Pediatric Respiratory Tract Infections and Circulating Influenza A Virus Subtypes: A Winter Study in Erbil, Iraq

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***Abstract*—Influenza and other viral respiratory infections are among the top three leading causes of morbidity and mortality in young children. This study aimed to investigate demographic and clinical characteristics of acute respiratory tract infection (ARTI) and to determine the incidence of influenza A virus subtypes among children in winter in Erbil, Iraq. A cross-sectional study was implemented to investigate the criteria of ARTI in pediatric patients aged ≤5 years who visited Raparin Teaching Hospital for Children from December 1, 2024, to February 28, 2025. A detailed history was collected, and multiplex reverse transcription quantitative polymerase chain reaction was employed for influenza A detection and subtyping. Out of 200 patients, the virus was detected in 14%, with H1N1pdm09 being the predominant subtype (10.5%). Most cases (55%) were hospitalized with severe acute respiratory infection, with ages ≤6 months showing higher susceptibility. Clinically, bronchiolitis was the main clinical diagnosis (66.5%), with hypoxia observed in 36% of cases. Infection among family members was a significant risk factor for pediatric ARTI ($p = 0.045$). Influenza A showed no significant correlation with hospitalization or age ($p = 0.512$ and $p = 0.987$, respectively) but demonstrated strong seasonal variation, peaking in December ($p < 0.001$). In conclusion, influenza A virus contributed notably, though not predominantly, to pediatric ARTI in Erbil City, with H1N1pdm09 as the predominant subtype and a peak in December. Most cases involved lower respiratory tract disease and hypoxia. Younger age and household infection increase susceptibility, highlighting the need for routine surveillance and preventive measures.**

***Index Terms*—Acute respiratory tract infection, Children, H1N1pdm09, Influenza A virus, Influenza-like illness.**

I. Introduction

Influenza is a highly contagious viral infection primarily affecting the respiratory system, presenting with symptoms such as fever, headache, myalgia, fatigue, sore throat, and cough (World Health Organization [WHO], 2025). The clinical severity varies with age and underlying health conditions, with young children, the elderly, and those with chronic illnesses experiencing the highest rates of hospitalization and mortality Iuliano, et al. (2018). The WHO defines two key surveillance case categories: Influenza-like illness (ILI) for outpatient settings, which is characterized by sudden fever (>38°C) and cough or sore throat without alternative diagnosis, and severe acute respiratory infection (SARI) for hospitalized patients exhibiting respiratory distress alongside fever and cough or sore throat (WHO, 2018a).

Influenza viruses belong to the Orthomyxoviridae family and include three types: A, B, and C. Types A and B are predominantly responsible for seasonal epidemics, whereas type C causes mild, cold-like illness (Krammer, et al., 2018). Influenza A (Flu A) viruses are further subtyped based on hemagglutinin (H) and neuraminidase (N) surface glycoproteins, with 16 H and 9 N subtypes identified to date (Tong, et al., 2012). These viruses infect multiple hosts, including humans, mammals, and avian species, facilitating genetic reassortment and frequent antigenic changes. Such variability underpins the seasonal epidemics and occasional pandemics that pose major global health threats. Notably, historical pandemics in 1918 (H1N1), 1957 (H2N2), and 1968 (H3N2) caused substantial morbidity and mortality worldwide, disproportionately affecting younger, otherwise healthy populations (Simonsen, et al., 1997). At present, the most widely recorded seasonal influenza A subtypes circulating globally are the pandemic type of H1N1 Flu A 2009 (Flu A H1N1pdn09) and H3N2, with the avian type, H5N1, posing a zoonotic risk due to its pandemic potential (WHO, 2023).

In Iraq, influenza surveillance studies remain limited. A study from Baghdad (2021 to 2022) demonstrated the predominance of influenza A H3N2, mostly affecting adults with low vaccination rates (Radhi, et al., 2023). Surveillance data from 2015 to 2017 highlighted a December seasonal peak of influenza A, emphasizing the need for timely vaccination campaigns (Aufi, et al., 2021). The lack of recent pediatric-focused data hampers efforts to understand the current epidemiology and subtype distribution of influenza A among children in Iraq. In addition, robust influenza

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surveillance is essential for the early detection of emerging strains, monitoring viral evolution, guiding immunization strategies, and implementing effective public health responses – particularly in vulnerable populations such as children (Moore, et al. 2008; CDC, 2024). Addressing this gap, the present study aimed to study demographic and clinical characteristics of acute respiratory tract infection (ARTI) and determine the winter incidence of influenza A infection and its subtypes among the pediatric population in Erbil City, Iraq, thereby providing vital epidemiological evidence to inform surveillance and control efforts.

II. Materials and Methods

A. Study Design

A prospective observational study was conducted to investigate the criteria of ARTI and to determine the incidence of influenza A virus infection and its subtypes in pediatric patients aged ≤5 years who visited Raparin Teaching Hospital for Children in Erbil City/Iraq from the December 1, 2024, to the February 28, 2025. A convenience sample of 200 patients was used. Patients who showed signs of allergic respiratory disease or had taken any treatment before sample collection (e.g., corticosteroids) were excluded from the study. Multiplex real-time reverse transcription polymerase chain reaction (RT-PCR) was applied for Flu A detection and subtyping. Written informed consent was acquired from the parents before sample collection, and all data were anonymized to ensure confidentiality. Information such as age, gender, date of visit or admission, signs, clinical diagnosis, and relevant detailed history was recorded in a previously prepared questionnaire form.

