



*Original Article*

## **Prevalence and Clinical Characteristics of Pediatric Rhinovirus Infection During Winter in Erbil City, Iraq**

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### **ABSTRACT**

Respiratory infections remain the leading infectious cause of childhood morbidity and mortality worldwide, particularly affecting children under five. Viral pathogens cause approximately 80% of pediatric acute respiratory tract infections (ARTIs), with human rhinovirus (HRV) emerging as an etiological agent associated with both mild and severe infections. This cross-sectional study was conducted to investigate the criteria of ARTI in 177 pediatric patients aged  $\leq 5$  years who visited Raparin Teaching Hospital for Children from December 1<sup>st</sup> 2024 to the 28<sup>th</sup> of February 2025. Following nucleic acid extraction, multiplex real-time RT-PCR was used for the detection of HRV. Among the studied 177 pediatric patients with ARTIs, 98 (55.4%) were admitted to the hospital and 79 (44.6%) received treatment and were sent home (outpatients). Their mean age was  $12.38 \pm 10.56$  months, with male predominance (56.5%). Cough (99.4%), fatigue (99.4%), and fever (98.3%) were the most frequent symptoms. Auscultation revealed wheezing (54.8%) and rales (22.6%) as the main lung sounds, with significantly higher rates in inpatients versus outpatients (58.2% vs. 50.6%,  $p = 0.03$ ; 26.5% vs. 19.0%,  $p = 0.02$ , respectively). Rhinovirus was detected in 15 cases (8.5%), predominantly associated with bronchiolitis (46.7%) and bronchitis (40.0%). A temporal clustering was observed, with 60% of HRV-positive cases occurring in January and 40% in February ( $p = 0.044$ ). Conclusion: This study highlighted rhinovirus as an important pathogen in pediatric ARTIs in Erbil city, predominantly causing bronchiolitis and bronchitis. The high rates of wheezing and rales-particularly among inpatients-suggested that these clinical signs may serve as severity markers. These findings underscore the need for routine HRV screening in pediatric respiratory cases to guide management and infection control measures.

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*Keywords: Pediatric respiratory infection, Human Rhinovirus, Bronchiolitis, Wheezing.*

### **Introduction**

Viral respiratory infections are major causes of illness, hospitalization, and even mortality among pediatric patients [1]. Morphologically, Human rhinoviruses (HRVs) are naked viruses that belong to the Picornavirus family with a single-stranded positive-sense RNA genome, encoding a polyprotein that is cleaved into structural and non-structural proteins [2]. HRVs are highly transmissible via respiratory droplets, direct contact, and contaminated surfaces [3]. Clinically, they are mostly associated with mild upper ARTIs, however, they are implicated in severe illnesses, particularly in young children and those with preexisting medical conditions [4,5]. Globally, the prevalence rate of HRV infection ranges from 10% to 50%. Studies from the Middle East showed that rhinovirus infection is highly prevalent

among children and represents a major cause of respiratory illness. In Jordan, a large prospective study of hospitalized children under 2 years old found that rhinovirus was detected in 46.9% of cases, making it the second most common virus [6]. In a study from Iran of 322 children with upper and lower respiratory tract infections, 70 (about 22%) tested positive for rhinovirus [7]. Multiple factors may influence its distribution, such as climate, season, age, and certain risk factors [8,9]. Locally, studies on the prevalence of HRV infection in the pediatric population are scarce [10]. To our knowledge, this is the first study to provide a contemporary and comprehensive analysis of HRV infection exclusively in the pediatric population of Erbil. It delivers the first detailed epidemiological and clinical profile of HRV in the region's children, establishing crucial, up-to-date baseline incidence data.

The aim of this study is to characterize and compare the clinical presentation and severity of illness and to investigate the incidence of HRV infection among pediatric patients presenting

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with respiratory symptoms in Erbil City and to analyze the associated demographic and clinical characteristics.

## 2 Methodology

### 2.1 Study design

This cross-sectional study aimed to examine the occurrence of HRV infection and to identify the clinical and demographic characteristics of pediatric patients exhibiting signs of acute RTIs. The study encompassed children aged five years and younger who visited Raparin Teaching Hospital for Children in Erbil, Iraq, between December 1, 2024, to February 28, 2025. Children exhibiting signs of allergic respiratory problems or those who had been administered corticosteroids before sample collection were excluded. Nasal and throat swab specimens were obtained from eligible individuals and examined with a multiplex real-time reverse transcription PCR (RT-PCR) (Viasure, Certest, Spain), specifically developed to identify human rhinovirus/enterovirus. The utilized RT-qPCR kit was specifically validated to exclude cross-reactivity with rhinovirus/enterovirus, as confirmed by both in silico and experimental analysis. Verbal parental agreement and (written consent whenever possible) were obtained prior to sample collection, and all personal data were anonymized to ensure privacy and confidentiality. Demographic and clinical characteristics of each patient were recorded utilizing a standardized questionnaire designed for the study.

