



Respiratory Syncytial Virus–Associated Hospitalizations in Children Under Five in Erbil City, Iraq: A Cross-Sectional Study

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Abstract: Respiratory syncytial virus (RSV) is a predominant etiological agent of acute respiratory tract infections (ARTI) in young children associated with elevated hospitalization rates. Rapid detection of the virus decreases serious complications. This study was conducted to investigate the incidence of RSV infection in pediatric patients and related demographic and clinical criteria through rapid RSV antigen detection in Erbil city/Iraq. A cross-sectional study performed within the 1st of December 2024, to the 28th of February 2025. It involved 177 children under 5 years who presented with signs of ARTI and visited Raparin Teaching Hospital for children in Erbil city. Nasopharyngeal specimens were collected and tested for RSV antigen using the Combo rapid test (Biotech, China). Approximately 72.4% of RSV-positive patients were hospitalized, with bronchiolitis being the most common clinical diagnosis. RSV infection was significantly higher in infants ≤ 6 months (53.3%, $p < 0.001$). Higher rates of RSV infection were recorded in infants with artificial feeding (51.7%) and delivered by cesarean section (63.8%). Dyspnea was a significant sign in RSV-associated hospitalizations ($p = 0.002$). RSV infection peaked in January despite higher ARTI rates in December ($p < 0.01$). RSV was a leading winter pathogen in young children with high hospitalization rates. The Combo rapid test offered a quick, cost-effective tool for multi-virus detection.

Keywords: RSV; ARTI; Pediatrics; Rapid detection; Bronchiolitis.

1. Introduction

Viral respiratory infections are known to be the leading cause of childhood sickness and death rates, especially in developing countries [1]. The majority of this disease burden was concentrated among children under the age of five. Acute respiratory tract infections (ARTIs) are one of the top five causes of sickness and admission in children [2]. While bacterial agents can induce acute respiratory infections, respiratory viruses are regarded as the primary causative agents, namely, Adenoviruses, coronaviruses, human enteroviruses, human rhinoviruses, influenza A and B viruses, parainfluenza viruses, human bocavirus, human metapneumovirus, and respiratory syncytial virus [3]. Respiratory Syncytial Virus (RSV) has been identified as one of the most prominent etiologies of acute upper and lower pulmonary infections in children. It belongs to the Pneumoviridae family of respiratory viruses and is an enveloped virus with a negative-sense, single-stranded RNA genome (approximately 15.2 kb) [4]. To date, no animal reservoir or intermediate host for RSV has been observed. It is primarily transmitted through the nasal or buccal fluids of infected individuals. Healthy individuals may contract the virus either directly through droplets or indirectly through contact with contaminated surfaces such as infants, toys, phones, doorknobs, and tabletops [5]. Infections in children range from mild common colds to life-threatening conditions, characterized by exacerbating cough, rhinorrhea, sneezing, nasal congestion, dyspnea, hypoxemia, and elevated respiratory rate. The virus was identified as the causative agent in approximately 50% to 90% of bronchiolitis cases and around 50% of pneumonia

cases within the global pediatric population [6], requiring hospital admission, with the majority of deaths occurring in infants under six months of age [7]. Inflammatory mediators, including cytokines and chemokines, play a central role in the pathophysiology of acute pulmonary inflammation during RSV infection by recruiting and activating immune cells such as macrophages in the alveoli, which contribute to both viral clearance and tissue damage [8]. In addition to the antigenic variability of the virus, children develop a degree of immune memory that is insufficient to prevent reinfection but sufficient to mitigate the severity of future infections following the initial RSV infection, resulting in milder infections [9]. In newborns, maternal antibodies may enhance local immunity, but the risk of infection persists due to insufficient immunity [10].

In temperate climate nations, RSV induces epidemics of lower respiratory tract infections in newborns and infants during late autumn, winter, and early spring; beginning around November and extending until March [11]. In our country, ARTI in infants below five predominantly occurs during winter. Epidemics of respiratory viruses are characterized by elevated morbidity and mortality rates [12]. Several studies have been conducted in Iraq concerning RSV, particularly in pediatric populations in cities like Baghdad and Hilla [13-15], however, to date, no studies have specifically addressed RSV infection among pediatric patients in Erbil city. Our current study is the first to examine the incidence and clinical features of RSV among children in Erbil city/Iraq.