B. Specimen Collection

Before specimen collection, patients included in this study have received a thorough clinical examination by at least two consultant pediatricians. Following diagnosis, they were either admitted to the hospital or received appropriate treatment and instruction before being sent home. A nasopharyngeal swab specimen was 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, whereas it was gently pushed into the posterior nasopharynx and rotated several times. Swabs were then kept and transported to the laboratory in a viral transport medium (VTM). Before testing, collected samples were stored at −80°C, avoiding any freeze-thaw cycles (CDC, 2025).

C. Nucleic Acid Extraction

The previously collected specimens were brought to room temperature; then viral RNA was extracted using the DBG-Spin™ Viral Nucleic Acid Kit (Debna BioGene BV/Netherlands). The kit is designed for the rapid extraction of highly pure viral nucleic acids from biological fluids. The procedure was applied according to the manufacturer's instructions. RNA concentration and quality were checked using a NanoDrop ND-1000 Spectrophotometer (Thermo Scientific/U.S.A.). RNA extracts were either kept at −80°C for a maximum of 2 weeks before use or tested directly for Flu A detection and typing. The extraction was done in the Research Center of Erbil Polytechnic University.

D. Detection and Typing of Influenza A Virus

A CE-IVD-certified *in vitro* diagnostic real-time reverse transcriptase quantitative polymerase chain reaction (RT-qPCR) (VIASURE Flu Typing II, CerTest Biotec/Spain) kit was used for simultaneous detection of H1N1pdm09, H3N2, H5N1, and H7N9 influenza A subtypes in respiratory samples with a detection limit of ≥10 RNA copies/reaction (Table I). The procedure involved the reverse transcription of the extracted RNA into a complementary DNA, followed by the amplification of the hemagglutinin gene for subtyping (H1N1pdm09, H3N2, H5N1, and H7N9) and a fragment of a conserved region of the neuraminidase gene for H5N1 and H7N9 subtypes' confirmation (Table II), using specific primers and fluorescently labeled probes (primer and probe sequences are proprietary and not publicly disclosed by the manufacturer). The work was done according to the manufacturer's instructions. Briefly, 15 µl of the rehydration buffer, and 5 µl of each of the RNA extract, positive, and negative controls were added to each well. Strips were then loaded into a Rotor-Gene RG-3000 thermocycler (Corbett Research, Australia) and run using the procedure described in Table III. Samples with cycle threshold (Ct) ≤ 38 were considered positive, per kit guidelines. The work was conducted at Nobel Genetic MedLab in Erbil City (Certest Biotec, 2023).

TABLE I
Components of Viasure Flu Typing ii Real Time pcr Detection Kit (Catalog no.: Vs-hxn136)

Reagent/Material	Description
Flu Typing II	Lyoprotectors and stabilizers
	Nucleotide triphosphate (dNTPs)
	Primers and probes
	Enzymes
H5N1+H7N9 Confirmation	Lyoprotectors and stabilizers
	Nucleotide triphosphate (dNTPs)
	Primers and probes
	Enzymes
Rehydration buffer	Saline solution mixture
	Buffer (TRIS, pH)

DNTPs: Deoxynucleoside triphosphates

TABLE II
Targets, Channels and Genes in Rt-Qpcr Protocol

Step	Target	Channel	Gene
Flu Typing II	Influenza A (H1N1) pdm09	FAM	Hemagglutinin gene
	Influenza A (H3N2)	ROX	Hemagglutinin gene
	Influenza A (H5N1)	HEX	Hemagglutinin gene
	Influenza A (H7N9)	Cy5	Hemagglutinin gene
H5N1+H7N9 confirmation	Influenza A (H5N1)	FAM	Neuraminidase gene
	Influenza A (H7N9)	ROX	Neuraminidase gene
	Internal control (IC)	HEX	-

RT-QPCR: Reverse transcriptase quantitative polymerase chain reaction

TABLE III
Real Time Rt-Pcr Protocol

Cycles	Step	Time	Temperature
1	Reverse transcription	15 min	45°C
1	Initial denaturation	2 min	95°C
45	Denaturation	10 s	95°C
	Annealing/extension	50 s	60°C

RT-PCR: Reverse transcription polymerase chain reaction

E. Ethics Approval

The research project was reviewed and approved by the Medical Ethics Committee of Erbil Polytechnic University. It adhered to the requirements of the Declaration of Helsinki and related medical ethics regulations (Approval No. 24/0068, dated May 5, 2024).

F. Statistical analysis

The statistical analysis of the collected data was conducted using SPSS version 28. Mean, standard deviation, and percentage were utilized to describe the obtained data, and the Pearson Chi-square test (χ^2) was used to determine the association between variables. When the expected cell counts were small, Fisher's Exact Test p-values were considered instead of χ^2 p-values. Statistical significance was considered when $p < 0.05$.