### 2.2 Ethics approval

The Medical Ethics Committee of Erbil Polytechnic University certified the research project, Compliance with the Declaration of Helsinki and related medical ethics standards was ensured throughout the study (Approval No. 24/0065, dated 28 April 2024).

### 2.3 Sample collection

Throat and nasal samples were collected from each patient diagnosed with ARTI using nylon-flocked swabs. The samples were kept in viral transport media (VTM) and stored at  $-70^{\circ}\text{C}$ .

### 2.4 Nucleic acid extraction

Viral RNA was extracted using the DBG-Spin<sup>TM</sup> Viral Nucleic Acid Kit (Debna BioGene BV, Netherland) according to the manufacturer's instructions. The concentration of the viral RNA was then tested using a NanoDrop ND-1000 Spectrophotometer (Thermo Scientific, U.S.A.). Extracts were either tested directly or stored at  $-80^{\circ}\text{C}$  for later testing.

### 2.5 Detection of Rhinovirus

For the detection of Rhinovirus, the VIASURE Rhinovirus + Enterovirus Real Time PCR Detection Kit was used. It was a one-step RT-qPCR format, where reverse transcription and amplification occur in the same reaction well. The reaction utilizes specific primers and fluorescent-labeled probes designed to amplify a conserved piece in the 5'UTR region of the genome. The reaction mix was rehydrated by adding 15  $\mu\text{L}$  of rehydration

buffer to each well. Each well received 5  $\mu\text{L}$  of RNA sample, positive control, or negative control as appropriate. For thermal cycling, the prepared strips were loaded into the Rotor-Gene RG-3000 thermocycler (Corbett Research, Australia) and run using a defined amplification protocol. All molecular procedures were conducted at Nobel Genetic MedLab in Erbil City.

### 2.6 Statistical analysis

The statistical Package for Social Sciences (SPSS) software (version 28) was used to perform the statistical analysis. Descriptive statistics, including the mean, standard deviation, and percentages, were calculated to summarize the data. To assess the associations between categorical variables, the Pearson Chi-square test ( $\chi^2$ ) was applied. Statistical significance was defined as a p-value less than 0.05.

**Table 1:** Demographic characteristics of pediatric patients with RTI.

Characteristic	Number	%
Patient type		
Inpatients	98	55.4%
Outpatients	79	44.6%
Residence		
Rural	80	45.2%
Urban	97	54.8%
Gender		
Male	100	56.5%
Female	77	43.5%
Age (months)		
Minimum	1	-
Maximum	60	-
Mean $\pm$ SD	12.38 $\pm$ 10.56	-
Weight (kg)		
Mean $\pm$ SD	9.520 $\pm$ 4.37	-

**Table 2:** Age categories of pediatric patients with RTI.

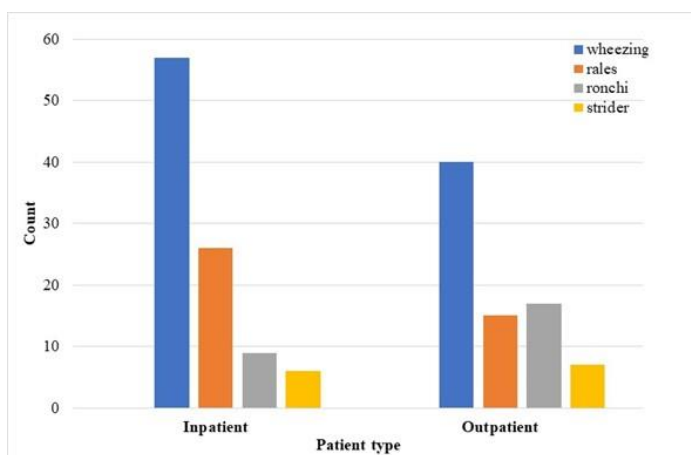
Age classes (month)	Number	%
$\leq 6$	60	33.9
7-12	63	35.6
$> 12$	54	30.5