Laboratory identification of RSV in nasopharyngeal swab specimens may be accomplished by immunological and molecular techniques. The immunochromatography assay, sometimes referred to as a "rapid test", is an immunological approach extensively utilized for the identification of viral antigens in various samples. A fast, simple, and cost-effective diagnostic equipment with high sensitivity and specificity could identify RSV quickly because the virus is highly transmissible, particularly among neonates; however, laboratories in Erbil/Iraq, infrequently detect it. This study aimed to detect the incidence of respiratory syncytial virus infection in pediatric patients in Erbil city/Iraq, using a rapid antigen detection method in an attempt to highlight the importance of rapid detection of the virus in clinical settings to minimize the risk of serious complications and mortality rates.

2. Materials and Methods

2.1 Study design

A cross-sectional study was implemented to determine the incidence of RSV infection in pediatric patients who visited Raparin Teaching Hospital for Children in Erbil city during the 1st of December 2024, to the 28th of February 2025. A total of 177 patients were enrolled. Rapid antigen test (Combo biotech/China) was used for RSV detection in nasopharyngeal swab specimens. Verbal informed consent was acquired from the parents before sample collection, and all data were anonymized to ensure confidentiality.

2.1.1 Inclusion criteria

Pediatric patients who were five years of age or younger clinically diagnosed as having ARTI were included. The study included both males and females.

2.1.2 Exclusion criteria

Pediatric patients older than 5 years having signs of allergic respiratory disease or having taken any treatment prior to sample collection (e.g., corticosteroids) were excluded from the study.

2.2 Sample collection

Nasopharyngeal swab specimen was collected from 177 pediatric patients ≤ 5 years presenting with signs and symptoms of ARTI who visited the outpatient clinics. Each patient received a thorough clinical examination by a consultant pediatrician, diagnosed as having either upper or lower ARTI,

then either admitted to the hospital or received appropriate treatment and instruction before being sent home. Specimens were collected by carefully inserting a sterile swab into the nostril that presented the most secretion under visual inspection. The swab was kept near the septum floor of the nose while it was gently pushed into the posterior nasopharynx, rotated several times, and finally added to the extraction tube with the buffer that was provided with the Combo rapid test kit. Information like age, gender, date of visit or admission, signs, clinical diagnosis, and relevant detailed history were recorded in a previously prepared questionnaire form (Appendix I).

2.3 Detection of RSV antigen by rapid immunochromatography assay

All the specimens were tested for the presence of RSV antigen using the Combo Rapid Test (Biotech, China), which was designed to detect multiple viruses simultaneously in nasopharyngeal specimens (Figure 1). The principle of this method relies on that specific antibodies against severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), Flu A and B, RSV, and Adenovirus are immobilized on a region of the membrane called the test region. During testing, the antigen in the specimen reacts with specific antibodies, the mixture then migrates through the membrane by capillary action and interacts with the reagent on the membrane, producing a colored line. Following placing the specimens into the extraction buffer (mentioned above), the tube was shaken well, then two drops of the mixture were poured into the samples (S) circular window. After incubation at room temperature for 10 minutes, the result was read through visual interpretation of color development as follows:

Negative result: just a single red line is visible in the control region (C).

Positive result: along with the red C line, a second red color line also appears in the test region (T).

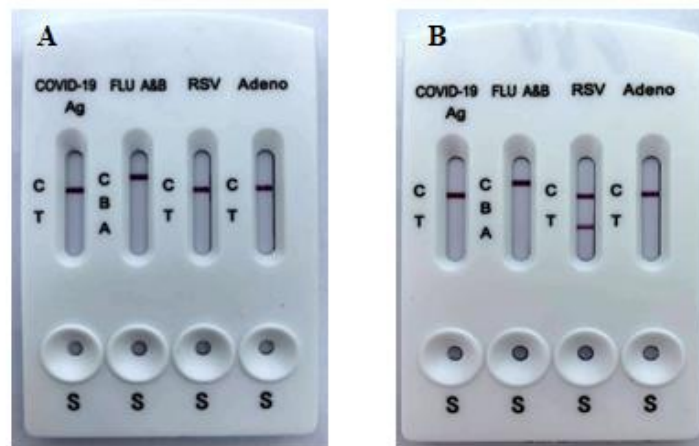


Figure 1: Combo rapid test showing; A: negative result, B: positive result for RSV.