III. Results

A. Demographic and Clinical Characteristics of Pediatric Patients with ARTI

Out of 200 pediatric patients diagnosed with ARTI in this study, 110 (55%) were hospitalized with SARI, whereas 90 (45%) were outpatients presenting with ILI. Table IV shows the demographic and clinical characteristics of the children. Most of the cases were from rural areas (54.5%, p = 0.764), and males outnumbered females (56.5% vs. 43.5%, p = 0.80). The average age of the children was 11.75 ± 10.37 months. Clinically, a variety of symptoms were observed. Fatigue (99.5%), rhinorrhea (97%), and cough (93%) were the most common symptoms reported by patients with ARTI. Symptoms significantly associated with hospitalization included fever (80.5%, p = 0.44%), nasal congestion (74.5%, p = 0.01), and dyspnea (63%, p = 0.0001). Hypoxia (SpO_2 < 92%) was present in 36% (p = 0.0001). Most children had mild (49%) or moderate (48.5%) illnesses; some required oxygen therapy, and only 2.5% needed ICU admission. Among lung auscultation findings, wheezing was most frequent (57.5%), followed by rales (21.5%), ronchi (14.5%), and stridor (6.5%) (p = 0.035). Clinical examination and chest X-rays revealed bronchiolitis in 66.5% of cases, bronchitis in 12.5%, and lower rates of pneumonia (4%) and croup (6.5%) (p = 0.049).

TABLE IV
Demographic and Clinical Characteristics of Children with Arti

Characteristics	Inpatient Number (%)	Outpatient Number (%)	Total Number (%)	χ^2 p-value
Demographic characteristics				
Address				
Urban	49 (44.5)	42 (46.7)	91 (45.5)	0.764
Rural	61 (55.5)	48 (53.3)	109 (54.5)	
Gender				
Male	63 (57.3)	50 (55.6)	113 (56.5)	0.807
Female	47 (42.7)	40 (44.4)	87 (43.5)	
Age (month)				
Minimum	1	3	1	0.039
Maximum	49	60	60	
Mean±SD	10.33±9.37	13.2±11.07	11.75±10.37	
Weight (kg)				0.230
Mean±SD	7.04±5.98	12.04±6.66	9.45±4.0	
Clinical characteristics				
Signs				
Fever	94 (85.5)	67 (74.4)	161 (80.5)	0.044
Cough	101 (91.8)	85 (94.4)	186 (93)	0.469
Sore throat	74 (67.3)	64 (71.1)	138 (69)	0.559
Fatigue	109 (99.1)	90 (100)	199 (99.5)	0.365
Nasal congestion	74 (67.3)	75 (83.3)	149 (74.5)	0.010
Rhinorrhea	107 (97.3)	87 (96.7)	194 (97)	0.803
Sneezing	88 (80)	81 (90)	169 (84.5)	0.127
Diarrhea	38 (34.5)	20 (22.5)	58 (29)	0.056
Vomiting	51 (46.4)	29 (32.2)	80 (40)	0.42
Dyspnea	82 (74.5)	44 (48.9)	126 (63)	0.0001
SpO_2				
≥92%	45 (40.9)	83 (92.2)	128 (64)	0.0001
<92%	65 (59.1)	7 (7.8)	72 (36)	
Lung sound				
Wheezing	65 (59.1)	50 (55.6)	115 (57.5)	
Rales (crackles)	26 (23.6)	17 (18.9)	43 (21.5)	
Ronchi	12 (10.9)	17 (18.9)	29 (14.5)	0.035
Strider	7 (6.4)	6 (6.7)	13 (6.5)	
Diagnosis				
Croup	8 (7.3)	5 (5.6)	13 (6.5)	
Bronchitis	14 (12.7)	11 (12.2)	25 (12.5)	
Bronchiolitis	65 (59.1)	68 (75.6)	133 (66.5)	0.049
Bronchopneumonia	16 (14.5)	5 (5.6)	21 (10.5)	
Pneumonia	7 (6.4)	1 (1.1)	8 (4)	
Disease severity				
Mild	25 (22.7)	73 (81.1)	98 (49)	
Moderate	80 (72.7)	17 (18.9)	97 (48.5)	0.801
Severe	5 (4.6)	0 (0)	5 (2.5)	

ARTI: Acute respiratory tract infection, SD: Standard deviation

B. Factors Contribute to the Increased Risk of Pediatric ARTI

Table V summarizes the common risk factors associated with ARTI among the studied pediatric population. Cesarean section (CS) delivery was more frequent than natural delivery (127 vs. 73, p = 0.423). Non-breastfeeding and parental smoking were slightly more common among patients (107 and 110, respectively), but none showed a statistically significant association with infection (p = 0.966 and p = 0.609, respectively). Congenital anomalies and family history of asthma were uncommon (11 and 23 cases, respectively; p = 0.554 and 0.053). Notably, recent ARTI among family members was significantly associated with pediatric infection (p = 0.045), highlighting the role of household exposure in disease transmission and susceptibility.

C. Distribution of Influenza A and its Subtypes

The bar chart in Fig. 1 illustrates the distribution of influenza A virus (Flu A) subtypes among patients. Of the 14%

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TABLE V
DISTRIBUTION OF COMMON RISK FACTORS AND THEIR ASSOCIATION WITH PEDIATRIC ARTI

Factor	Inpatient Number (%)	Outpatient Number (%)	Total Number (%)	χ^2 p-value
Delivery type				
Natural	39 (53.4)	34 (46.6)	73 (100)	0.423
Cesarean section	71 (55.9)	56 (44.1)	127 (100)	
Feeding type				
Breast feeding	51 (54.8)	42 (45.2)	93 (100)	0.966
Non-breast feeding	59 (55.1)	48 (44.9)	107 (100)	
Parental smoking				
Yes	59 (56.7)	51 (43.3)	110 (100)	0.609
No	45 (53.1)	45 (46.9)	90 (100)	
Congenital cardiac and respiratory anomalies				
Yes	7 (63.6)	4 (36.4)	11 (100)	0.554
No	103 (54.5)	86 (54.5)	189 (100)	
Family history of asthma				
Yes	17 (73.9)	6 (26.1)	23 (100)	0.053
No	93 (52.5)	84 (47.5)	177 (100)	
Family history of recent ARTI infection				
Yes	85 (55)	56 (45)	141 (100)	0.045
No	25 (42.4)	34 (57.6)	59 (100)	