A summary of the clinical findings among the studied subjects is depicted in Table 3. The most frequent symptoms exhibited by pediatric patients were cough (99.4%), fatigue/body ache (99.4%), rhinorrhea (97.2%), fever (98.3%), and sore throat (95.5%). Approximately 35.6% of patients had oxygen saturation

(SpO<sub>2</sub>) below 90%, indicating hypoxemia, while 64.4% maintained SpO<sub>2</sub> ≥ 90%. The comprehensive evaluation of the pediatric cohort revealed several noteworthy patterns in respiratory manifestations and disease profiles as presented in Table 3. Auscultation findings demonstrated that wheezing was the most prevalent abnormal lung sound recorded in 54.8% of the cases, a finding consistent with lower airway obstruction, followed by Rales which were detected in 22.6%. Stridor, indicative of upper airway pathology, was the least common finding (7.3%). Concerning the distribution of the above lung sounds among different patient groups, the analysis revealed distinct patterns presented in Figure 1, in which inpatients exhibited higher rates of wheezing (58.2% vs. 50.6%) and rales (26.5% vs. 19.0%), suggesting more severe obstructive pathology requiring hospitalization. In contrast, outpatients showed a greater proportion of ronchi (21.5% vs. 9.2%), potentially indicative of milder or chronic conditions managed ambulatory. These findings underscore wheezing and rales as markers of disease severity, warranting inpatient care, while ronchi may correlate with stable or resolving disease in outpatient settings ( $\chi^2$   $p < 0.001$ ). The same data included the clinical diagnosis made by clinical examination and chest radiograph, in which bronchiolitis was found to be the predominant one, accounting for up to 55.9% of the cases, followed by bronchitis (23.7%). More severe pulmonary infections were less common, with bronchopneumonia present in 9.6% and pneumonia in only 4% of patients. The relatively low incidence of croup (6.8%) suggests limited upper airway involvement in this cohort. Inpatients accounted for most bronchopneumonia (64.7%) and pneumonia (85.7%) cases, reinforcing their association with severe disease (Figure 2), however the association was not statistically significant ( $\chi^2$   $p = 0.11$ ). Moreover, disease severity assessment among the studied population revealed that nearly half of the cases (50.8%) were classified as moderate, while 46.3% were mild. Notably, severe disease manifestations were uncommon, occurring in just 2.8% of patients. Mild respiratory infections usually involve symptoms such as cough, sore throat, runny or stuffy nose, sneezing, headache, muscle aches, and low-grade fever, without significant breathing difficulty or changes in vital signs [11]. Moderate infections are characterized by more pronounced symptoms, such as increased respiratory rate, mild hypoxia (lowered oxygen saturation), and may require closer monitoring or supportive care, but generally do not cause severe distress or require intensive interventions [12]. Severe respiratory infections are marked by serious symptoms like significant difficulty breathing, marked hypoxia (low oxygen saturation), use of accessory muscles for breathing, altered level of consciousness, and may require hospitalization, oxygen therapy, or intensive care [13]. This severity distribution, combined with the diagnostic findings, suggests that while most cases presented with significant respiratory symptoms as evidenced by the high prevalence of wheezing, the majority represented moderate rather than life-threatening illness. However, inpatients comprised 81.1% of moderate and 100% of severe cases, while outpatients accounted for 75.6% of mild cases, and this correlation between severity and hospitalization was statistically significant (Figure 3) ( $\chi^2$   $p = 0.001$ ).

**Table 3:** Clinical characteristics of pediatric patients with RTI.

Characteristic	Number	%
Signs and symptoms		
cough	176	99.4%
Fatigue and body ache	176	99.4%
Fever (>38°C)	174	98.3%
diarrhea	54	30.5%
Sneezing	159	89.8%
Nasal congestion	173	80.8%
Sore throat	169	95.5%
Vomiting	71	40.1%
Dyspnea	112	63.3%
rhinorrhea	172	97.2%
SpO <sub>2</sub>		
< 90%	114	64.4%
≥90%	63	35.6%
Lung sounds		
Wheezing	97	54.8%
Rales	40	22.6%
Ronchi (crackles)	26	14.7%
Strider	13	7.3%
Clinical diagnosis		
Croup	12	6.8%
Bronchitis	42	23.7%
Bronchiolitis	99	55.9%
Bronchopneumonia	17	9.6%
Pneumonia	7	4%
Disease severity		
Mild	80	46.3%
Moderate	90	50.8%
Severe	5	2.8%