2.4 Statistical analysis

The statistical analysis of the collected data was conducted using SPSS 28. The chi-square test and frequency % were utilized to identify the accurate data. Statistical significance has been determined when the P value is less than 0.05.

3. Results

The results in Table 1 showed that among the 177 pediatric patients who showed symptoms of ARTI, RSV was detected in 72.4% and 27.6% of hospitalized and non-hospitalized children, respectively, most of whom were clinically diagnosed by pediatricians as having bronchiolitis. the association between RSV infection and admission was shown to be statistically significant ($P < 0.001$).

Table 1: RSV distribution among hospitalized and non-hospitalized patients.

Group	RSV Positive		RSV Negative		Total		Chi ² P value
	No.	%	No.	%	No.	%	
Hospitalized	42	72.4%	56	47.1%	98	55.4%	0.001
Non-hospitalized	16	27.6%	63	52.9%	79	44.6%	
Total	58	100.0%	119	100.0%	177	100.0%	

Our results revealed that the mean age of patients was 11.73 ± 9.67 , and their ages ranged from 1-48 months. The highest rate of RSV infection was in patients aged ≤ 6 months (53.3%), and the lowest rate was in patients ≥ 13 months (19%). Statistically, age was significantly related to RSV infection (P value < 0.001) (Table 2).

Table 2: RSV distribution according to age groups.

Age group (month)	RSV Positive		RSV Negative		Total		Chi ² P value
	No.	%	No.	%	No.	%	
≤ 6	32	53.3%	28	46.7%	60	100.0%	<0.001
7-12	15	25.4%	44	74.6%	59	100.0%	
≥ 13	11	19.0%	47	81.0%	58	100.0%	
Total	58	32.8%	119	67.2%	177	100.0%	

There was no statistically significant correlation between gender and RSV infection ($P = 0.47$), despite that males exhibited a greater infection rate than females (60.3% and 39.7%, respectively). The male-to-female ratio among positive cases was 1.3:1 (Table 3).

Table 3: RSV distribution according to gender

Gender	RSV Positive		RSV Negative		Total		Chi ²
	No.	%	No.	%	No.	%	P value
Male	35	60.3%	65	54.6%	100	56.5%	0.47
Female	23	39.7%	54	45.4%	77	43.5%	
Total	58	100.0%	119	100.0%	177	100.0%	

Table 4 presents a number of risk factors that have been shown in previous literature to increase the risk of pediatric respiratory infections. A slightly higher rate of RSV infection was seen in patients with artificial feeding (51.7%) than breastfeeding (48.3%); however, no significant association was seen ($P = 0.79$). On the other hand, an increased ARTI was recorded in infants born by cesarean section (63.8%) compared to those born normally (36.2%); however, no association was found with RSV infection (P value 0.99).

Table 4: Association between various risk factors in ALRTI Case

Risk factors	RSV Positive		RSV Negative		Total		Chi ²
	No.	%	No.	%	No.	%	P value
feeding type							
Breast	28	48.3%	55	46.2%	83	46.9%	0.79
Artificial	30	51.7%	64	53.8%	94	53.1%	
Total	58	100.0%	119	100.0%	177	100.0%	
Delivery Type							
Normal	21	36.2%	43	36.1%	64	36.2%	0.99
Cesarean section	37	63.8%	76	63.9%	113	63.8%	
Total	58	100.0%	119	100.0%	177	100.0%	
Parental smoking							
Yes	30	51.7%	61	51.3%	91	51.4%	0.95
No	28	48.3%	58	48.7%	86	48.6%	
Total	58	100.0%	119	100.0%	177	100.0%	
Family history of asthma							
Yes	8	13.8%	12	10.1%	20	11.3%	0.46
No	50	86.2%	107	89.9%	157	88.7%	
Total	58	100.0%	119	100.0%	177	100.0%	

Cough, fever, Rhinorrhea, and dyspnea (shortness of breath) were the common signs seen in patients with RSV infection (96.6%, 98.3%, 82.8% and 79.3%, respectively). Dyspnea was the main cause of hospitalization of all cases with ARTI, with a higher rate in RSV-positive (79.3%) compared to RSV-negative (55.5%) patients, and was significantly associated with RSV infection (P value 0.002) (Table 5).