ARTI: Acute respiratory tract infection

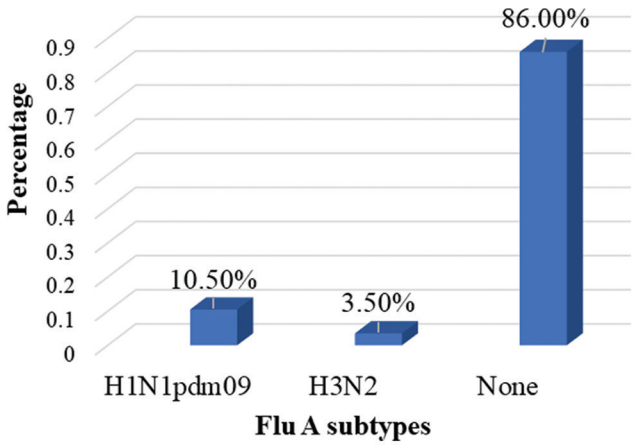

Fig. 1. Distribution of influenza A virus (Flu A) subtypes among the study population.

of children who tested positive for influenza A virus, 75% (10.5% of the total cohort) were positive for H1N1pdm09, and 25% (3.5% of the total cohort) were positive for H3N2, indicating that H1N1pdm09 was three times more common than H3N2 among detected cases. Details on the real-time RT-qPCR assay for subtyping of influenza A virus are shown in Fig. 2, in which Fig. 2a represents a single positive sample for H3N2, as indicated by a ROX-labeled amplification curve targeting the hemagglutinin gene with a Ct value of 23, whereas Fig. 2b shows results for H1N1pdm09 detection through the FAM channel in which several samples showed exponential amplification with Ct values between 22 and 30, confirming infection. Overall, the mean Ct value for all positive samples (both H3N2 and H1N1pdm09) was 23.1 ± 3.8, reflecting moderate viral loads. Negative samples and no-template controls exhibited no detectable amplification, demonstrating assay specificity.

Fig. 3 represents a comparison between influenza A infection among different patient types. A higher number of Flu A-positive cases was recorded in patients with SARI than patients with ILI (16 and 12, respectively, $p = 0.512$), suggesting a possible link between Flu A infection and hospitalization.

Fig. 4 shows the distribution of Flu A across three age classes: ≤6 months, 7–13 months, and >13 months. Both ARTI and Flu A were the highest among infants less than 6 months of age (74 and 12, respectively), indicating the increased susceptibility of this age to infection. Statistical analysis showed no significant association between age and Flu A infection (χ^2 $p = 0.987$).

Fig. 5 provides insights into ARTI and Flu A infections over the three winter months. ARTI cases were highest in January (79 cases), compared to December (50 cases) and February (43 cases). In contrast, Flu A infections peaked in December (26 cases), then sharply declined in January (2 cases), and were absent in February, indicating a rapid decrease in Flu A activity as winter progressed. The association between Flu A and seasonality was highly significant ($p < 0.001$).

IV. DISCUSSION

One of the most prevalent and serious health issues affecting children is ARTI, which significantly increases morbidity and mortality rates globally (Troeger, et al., 2018). According to a fact sheet by the WHO (2025), pneumonia and other respiratory infections are among the top causes of death in children under five, highlighting the urgent need for efficient care, quick diagnosis, and prevention methods (WHO, 2025). This study described the demographics and clinical characteristics of 200 children diagnosed with ARTI and identified a number of important epidemiological and clinical patterns in the context of the health of young children in the winter season in Erbil City. In this study, ARTI was higher in cases from rural areas than urbanized areas, although the association was not significant. Children living in less urbanized areas are associated with a greater exposure to environmental risk factors such as indoor air pollution, use of biomass fuel, and inadequate access to healthcare services. However, the non-significant association may be due to an insufficient sample size to detect a true disparity, or possibly reflects a relatively small urban–rural divide in healthcare access and living conditions within Erbil, compared to broader national or international contexts (Rudan, et al., 2008). The male predominance in this study was also reported by previous studies that attributed the increased susceptibility of boys to respiratory infections in infancy to genetic and hormonal factors that determine immune responses (Falagas, et al., 2007; Ygberg and Nilsson, 2012). One of the important factors that may increase susceptibility to infection is age. In this study, age was significantly associated with ARTI, indicating that younger

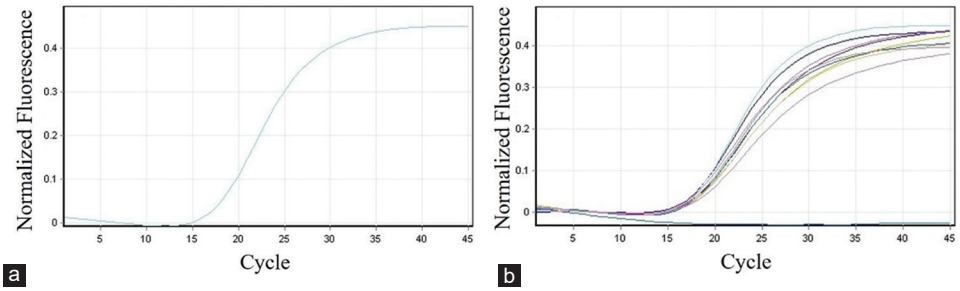

Fig. 2. Amplification curves for influenza A subtypes using real-time reverse transcriptase quantitative polymerase chain reaction assay. (a) The exponential fluorescence increase starting at cycle 20 (cycle threshold [Ct] ~23) confirms a positive result for the H3N2 subtype in the ROX channel; and (b) the exponential fluorescence increase starting at Ct values ranging from 22 to 30 confirms a positive result for the H1N1pdm09 subtype in the FAM channel.