**Figure 1:** Comparison of auscultation findings between inpatient and outpatient groups ( $\chi^2$   $p = 0.001$ ).

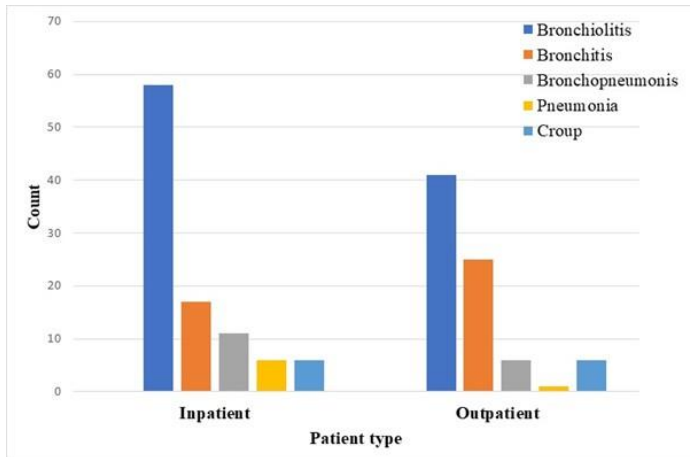


Figure 2: Comparison of clinical diagnosis between inpatient and outpatient groups ( $\chi^2 p = 0.11$ ).

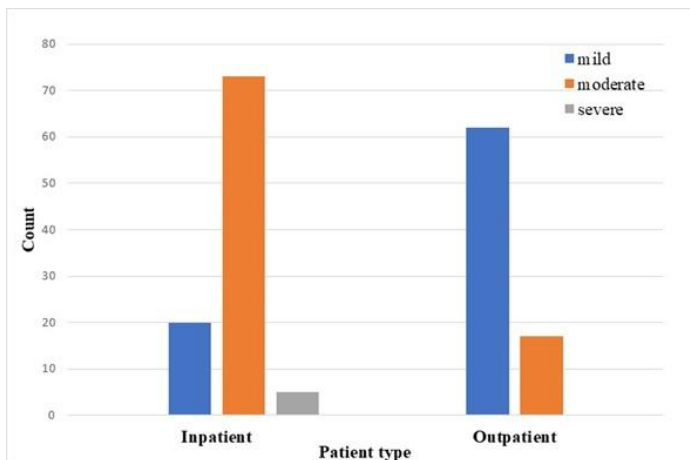


Figure 3: Comparison of disease severity between inpatient and outpatient groups ( $\chi^2 p = 0.001$ ).

The analysis of the risk factors that may contribute to the increased susceptibility of respiratory infection in children is presented in Table 4. Cesarean section deliveries were more common than vaginal births (63.8% vs 36.2%), however statistical analysis failed to find a correlation ( $p = 0.271$ ), while Non-breast feeding slightly predominated over breastfeeding (53.1% vs 46.9%) as older children usually left breast feeding ( $p = 0.989$ ). More than half of the parents were smokers (51.41%), an important risk factor for generating respiratory problems in infants and newborns, however the relation was not significant ( $p = 0.625$ ). The prevalence of children’s respiratory problems was relatively low (4%), as well as cardiac anomalies (1%). Notably, a substantial proportion of patients had a family history of recent ARTIs (36.2%) with no statistical correlation observed ( $p = 0.083$ ). The only risk factor that showed statistical correlation was family history of asthma (11.3%) ( $p = 0.019$ ).

Table 4: Risk factor profile of pediatric patients with RTI.

Risk Factor	Number	%	$\chi^2 p$ value
Delivery type			
Normal	64	36.2%	0.271
Cesarean section	113	63.8%	
Feeding type			
Breast feeding	83	46.9%	0.989
Non-breast feeding	94	53.1%	
Parental smoking			
Smoker	91	51.41%	0.625
Non-smoker	86	48.59%	
Child respiratory problems	7	4%	0.202
Congenital cardiac anomalies	2	1.1%	0.099
Family history of asthma	20	11.3%	0.019*
Family history of recent ARTI	64	36.2%	0.083

Molecular detection of HRV infection revealed that 15 (8.5%) out of 177 patients had Human Rhinovirus (HRV) infection. All of the HRV-infected patients were among the outpatient cohort suggesting mild to moderate infections ( $p = 0.001$ ) (Figure 4). Figure 5 represents the age distribution of HRV-positive children, in which among the HRV-positive subjects a significantly higher infection rate was recorded in children > 6 months (80%) ( $p = 0.471$ ). This pattern contrasts with the overall age distribution suggesting age-specific biological or exposure factors influencing HRV susceptibility. Figure 6 shows the seasonal distribution of HRV in pediatric patients with RTIs, the majority (60%) of the cases were recorded in December, 40% in January, and no record in February ( $p = 0.044$ ), a finding that may link the occurrence of HRV in warmer weathers.