Table 5: Clinical signs associated with RSV infection

Signs of the infection	RSV Positive		RSV Negative		Total		Chi ²
	No.	%	No.	%	No.	%	P value
Cough	56	33.9%	109	66.1%	165	100.0 %	0.218
Fever	48	33.6%	95	66.4%	143	100.0%	0.64
Sneezing	41	27.9%	106	72.1%	147	100.0 %	0.002
Rhinorrhea	57	33.3%	114	66.7%	171	100.0%	0.39
Nasal congestion	30	22.9%	101	77.1%	131	100.0%	0.001
Sore throat	25	21.0%	94	79.0%	119	100.0%	0.001
Dyspnea	46	41.1%	66	58.9%	112	100.0%	0.002

As previously explained, specimen collection was performed in the peak season of ARTI (winter), starting on the 1st of December and ending on the 28th of February 2025. Figure 2 shows an insight into ARTI and RSV infection among 3-month-olds. Although ARTI was higher in December (54%), but RSV detection rate was low (9%); the highest detection rate was seen in January (33%) (P<0.01).

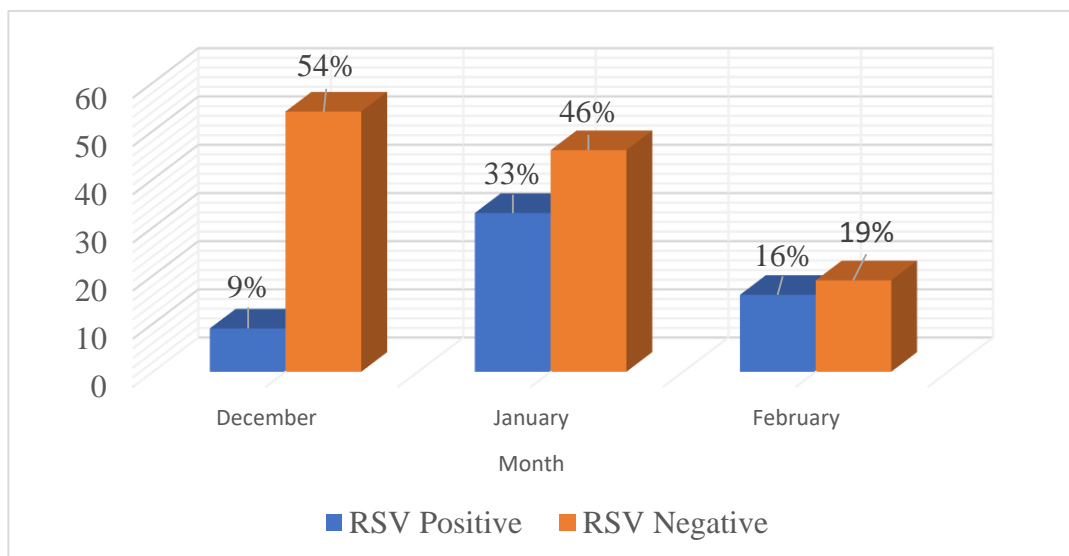


Figure 2: Monthly variation in the frequency of ARTI and RSV infection.

4. Discussion

Respiratory infections are known to be more common during the winter months, with the peak incidence of bronchiolitis typically occurring in the same period[16]. Despite this, routine diagnostic testing for respiratory syncytial virus (RSV) in nasopharyngeal specimens is not widely available in

pediatric clinical settings in our country. Furthermore, there is a lack of local studies investigating the prevalence or incidence of RSV infection among pediatric patients, as well as the associated demographic and clinical characteristics. These gaps in knowledge formed the primary motivation for conducting this study during the winter season in Erbil city/Iraq. The results of this study showed higher RSV detection rates in hospitalized patients compared to mild cases. This finding is similar to that reported by Yadav et al (2016) that RSV was shown to be much more common in inpatient children having acute lower respiratory tract infection. However, other studies showed that hospitalization rates displayed a clear decrease during 2018–2021 in Spain, and during 2020-2021 in the US [17, 18]. The reason was attributed to the COVID-19 pandemic, which has significantly altered the epidemiology of several viral respiratory infections in both pediatric and adult populations. The divergence in RSV epidemiology across various regions of the world may be attributed to the severity of its epidemics, ambient factors, and climatic conditions from one year to the next [19].

