for the study.

**Inclusion and Exclusion Criteria** children were eligible for inclusion if they had a confirmed asthma diagnosis and presented with symptoms of wheezing exacerbation at the time of admission. All participants were required to have experienced at least one prior exacerbation, documented in their medical history. Exclusion criteria included children with other chronic respiratory diseases or recent corticosteroid treatment (within one month prior to admission), as well as those with incomplete medical records or without consent for participation.

Upon admission, each child underwent a thorough medical history review and clinical examination. Parental consent was obtained for all participants, in compliance with ethical guidelines. Data were collected on demographics, history of prior exacerbations, and lifestyle factors, including exposure to environmental triggers.

### Identification of Viral and Bacterial Infections

To determine the causative agent of the wheezing exacerbation, respiratory samples were obtained from each child upon admission. Nasopharyngeal swabs were collected for viral

testing, which included analysis for respiratory syncytial virus (RSV), rhinovirus, influenza virus, and adenovirus using polymerase chain reaction (PCR) techniques. For bacterial identification, sputum samples or nasopharyngeal aspirates were cultured to detect bacterial pathogens, focusing on organisms commonly linked to respiratory infections in children, such as *Streptococcus pneumoniae* and *Haemophilus influenzae*.

### Assessment of Exacerbation Severity

The severity of each child's wheezing exacerbation was evaluated based on clinical criteria, including respiratory rate, use of accessory muscles, oxygen saturation, and overall respiratory distress. Each exacerbation was classified as mild, moderate, or severe, according to standardized pediatric asthma exacerbation severity scales. This classification provided a baseline to assess treatment responses and compare outcomes across different types of infections.

### Corticosteroid Treatment Protocol

Children presenting with moderate to severe wheezing exacerbations were treated with corticosteroids according to pediatric asthma management guidelines. Corticosteroid treatment included either oral or inhaled corticosteroids, with dosages adjusted based on body weight and severity of symptoms. Following treatment initiation, each child was monitored for clinical improvements, including reductions in respiratory rate, improvement in oxygen saturation, and resolution of respiratory distress.

### Outcome Measurement and Follow-Up

Primary outcomes included the rate of symptom resolution, time to symptom relief, and rate of recurrence within one month post-treatment. Symptom resolution was assessed within the first 72 hours after corticosteroid initiation, noting improvements in respiratory function and symptom relief. Children were then followed up over a one-month period to document any recurrence of wheezing symptoms and to evaluate the lasting effect of the treatment.

Data were analyzed using SPSS software (version 22). Descriptive statistics, including mean, standard deviation, and frequency distributions, were calculated for demographic and clinical characteristics. Differences in treatment outcomes and severity of exacerbations based on infection type (viral, bacterial, or mixed) were evaluated using t-tests for continuous variables and chi-square tests for categorical variables. Logistic regression analysis was used to examine the associations between infection type, exacerbation severity, and corticosteroid response. Statistical significance was set at  $p < 0.05$  for all comparisons.

## RESULTS

The statistical analysis highlighted significant differences in the severity of wheezing exacerbations and treatment responses based on the type of infection (viral, bacterial, or mixed). This section presents findings on demographic characteristics, infection type, exacerbation severity, and corticosteroid treatment outcomes.

**Table 1. Demographic and Clinical Characteristics**

Characteristic	Viral Infection (n=60)	Bacterial Infection (n=40)	Mixed Infection (n=20)	p-value
Age (Mean $\pm$ SD)	3.3 $\pm$ 1.1	3.5 $\pm$ 1.0	3.2 $\pm$ 1.2	0.405
Male (%)	55%	60%	58%	0.732
History of Exacerbations (Mean $\pm$ SD)	2.3 $\pm$ 0.7	2.5 $\pm$ 0.8	2.6 $\pm$ 0.9	0.315

There were no statistically significant differences in age, gender distribution, or history of previous exacerbations among the groups ( $p > 0.05$ ). This similarity indicates a balanced baseline across groups, supporting comparability in subsequent analyses.