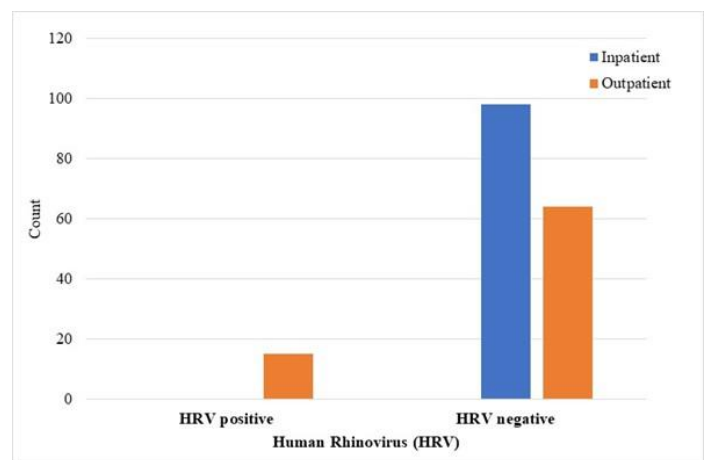
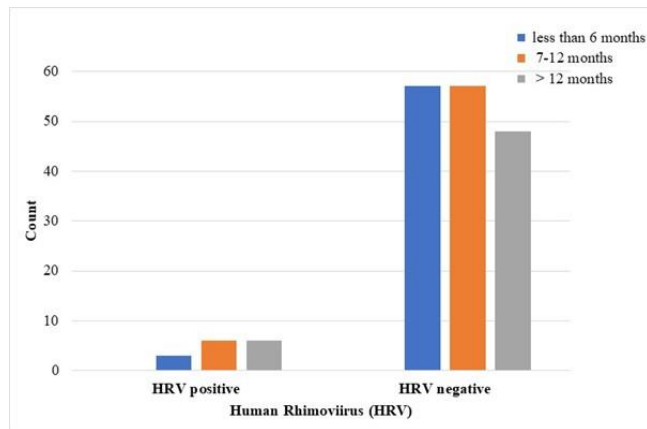
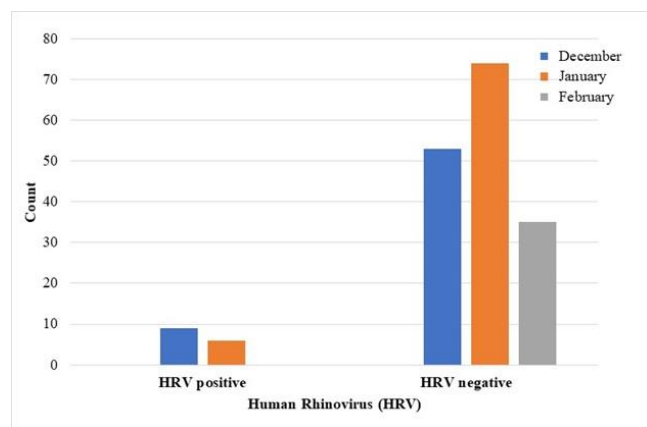


Figure 4: Distribution of HRV infection between inpatient and outpatient groups ( $\chi^2 p = 0.001$ ).