In this study, the highest detection rate of RSV was found in patients less than 6 months age. This finding is in concordance with the previous studies indicated that this age group is greatly susceptible to ARTI and hospitalization due to lower respiratory complications, with RSV admissions peaking within the first year of life [20]. There are several possible explanations for this phenomenon, including the presence of immature immune systems, the presence of weaning transplacental maternal antibodies, and the presence of tiny airways that are more prone to physical obstruction. For instance, the typical bronchiole width in neonates aged between two and four months is 120 micrometres (μm), whereas in adults, it is 250 micrometres (μm) [21].

Following an examination of the patient population according to gender type, a higher male-to-female ratio was detected among RSV-positive patients, which coincides with the results presented by previous studies [22, 23]. Yet, Sangaré et al. (2006) reported that female patients had a lower rate of hospitalization [24, 25]. However, in line with other studies, gender was not found to be a significant risk factor for RSV infection [26, 27].

Among the studied risk factors in our study that were shown by other literature to increase the risk of pediatric respiratory infections, an increased rate of RSV infection was recorded in pediatric patients who received artificial feeding. This finding agrees with those reported by Naeem and his colleagues and Tromp and his colleagues, who stated that infants who are breastfed have a lower incidence of RSV-associated hospitalizations and a lower risk of respiratory failure than infants who are fed artificially [20, 28]. Breast milk contains many protective factors, such as lactoferrin, immunoglobulins, and lymphocytes, as well as other factors that may help reduce an infant's susceptibility to infection [29]. We have demonstrated that infants born by caesarean section (CS) were associated with higher hospitalization rates compared to natural delivery. Similar to our finding, prior studies have also identified caesarean as a risk factor for acute lower respiratory tract infection [30]. This phenomenon was scientifically related to the lack of labour exposure in children born via elective cesarean section, as labour stimulates the synthesis of numerous cytokines, including interleukin 10 [31], which is associated with resistance to respiratory tract infection in children up to 5 years [32]. Moreover, Kristensen and coworkers (2015) mentioned that the aberrant gut flora found in children delivered by CS compared to those delivered naturally might be responsible for increased susceptibility to viral infections [33, 34]. Newborns pass through the birth canal during a vaginal delivery, coming into contact with a wide variety of maternal microbes that provide an early gut inoculation, in contrast to cesarean delivery [35-37].

A number of clinical signs of ARTI were recorded in this study, in which dyspnea was the main sign significantly associated with RSV infection and mostly seen in hospitalized patients. This result coincides with findings reported by previous studies that RSV virus replication in small airways

(bronchioles) and air sacs (alveoli) of the lungs stimulates the immune system, especially inflammatory molecules, including cytokines and chemokines, which leads to inflammation, necrosis, and ciliated cell tropism [21, 38].

Additionally, the findings of the current study showed that during the study period, the highest rate of ARTI was in December. Still, the RSV infection rate was the highest in January. This result is in agreement with those stated by Al-Shuwaikh (2018), who stated that “RSV is a primary infantile infection and typically represented as a winter respiratory tract infection.” [14]. Further studies on RSV in developing countries such as Indonesia [39] and South Africa [40] and Gambia [41] indicated that RSV infection is mostly prevalent at the coldest times of the year. However, Fry et al (2010) and Chaiut et al (2023) found that the peak of RSV infection was from August to November [27, 42]. Low temperature, relatively high humidity, and high wind speeds in winter are factors that contribute to the increased rates of respiratory infections [43].

This study faced several limitations, including challenges in obtaining parental consent and cooperation from young children during nasopharyngeal sampling, which can be uncomfortable, in addition to the limited access to appropriate swabs, viral transport media, or cold chain maintenance, and some pediatricians were uncooperative due to overcrowding and high patient load during the winter season, which affected sample collection.

5. Conclusions

This study revealed that RSV is a primary winter virus in pediatric environments, significantly elevating hospitalization rates and requiring emergency treatment in many circumstances. Infants under 6 months were the most susceptible age group. Natural delivery and breastfeeding were factors that might decrease the risk of ARTIs. The Combo rapid test represented an easy, cost-effective, and rapid method that could be used routinely for the simultaneous detection of multiple viruses, which would absolutely decrease serious complications and mortality rate.

Conflict of Interest

The authors have no conflicts with any step of the article preparation.

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Authors' contributions

Aumed Jalil Ramadhan: Sample collection, laboratory procedures, and manuscript writing. Sazan Moffaq Abdulaziz: Research design, supervision, manuscript writing, and editing.

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