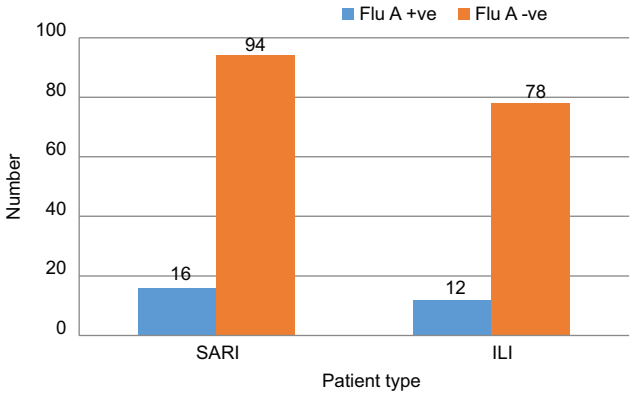

Fig. 3. Distribution of influenza A virus among SARI and ILI patient groups. Flu A +ve: Influenza A–positive; Flu A –ve: Influenza A–negative; ILI: Influenza-like illness; and SARI: Severe acute respiratory infection.

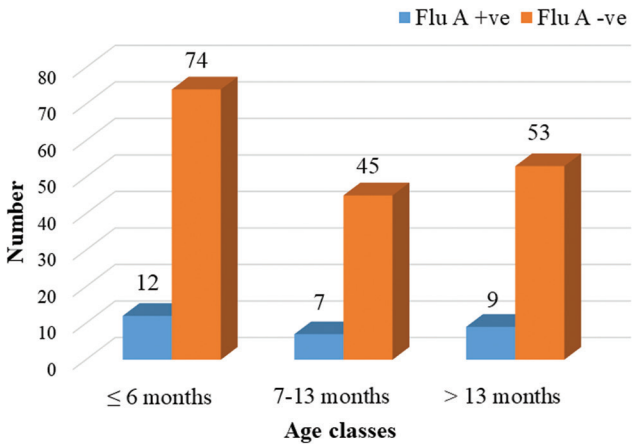

Fig. 4. Distribution of influenza A virus among different age groups. Flu A +ve: Influenza A–positive; Flu A –ve: Influenza A–negative.

children are more vulnerable to infection, a finding that is consistent with the known vulnerability of younger infants to respiratory pathogens due to their immature immune systems and smaller airway anatomy (Rhedin, et al., 2012; Kirolos, et al., 2021). The increased susceptibility to influenza A infection in children could be attributed to waning maternal antibodies, limited immunological memory, and ineligibility

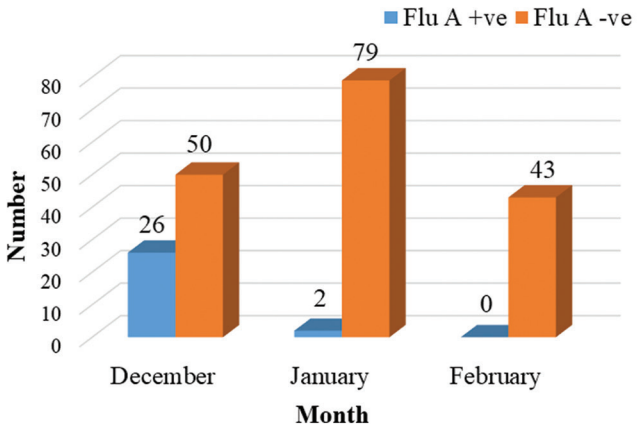

Fig. 5. Seasonal distribution of influenza A virus. Flu A +ve: Influenza A–positive; and Flu A –ve: Influenza A–negative.

for influenza A immunization in ages less than 6 months, and the absence of vaccination programs in developing countries for older ages (Nair, et al., 2011; Grohskopf, et al., 2024).

In our cohort, common symptoms such as fatigue, cough, and rhinorrhea were observed both ILI and SARI patient groups. However, fever, nasal congestion, and dyspnea were significantly associated with hospitalization. These symptoms are typical of acute respiratory infections (WHO, 2018a). Gastrointestinal symptoms such as diarrhea and vomiting were less frequently recorded, as their occurrence depends on the pathogenic pathways of specific respiratory viruses (Rafeek, et al., 2022). The pattern of hypoxia observed among patients suggests a substantial burden of lower respiratory tract involvement, particularly among SARI cases, a fact that totally aligning with WHO, (2018b) reports that oxygen desaturation marks disease severity and the need for hospitalization. The predominance of bronchiolitis cases in our cohort further supports the likelihood that viral infections were a major contributor to lower respiratory pathology, consistent with findings from other global studies (Basnet, et al., 2006; Tian, et al., 2023). The relatively low pneumonia proportion in this study is attributed to the fact that all the cases were collected at the very start of the onset of ARTI, even before hospital admission. It was found that pneumonia is mostly seen either in patients with debilitating risk factors or as a result of secondary bacterial infection and accounts

for only 4-10% during viral respiratory epidemics (Beletew, et al., 2020)