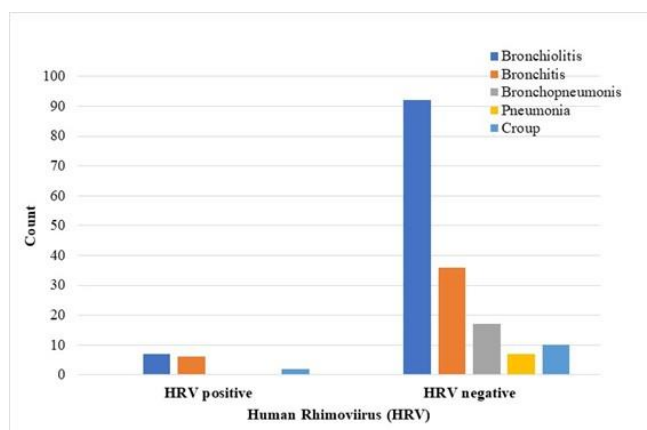


**Figure 5:** Distribution of HRV infection among different age classes ( $\chi^2$   $p = 0.471$ ).



**Figure 6:** Seasonal distribution of HRV among pediatric patients with RTI ( $\chi^2$   $p = 0.044$ ).

The clinical picture of HRV-positive cases is presented in Figure 7. HRV-positive patients were distributed across three primary clinical diagnosis of acute RTI status: mainly bronchiolitis (46.7%), bronchitis (40%), and a lower detection rate among patients with croup (13.3%). These findings demonstrate HRV's significant involvement in lower respiratory tract infections.



**Figure 7:** Clinical picture of HRV-positive pediatric patients with RTI ( $\chi^2$   $p = 0.254$ ).

## 4 Discussion

This study was designed and conducted to characterize the demographic, clinical, and virological features of respiratory infections in a pediatric cohort in Erbil city, with a focus on HRV infection. ARTIs are a major cause of illness in children, leading to both outpatient visits and hospitalizations. Our study of 177 pediatric ARTI cases revealed that slightly more than half (55.4%) required hospitalization, while 44.6% were managed as outpatients. The predominance of urban residents (54.8%) and males (56.5%) in this study aligns with prior studies linking urban environments and gender to higher respiratory infection rates. A study examining the long-term effects of air pollution on respiratory health in urban populations revealed a significant correlations between pollutant exposure and respiratory conditions, elevated levels of pollutants such as particulate matter (PM2.5 and PM10), nitrogen dioxide (NO<sub>2</sub>), sulfur dioxide (SO<sub>2</sub>), ozone (O<sub>3</sub>), and carbon monoxide (CO), increase the incidence of asthma and chronic obstructive pulmonary disease (COPD), which can exacerbate respiratory infections among urban residents, particularly affecting vulnerable populations like children and the elderly [14]. Large-scale studies showed that males have higher incidence rates of both viral and bacterial respiratory infections, particularly in infancy, childhood, and older adulthood, with the disparity most pronounced in young children and elderly men [15-17]. Possible explanations indicate that males generally have weaker innate antiviral immune responses, including lower interferon production, which may contribute to their higher susceptibility and worse outcomes [18,19]. The study population comprised three distinct age groups, with infants aged 7-12 months representing the largest proportion (35.6%), closely followed by those  $\leq 6$  months (33.9%) and children >12 months (30.5%). The predominance of cases in infants under one year (69.5% combined for  $\leq 6$  and 7-12 month groups) aligns with established epidemiological patterns of increased respiratory infection susceptibility during infancy. Infants have underdeveloped innate and adaptive immune responses, with a predominance of type 2 immune cells and less effective antiviral defenses [20].

This study revealed important patterns in clinical presentation, disease severity, and etiological factors. The nearly universal presence of cough (99.4%), fatigue (99.4%), and fever (98.3%) aligns with global acute RTI profiles [21], but the high prevalence of hypoxemia (SpO<sub>2</sub> < 90% in 35.6%) and dyspnea (63.3%) suggests a substantial burden of lower respiratory involvement [22]. Notably, wheezing (54.8%) and rales (22.6%) were key auscultation findings, correlating strongly with bronchiolitis (55.9%), the most common diagnosis, and supporting their use as clinical markers of disease severity [23]. Our findings revealed frequent gastrointestinal (GI) involvement accompanying respiratory infections, with vomiting present in 40.1% of cases and diarrhea in 30.5%. GI symptoms in respiratory infections may signal more severe disease or atypical presentations, especially in children. Diarrhea and vomiting occur especially in viral illnesses like COVID-19, influenza, and adenovirus infections [24-26]. Viruses like SARS-CoV-2 use receptors (e.g., ACE2) present in both respiratory and GI tracts, allowing direct

infection of the gut. Influenza-induced immune changes can alter gut bacteria and increase susceptibility to secondary GI infections [27-31].

The high rates of bronchiolitis (55.9%) and bronchitis (23.7%), coupled with wheezing (54.8%) and rales (22.6%), mirror established HRV pathogenicity in pediatric lower respiratory infections [32,33]. HRV infects the epithelial cells lining the airways, including the bronchi and bronchioles. It can replicate efficiently at temperatures found in the lower respiratory tract, infection triggers the release of pro-inflammatory cytokines and chemokines (such as IL-8, IL-1 $\beta$ , and interferons), activating the nuclear factor (NF)-kappa B pathway. This leads to recruitment of immune cells and inflammation in the airway tissues [34].