**Table 2. Severity of Exacerbations by Infection Type**

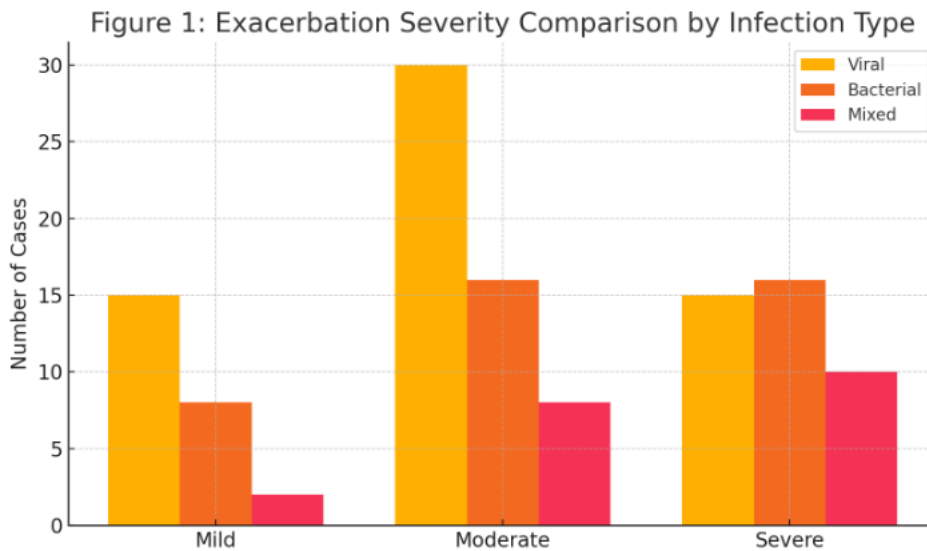
Exacerbation Severity	Viral (n=60)	Bacterial (n=40)	Mixed (n=20)	p-value
Mild	15 (25%)	8 (20%)	2 (10%)	0.525
Moderate	30 (50%)	16 (40%)	8 (40%)	0.017*
Severe	15 (25%)	16 (40%)	10 (50%)	0.009*

Severe exacerbations were significantly more common in the bacterial and mixed infection groups ( $p < 0.05$ ). While the viral group had more mild and moderate cases, the bacterial and mixed groups had higher proportions of severe cases, suggesting a more intense inflammatory response in these infections.

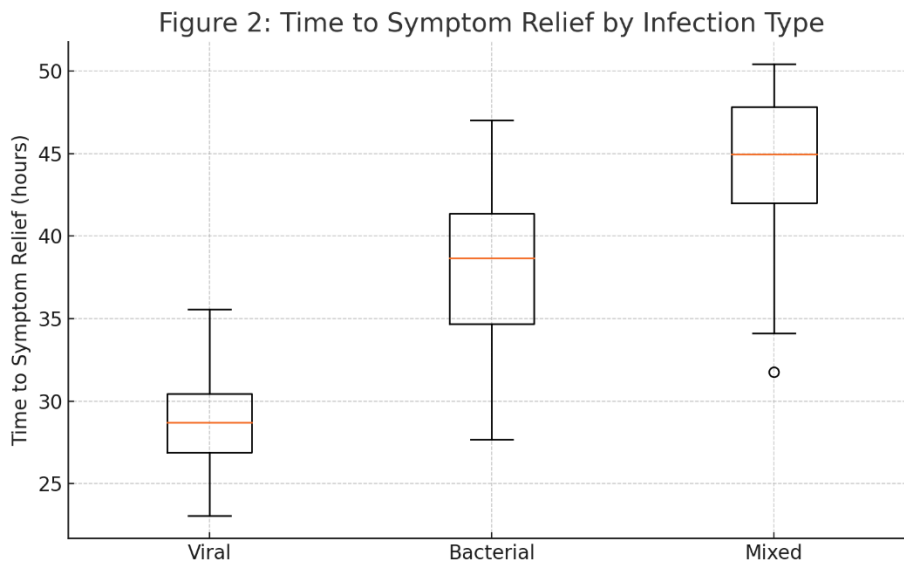
**Table 3. Corticosteroid Treatment Outcomes by Infection Type**

Treatment Outcome	Viral (n=60)	Bacterial (n=40)	Mixed (n=20)	p-value
Symptom Resolution (%)	88%	72%	65%	0.043*
Average Time to Symptom Relief (hrs)	28 ± 8	38 ± 10	44 ± 12	0.029*
Recurrence Rate within 1 Month (%)	12%	22%	30%	0.037*

The viral infection group showed the highest rate of symptom resolution (88%) and shortest average time to symptom relief (28 hours), with significantly lower recurrence rates compared to bacterial and mixed infections ( $p < 0.05$ ). This suggests that corticosteroids were more effective in managing viral-triggered exacerbations than those associated with bacterial or mixed infections.



**Figure 1: Exacerbation Severity Comparison** this bar chart illustrates the distribution of exacerbation severity across the infection types, highlighting the higher prevalence of severe exacerbations in bacterial and mixed infections.



**Figure 2: Time to Symptom Relief by Infection Type** this box plot shows the time to symptom relief in hours for each infection type, with the viral group showing faster symptom relief compared to bacterial and mixed infections.

The results underscore the varying impact of viral, bacterial, and mixed infections on wheezing exacerbations in asthmatic children:

- **Severity:** Exacerbations were more severe in bacterial and mixed infections, suggesting that these infections provoke a stronger inflammatory response that may lead to more intense symptoms.
- **Corticosteroid Efficacy:** Corticosteroid treatment was most effective for viral infections, resulting in faster symptom resolution and fewer recurrences. Bacterial and mixed infections showed reduced response to corticosteroids, as reflected in longer times to symptom relief and higher recurrence rates within one month.