The detection of the influenza A virus among pediatric patients highlights its continued circulation in Iraq, with H1N1pdm09 remaining the predominant subtype. This pattern agrees with previous national surveillance studies, which also reported shifts in subtype dominance during and after the COVID-19 pandemic (Aufi, et al., 2021; Radhi, et al., 2023). Such variations are consistent with global trends influenced by viral evolution, immunity, and public health measures (WHO, 2014; Han et al., 2021). The higher occurrence of influenza among severe acute respiratory infection cases supports the established link between influenza A infection and hospitalization in young children (Nair, et al., 2011). The virus's ability to cause systemic and lower respiratory tract symptoms likely explains its clinical severity (Nair, et al., 2011; Han et al., 2021). In our country, the peak viral respiratory infection occurs in winter months. The observed winter seasonality of influenza A infection corresponds with the typical pattern reported in Iraq and other regions, where activity peaks during colder months, which defines the stability of most respiratory viruses in colder months and increased indoor crowding that facilitates transmission (Krammer, et al., 2018). The sharp decrease in Flu A-infected children may reflect the natural decline of seasonal outbreaks or a shift in circulatory virus types (Petrova and Russell, 2018).

This study aligns with the United Nations Sustainable Development Goals (UNSDGs), specifically Goal 3, Target 3.3, which aims to "end the epidemics of AIDS, tuberculosis, malaria and neglected tropical diseases and combat hepatitis, water-borne diseases, and other communicable diseases" (UN, 2025). Our cohort has important practical implications for child health in Iraq by highlighting that influenza A, especially the H1N1pdm09 subtype, is a significant cause of ARTI in young children and is linked to more severe illness. This highlights the need for regular viral monitoring and early diagnosis to better control outbreaks. The finding that younger children and those with infected family members are at greater risk suggests that preventive measures, such as vaccination campaigns, public health education, and infection control at home, should be a priority. Using these strategies, healthcare providers and policymakers can help lower the rates of viral severe respiratory infections, as a highly prevalent communicable disease, and hospitalizations in children.

This study was subject to several limitations. Obtaining parental consent and ensuring the cooperation of young children during nasopharyngeal sampling proved difficult as the procedure is often uncomfortable. There were also resource constraints, including restricted access to essential materials such as specified swabs for children, VTM, and reliable cold chain systems. In addition, sample collection was hindered by limited cooperation from some pediatricians, largely due to increased workload and overcrowding during the winter months. Furthermore, the sample size of 200 participants may have limited the statistical power to detect certain associations.

V. Conclusion

This study highlights the clinical burden and virological characteristics of respiratory tract infections among children under five in Erbil, Iraq, during peak winter months. Influenza A virus, particularly the pdm09 subtype, accounts for a notable proportion of infections. Most cases showed signs of lower respiratory tract involvement with the urgent need for oxygen supply. The association of young age and family history of asthma with increased susceptibility highlights critical host and environmental factors. These findings underscore the need for routine viral surveillance, timely diagnosis, and preventive measures such as influenza vaccination to reduce disease impact in pediatric populations, particularly during seasonal peaks. Further studies are recommended to assess long-term outcomes and the effectiveness of public health interventions in reducing viral transmission and complications. In addition, research involving larger, multi-center cohorts across different regions is needed to provide a more comprehensive understanding of pediatric respiratory infections and to better inform national public health strategies.

VI. Acknowledgment

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References

Aufi, I.M., Khudhair, A.M., Al-Saadi, G.L., Almoneem, A.M.A., and Shukur M.F.M., 2021. Epidemiology and molecular characterization of seasonal influenza viruses in Iraq. *Archives of Razi Institute*, 76(4), pp.67-79.

Basnet, S., Adhikari, R.K., and Gurung, C.K., 2006. Hypoxemia in children with pneumonia and its clinical predictors. *The Indian Journal of Pediatrics*, 73(9), pp.777-781.

Beletew, B., Bimerew, M., Mengesha, A., Wudu, M., and Azmeraw, M., 2020. Prevalence of pneumonia and its associated factors among under-five children in East Africa: A systematic review and meta-analysis. *BMC pediatrics*, 20(1), p.254.

Centers for Disease Control and Prevention, 2024. *About CDC's Global Influenza Program- Global Influenza*. Available from: https://www.cdc.gov/flu-global/about/index.html [Last accessed on 2025 Jun 07].

Centers for Disease Control and Prevention, 2025. *Interim Guidelines for Collecting and Handling of Clinical Specimens for COVID-19 Testing, COVID-19*. Available from: https://www.cdc.gov/covid/hcp/clinical-care/clinical-specimen-guidelines.html [Last accessed on 2025 Nov 15].

Certest Biotec., (2023). *VIASURE Flu Typing II Real Time PCR Detection Kit: Instructions for Use*. Available from: https://www.certest.es/products/flu-typing-ii [Last accessed on 2025 Jun 07].

Falagas, M.E., Mourtzoukou, E.G., and Vardakas, K.Z., 2007. Sex differences in the incidence and severity of respiratory tract infections. *Respiratory Medicine*, 101(9), pp.1845-1863.