This study reveals clear differences between inpatient and outpatient cases. Hospitalized children showed greater disease severity, with 74.5% moderate and 5.1% severe cases (all severe cases were inpatients). Inpatients with respiratory infections have a much higher need for ICU care and oxygen therapy compared to outpatients, they frequently require oxygen support, with many progressing to ICU care for respiratory failure. While noninvasive methods such as High-Flow Nasal Cannula (HINC), Continuous Positive Airway Pressure (CPAP) and Non-Invasive Ventilation (NIV) may suffice for moderate cases, severe presentations often necessitate invasive ventilation and intensive monitoring [35]. Inpatients accounted for most pneumonia (85.7%) and bronchopneumonia (64.7%) cases, while outpatients were primarily mild (78.5%) or had uncomplicated bronchitis (59.5%), consistent with the results of other studies [36,37].

Our risk factor analysis revealed both expected and novel patterns. The higher infection rates in cesarean-delivered infants (63.8% vs 36.2%,  $p=0.271$ ) align with studies in India and the UK confirming a higher incidence of ARTIs in cesarean-delivered infants compared to vaginally delivered infants [38], though effect sizes vary across populations. The main reasons are altered lung fluid clearance, lack of exposure to maternal vaginal microbiota, and earlier gestational age at delivery, especially with planned cesareans [39-41]. Similarly, the 53.1% prevalence among non-breastfed infants ( $p=0.989$ ) echoes known immunological benefits of breastfeeding. Breast milk contains antibodies (especially secretory IgA), lactoferrin, lysozyme, and other immune factors that directly neutralize viruses and bacteria, reducing the risk and severity of respiratory infections. Non-breastfed infants miss out on these immune defenses, making them more vulnerable to infections [42]. Notably, the significant association with family history of asthma (11.3%,  $p=0.019$ ) mirrors genetic studies identifying shared susceptibility loci for asthma and severe respiratory infections. Certain genetic variants linked to asthma such as Cadherin Related Family Member 3 (CDHR3), Gasdermin A (GSDMA), and Gasdermin B (GSDMB) genes are also associated with increased rates of ARTIs and viral wheezing illnesses in early childhood, suggesting shared genetic risk factors for both conditions [43]. The high rate of parental smoking exposure (51.4%) exceeds national averages, suggesting this modifiable risk factor may be under-addressed in our population [44].

While congenital comorbidities were rare (cardiac anomalies 1.1%), the 36.2% prevalence of recent household ARTIs underscores findings from viral transmission studies. Studies consistently reported that when an index case (the first infected person) brings a respiratory virus into the household, the secondary attack rate, the proportion of household contacts who become infected, ranges from 10% to 38%, depending on the virus and household conditions [45,46].

There was a gap in the recorded data regarding HRV infection in the pediatric population in Erbil city and Iraq. In recent years, there has been a rise in HRV respiratory infection epidemics in multiple countries. To address this gap, the present cross-sectional study was performed between December 2024 and February 2025. The rate of HRV infection among the pediatric population was 8.5%. This result is consistent with several previous studies reporting similar rates. In a study from China, HRV was identified in 11.4% of samples obtained from hospitalized children with lower respiratory tract infection between January 2013 and December 2015 [47]. In an 8-year surveillance study conducted across six hospitals in Shanghai, China (2012–2020), HRV was detected in 2.74% of patients with acute RTI [48]. Yet, a study from Iran found a 10% detection rate of HRV among patients with respiratory symptoms from January to December 2021, with higher rates in children aged less than two years [49]. A Higher detection rate was reported in a study that included children under two years old in Amman, Jordan, in which HRV detection rate was 47% among patients with ARTI [6]. Locally, a single study was conducted in Erbil city during the period 2012–2013, which included the screening of viral causes of acute RTI among hospitalized patients under 15 years old, it was found that the detection rate of enterovirus/rhinovirus was 32.7% [10]. Compared to both previous studies that showed higher detection rates of HRV infection, the lower detection rate in our study could probably be attributed to different reasons, such as differences in the sampling period and the age of the studied population. It was found that in subtropical climate regions, HRV incidence peaks during warmer months [47]. In addition, viral interference might also be a significant factor in the low detected numbers of HRV infection, a negative bidirectional association between rhinovirus and other RNA respiratory viruses, such as respiratory syncytial virus (RSV) and seasonal coronaviruses, suggesting that infection with one can temporarily suppress the other within the same host. A study that investigated the interaction between RSV and HRV infections in infants by analyzing data from three different cohorts found a consistent negative association between RSV and HRV, indicating that infants infected with RSV were significantly less likely to have HRV infection [50]. Based on systematic reviews covering the broader Middle East and North Africa (MENA) region confirm that RSV prevalence is the highest during the winter season in nearly all countries, with the majority of cases occurring from late autumn through early spring [51,52], the fact that coincides with the sampling period of our study that closely aligned with the peak period of RSV [53].