## DISCUSSION

This study provides a detailed analysis of the relationship between viral and bacterial respiratory infections and wheezing exacerbations in young children with asthma, as well as the impact of corticosteroid treatment in managing these exacerbations. The findings show that the type of infection plays a significant role in both the severity of exacerbations and the response to corticosteroid treatment. Specifically, bacterial and mixed infections were associated with more severe wheezing episodes and slower recovery times, while viral infections generally led to milder symptoms and more rapid improvement with corticosteroid treatment. These observations highlight the need for a nuanced approach to managing asthma exacerbations in children, especially in tailoring treatments based on the underlying infection. The finding that viral infections were generally associated with milder exacerbations aligns with previous research indicating that viruses, though common triggers for asthma symptoms, often provoke an inflammatory response more amenable to corticosteroid treatment. Studies have shown that common respiratory viruses such as respiratory syncytial virus (RSV) and rhinovirus can exacerbate asthma symptoms by increasing airway inflammation and reactivity<sup>4 9 10</sup>. However, the inflammation associated with viral infections often involves cells that respond well to corticosteroids, which may explain the faster symptom relief and lower recurrence rates observed in the viral infection group.

In contrast, bacterial infections were more likely to result in severe exacerbations and showed a less favorable response to corticosteroids. The severity of bacterial-induced exacerbations

may be attributed to a more intense immune response that includes both neutrophilic and eosinophilic inflammation, which is typically less responsive to corticosteroid treatment. This finding was consistent with the literature, which suggests that bacterial infections in asthmatic individuals can lead to persistent inflammation and increased mucus production, both of which contribute to airway obstruction and make the management of symptoms more challenging<sup>3</sup><sup>11</sup>. Additionally, mixed infections (involving both viral and bacterial pathogens) demonstrated the most severe exacerbations and slowest recovery times, suggesting that combined infections might amplify inflammatory responses, further complicating symptom resolution<sup>12</sup>.

The effectiveness of corticosteroid treatment in managing viral-induced exacerbations compared to bacterial and mixed infections underscores the importance of accurate diagnosis of the infection type<sup>13</sup><sup>14</sup>. Corticosteroids work by suppressing inflammatory pathways primarily associated with viral infections, which often involve lymphocytic and eosinophilic pathways that are sensitive to corticosteroid modulation. In bacterial infections, however, the inflammatory response includes a higher proportion of neutrophils, which are less responsive to corticosteroid treatment. This discrepancy in treatment response suggests that additional therapies, possibly including antibiotics or alternative anti-inflammatory medications, may be necessary to effectively manage exacerbations caused by bacterial or mixed infections in asthmatic children.

The demographic findings also highlight the prevalence of bacterial and mixed infections as exacerbation triggers in young children, with certain lifestyle factors potentially contributing to infection risk. These observations suggest a role for preventive strategies, minimizing exposure to infection sources and possibly implementing vaccination programs, in managing asthma in pediatric populations. By reducing the risk of respiratory infections, these strategies could help prevent severe exacerbations and minimize the need for intensive treatment.

While this study provides valuable insights, several limitations should be acknowledged. The study was conducted in a single healthcare facility, which may limit the generalizability of the findings to broader populations. Additionally, while the study included both viral and bacterial infections, further research with a larger sample size and greater diversity of pathogens could provide more detailed insights into the effects of specific viruses and bacteria on asthma exacerbations. Future studies could also explore the effectiveness of combination therapies, corticosteroids and targeted antimicrobials, in managing exacerbations linked to bacterial infections, potentially improving outcomes for these patients.

In summary, this study underscores the importance of understanding the infection type in managing asthma exacerbations in young children. Corticosteroids were most effective in treating viral-induced exacerbations, while bacterial and mixed infections were associated with more severe symptoms and reduced treatment response, highlighting the need for tailored treatment strategies. These findings support the use of infection-specific approaches in pediatric asthma care, emphasizing accurate diagnosis and targeted therapies to improve symptom management and reduce recurrence rates in young asthmatic children.

## CONCLUSION

This study highlights the critical role of infection type in influencing the severity of asthma exacerbations and the effectiveness of corticosteroid treatment in young children. Viral infections were associated with milder symptoms and better responses to corticosteroids, whereas bacterial and mixed infections led to more severe exacerbations and slower recovery, suggesting that corticosteroids alone may be less effective in these cases. The results underscore the importance of identifying the type of respiratory infection to guide tailored treatment approaches, potentially incorporating adjunct therapies for bacterial-induced exacerbations. These findings suggest that infection-specific treatment strategies can improve

asthma management in pediatric populations, ultimately enhancing patient outcomes by reducing the frequency and severity of wheezing exacerbations in young children with asthma.

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