Grohskopf, L.A., Ferdinands, J.M., Blanton, L.H., Broder, K.R., and Loehr, J., 2024. Prevention and control of seasonal influenza with vaccines: Recommendations of the advisory committee on immunization practices-United States, 2024-25 influenza season. *MMWR Recommendations and Reports*, 73(5), pp.1-17.

Han, S.B., Rhim, J.W., Kang, J.H., and Lee, K.Y., 2021. Clinical features and outcomes of influenza by virus type/subtype/lineage in pediatric patients. *Translational Pediatrics*, 10(1), pp.54-63.

Iuliano, A.D., Roguski, K.M., Chang, H.H., Muscatello, D.J., Palekar, R., Tempia, S., Cohen, C., Gran, J.M., Schanzer, D., Cowling, B.J., Wu, P., Kyncl, J., Ang, L.W., Park, M., Redlberger-Fritz, M., Yu, H., Espenhain, L., Krishnan, A., Emukule, G., van Asten, L., da Silva, S.P., Aungkulanon, S., Buchholz, U., Widdowson, M.A., and Bresee, J.S., 2018, Estimates of global seasonal influenza-associated respiratory mortality: A modelling study. *Lancet (London)*, 391(10127), pp.1285-1300.

Kirolos, A., Blacow, R.M., Parajuli, A., Welton, N.J., Khanna, A., Allen, S.J., McAllister, D.A., Campbell, H., and Nair, H., 2021. The impact of childhood malnutrition on mortality from pneumonia: A systematic review and network meta-analysis. *BMJ Global Health*, 6(11), p.e007411.

Krammer, F., Smith, G.J.D., Fouchier, R.A.M., Peiris, M., Kedzierska, K., Doherty, P.C., Palese, P., Shaw, M.L., Treanor, J., Webster, R.G., and García-Sastre, A., 2018. Influenza. *Nature Reviews,* 4(1), p.3.

Moore, M., Chan, E., Lurie, N., Schaefer, A.G., Varda, D.M., and Zambrano, J.A., 2008. Strategies to improve global influenza surveillance: A decision tool for policymakers. *BMC Public Health*, 8, p.186.

Nair, H., Brooks, W.A., Katz, M., Roca, A., Berkley, J.A., Madhi, S.A., Simmerman, J.M., Gordon, A., Sato, M., Howie, S., Krishnan, A., Ope, M., Lindblade, K.A., Carosone-Link, P., Lucero, M., Ochieng, W., Kamimoto, L., Dueger, E., Bhat, N., Vong, S., Theodoratou, E., Chittaganpitch, M., Chimah, O., Balmaseda, A., Buchy, P., Harris, E., Evans, V., Katayose, M., Gaur, B., O'Callaghan-Gordo, C., Goswami, D., Arvelo, W., Venter, M., Briese, T., Tokarz, R., Widdowson, M-A., Mounts, A.W., Breiman, R.F., Feikin, D.R., Klugman, K.P., Olsen, S.J., Gessner, B.D., Wright, P.F., Rudan, I., Broor, S., Simões, E.A., and Campbell, H., 2011. Global burden of respiratory infections due to seasonal influenza in young children: A systematic review and meta-analysis. *The Lancet*, 378(9807), pp.1917-1930.

Petrova, V.N., and Russell, C.A., 2018. The evolution of seasonal influenza viruses. *Nature Reviews Microbiology*, 16(1), pp.47-60.

Radhi, A.H., Ibrahim, Z.H., and Alhilifi, R., 2023. The epidemiological pattern of seasonal influenza in four sentinel sites in Iraq. *Influenza and Other Respiratory Viruses*, 17(4), p.e13134.

Rafeek, R.A.M., Divarathna, M.V.M., Morel, A.J., and Noordeen, F., 2022. Clinical and epidemiological characteristics of influenza virus infection in hospitalized children with acute respiratory infections in Sri Lanka. *PLoS One*, 17(9), p.e0272415.

Rhedin, S., Hamrin, J., Naucler, P., Bennet, R., Rotzén-Östlund, M., Färnert, A., and Eriksson, M., 2012. Respiratory viruses in hospitalized children with influenza-like illness during the H1n1 2009 pandemic in Sweden. *PLoS One*, 7(12), p.e51491.

Rudan, I., Biloglav, Z., Boschi-Pinto, C., Mulholland, K., and Campbell, H., 2008. Epidemiology and etiology of childhood pneumonia. *Bulletin of the World Health Organization*, 86(5), pp.408-416.

Simonsen, L., Clarke, M.J., Williamson, G.D., Stroup, D.F., Arden, N.H., and Schonberger, L.B., 1997. The impact of influenza epidemics on mortality: Introducing a severity index. *American Journal of Public Health*, 87(12), pp.1944-1950.

Tian, J., Wang, X.Y., Zhang, L.L., Liu, M.J., Ai, J.H., Feng, G.S., Zeng, Y.P., Wang, R., and Xie, Z.D., 2023. Clinical epidemiology and disease burden of bronchiolitis in hospitalized children in China: A national cross-sectional study. *World Journal of Pediatrics*, 19(9), pp.851-863.