All HRV-positive cases were managed as outpatients. To our knowledge, only one published study has directly compared HRV

prevalence between pediatric outpatients and inpatients. In the study HRV was detected in 47% of hospitalized patients but only 27% of outpatients. This contrast can be due to differences in hospitalization thresholds between regions<sup>[54]</sup>. Yet, the highest detection rates of HRV infection occurred in infants younger than 6 months, followed by those aged 7-12 months, and the lowest in children over 12 months. Previous studies also showed that HRV infections are most frequently observed in children under 2 years<sup>[55]</sup>. Children's immune systems, especially in early years, are less experienced at recognizing and fighting HRV. This leads to higher rates of infection compared to adults<sup>[34]</sup>.

Our results demonstrated distinct monthly variations in HRV detection among the studied population from December to February. HRV-positive cases accounted for 14.5% of cases in January but declined sharply to 7.5% in February. Notably, February showed the highest overall respiratory infection rates (45.2% of total cases). The late arrival of winter weather in our region may have influenced the timing of peak HRV activity. January's weather was more characteristic of fall than typical winter conditions in our region. HRV spreads most easily when there is a sudden drop in temperature and humidity, which coincides with the temperature of January 2025<sup>[56]</sup>. Moreover, HRV-positive cases were primarily associated with bronchiolitis (46.7%) and bronchitis (40.0%), while absent in bronchopneumonia and pneumonia cases. Notably, HRV accounted for 14.3% of total bronchitis and 16.7% of total croup cases recorded, reinforcing its role in these conditions. The complete absence of severe lower respiratory infections suggests other pathogens may dominate these presentations. These findings highlight HRV's distinct clinical associations in pediatric respiratory disease. The most common diagnoses given to pediatric patients with HRV infection in clinical studies are acute upper respiratory tract infections (URTIs) and bronchiolitis<sup>[34]</sup>. HRV can infect the tracheobronchial tree, causing productive infection and inflammation in the bronchi, leading to bronchitis. It is a recognized cause of acute bronchitis and can exacerbate chronic airway diseases like asthma and COPD<sup>[57]</sup>. Bronchiolitis and bronchitis involve inflammation of different parts of the lower respiratory tract, but HRV plays a significant role in both. In addition, HRV is a notable cause of croup in infants and young children. In a large prospective study, HRV was detected in 39% of infants with croup, making it the most common virus identified in these cases, more frequent than parainfluenza virus (28%) and RSV (28%)<sup>[58]</sup>.

While this study successfully determined the incidence and clinical characteristics of rhinovirus infection in Erbil, further molecular research is required to identify the circulating genotypes and their specific molecular characteristics, and further surveillance to include a wider array of respiratory pathogens to establish the full etiological landscape and HRV's role within it, is needed.

## Conclusion

Our study of winter pediatric respiratory infections in Erbil identified key demographic and clinical patterns. The cohort

showed male predominance and urban residence, with children one year old being the most vulnerable. Clinically, cough, fever, and rhinorrhea were nearly universal, while wheezing and rales served as critical severity markers - particularly for hospitalized cases. Diagnostically, bronchiolitis and bronchitis predominated generally and among HRV-positive cases. Strikingly, all HRV cases were managed outpatient, with significant January clustering. Disease severity distribution revealed that most cases were moderate, while severe presentations were rare and exclusively required hospitalization. These findings demonstrate HRV's unique outpatient-driven epidemiology in Iraq's winter season, advocating for its inclusion in routine pediatric respiratory testing and revised bronchiolitis management protocols that account for this predictable winter burden.

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## Authors' contributions

Ashty Azad Aziz: Sample collection, laboratory procedures and manuscript writing. Sazan Moffaq Abdulaziz: Research design, supervision, manuscript writing and editing.

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