Tong, S., Li, Y., Rivailler, P., Conrardy, C., Castillo, D.A.A., Chen, L-M., Recuenco, S., Ellison, J.A., Davis, C.T., York, I.A., Turmelle, A.S., Moran, D., Rogers, S., Shi, M., Tao, Y., Weil, M.R., Tang, K., Rowe, L.A., Sammons, S., Xu, X., Frace, M., Lindblade, K.A., Cox, N.J., Anderson, L.J., Rupprecht, C.E., and Donis, R.O., 2012. A distinct lineage of influenza A virus from bats. *Proceedings of the National Academy of Sciences of the United States of America*, 109(11), pp.4269-4274.

Troeger, C., Blacker, B., Khalil, I.A., Rao, P.C., Cao, J., Zimsen, S.R.M., Albertson, S.B., Deshpande, A., Farag, T., Abebe, Z., Adetifa, I.M.O., Adhikari, T.B., Akibu, M., A.l., Lami, F.H., Al-Eyadhy, A., Alvis-Guzman, N., Amare, A.T., Amoako, Y.A., Antonio, C.A.T., Aremu, O., Asfaw, E.T., Asgedom, S.W., Atey, T.M., Attia, E.F., Avokpaho, E.F.G.A., Ayele, H.T., Ayuk, T.B., Balakrishnan, K., Barac, A., Bassat, Q., Bhaumik, S., Bhutta, Z.A., Bijani, A., Brauer, M., Brown, A., Camargos, P.A.M., Castañeda-Orjuela, C.A., Colombara, D., Conti, S., Dadi, A.F., Dandona, L., Dandona, R., Do, H.P., Dubljanin, E., Edessa, D., Elkout, H., Endries, A.Y., Fijabi, D.O., Foreman, K.J., Forouzanfar, M.H., Fullman, N., Garcia-Basteiro, A.L., Gessner, B.D., Gething, P.W., Gupta, R., Gupta, T., Hailu, G.B., Hassen, H.Y., Hedayati, M.T., Heidari, M., Hibstu, D.T., Horita, N., Ilesanmi, O.S., Jakovljevic, M.B., Jamal, A.A., Kahsay, A., Kasaeian, A., Kassa, D.H., Khader, Y.S., Khan, E.A., Khan, M.N., Khang, Y-H., Kim, Y.J., Kissoon, N., Knibbs, L.D., Kochhar, S., Koul, P.A., Kumar, G.A., Lodha, R., Magdy Abd El Razek, H., Malta, D.C., Mathew, J.L., Mengistu, D.T., Mezgebe, H.B., Mohammad, K.A., Mohammed, M.A., Momeniha, F., Murthy, S., Nguyen, C.T., Nielsen, K.R., Ningrum, D.N.A., Nirayo, Y.L., Oren, E., Ortiz, J.R., Pa, M., Postma, M.J., Qorbani, M., Quansah, R., Rai, R.K., Rana, S.M., Ranabhat, C.L., Ray, S.E., Rezai, M.S., Ruhago, G.M., Safiri, S., Salomon, J.A., Sartorius, B., Savic, M., Sawhney, M., She, J., Sheikh, A., Shiferaw, M.S., Shigematsu, M., Singh, J.A., Somayaji, R., Stanaway, J.D., Sufiyan, M.B., Taffere, G.R., Temsah, M-H., Thompson, M.J., Tobe-Gai, R., Topor-Madry, R., Tran, B.X., Tran, T.T., Tuem, K.B., Ukwaja, K.N., Vollset, S.E., Walson, J.L., Weldegebreal, F., Werdecker, A., West, T.E., Yonemoto, N., Zaki, M.E.S., Zhou, L., Zodpey, S., Vos, T., Naghavi, M., Lim, S.S., Mokdad, A.H., Murray, C.J.L., Hay, S.I., and Reiner, R.C., 2018. Estimates of the global, regional, and national morbidity, mortality, and aetiologies of lower respiratory infections in 195 countries, 1990–2016: A systematic analysis for the Global Burden of Disease Study 2016. *The Lancet Infectious Diseases*, 18(11), pp.1191-1210.

United Nations, 2025. *Sustainable Development Goal 3: Ensure Healthy Lives and Promote Well-Being for all at all Ages*. United Nations Department of Economic and Social Affairs. Available from: https://sdgs.un.org/goals/goal3 [Last accessed on 2025 Nov 06].

World Health Organization, 2014. *Revised WHO Classification and Treatment of Pneumonia in Children at Health Facilities: Evidence Summaries*, World Health Organization, Geneva. Available from: https://iris.who.int/handle/10665/137319 [Last accessed on 2025 Jun 16].

World Health Organization, 2018a. *Surveillance Case Definitions for ILI and SARI.* World Health Organization - Regional Office for the Eastern Mediterranean. Available from: https://www.who.int/teams/global-influenza-programme/surveillance-and-monitoring/case-definitions-for-ili-and-sari [Last accessed on 2025 Jun 01].

World Health Organization, 2018b. *Influenza Monthly Update*. World Health Organization-Regional Office for the Eastern Mediterranean Retrieved. Available from: https://cdn.who.int/media/docs/default-source/influenza/influenza-updates/2023/2023_10_30_surveillance_update_457.pdf?sfvrsn=d94c8c1_3&download=true [Last accessed on 2025 Jun 15].

World Health Organization, 2025. *Influenza (Seasonal).* World Health Organization, Geneva. Available from: https://www.who.int/news-room/fact-sheets/detail/influenza-(seasonal) [Last accessed on 2025 Jun 15].

Ygberg, S., and Nilsson, A., 2012. The developing immune system-from foetus to toddler. *Acta Paediatrica*, 101(2), pp.120-127.