Prevalence of Influenza Viruses in Northern India: A Retrospective Surveillance Study

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Abstract

Background: Influenza viruses, particularly Influenza A and B, are among the most common causes of acute respiratory infections (ARIs) worldwide. Understanding their seasonal and demographic patterns is vital for planning vaccination strategies and public health interventions.

Methods: This retrospective study analyzed 231 respiratory samples collected from patients with influenza-like illness (ILI) and severe acute respiratory infections (SARI) between August 2024 and June 2025. Samples were tested for respiratory viruses using RT-PCR. Influenza A (H1N1, H3N2) and Influenza B (Victoria and Yamagata) detections were analyzed by age, gender, geography, and seasonality.

Results: Among 231 tested cases, a total of 55 (23.8%) were tested positive for Influenza viruses. Influenza B (Victoria) was the most prevalent (27 cases; 11.7%), followed by Influenza A (H3N2) (24 cases; 10.4%) and Influenza A (H1N1) (4 cases; 1.7%). No cases of Influenza B (Yamagata) were detected. Most cases occurred in infants and young children, with a significant seasonal peak in February 2025. Both rural and urban areas were equally affected, and males slightly outnumbered females among positive cases.

Conclusion:

Influenza B (Victoria) and Influenza A (H3N2) were the dominant circulating strains during the surveillance period. These findings emphasize the need for continued influenza surveillance and age-targeted immunization strategies to minimize disease burden.

Keywords: Influenza, H1N1, H3N2, Victoria, Yamagata, epidemiology, seasonality, RT-PCR, India

Introduction

Influenza viruses are significant contributors to global morbidity and mortality, causing seasonal outbreaks that strain healthcare systems. These viruses are divided into types A and B, with subtypes such as H1N1 and H3N2 (Influenza A) and lineages like Victoria and Yamagata (Influenza B) that display distinct epidemiological characteristics [1].

Influenza viruses, particularly types A and B are among the most common causative agents of acute respiratory infections (ARIs) worldwide [2], responsible for significant seasonal morbidity and mortality [3]. These viruses are characterized by high mutation rates and antigenic variability, necessitating continuous epidemiological surveillance [4]. The global burden of influenza is substantial, with the World Health Organization estimating 3–5 million cases of severe illness and up to 650,000 influenza-related deaths annually [5]. Understanding the local circulation patterns of these viruses is crucial for informing public health responses, particularly vaccination strategies and outbreak management [6].

India experiences a diverse climatic profile, influencing viral circulation. In northern India, influenza activity typically peaks during the winter and early spring months (December to March) [7]. However, the COVID-19 pandemic significantly disrupted viral circulation patterns due to widespread non-pharmaceutical interventions such as mask-wearing, physical distancing, and reduced mobility. As these measures were relaxed, influenza viruses have gradually resurged, though their patterns of re-emergence, seasonality, and demographic distribution may differ from the pre-pandemic period [8]. Surveillance data, especially post-COVID-19, are essential to understand evolving transmission patterns, assess vaccine effectiveness, and prepare for future outbreaks [9].

The present study was conducted in a tertiary care hospital in northern India to monitor and evaluate the circulation of influenza viruses between August 2024 and June 2025. The surveillance aimed to determine the prevalence of Influenza A (H1N1 and H3N2) and Influenza B (Victoria and Yamagata), identify high-risk age groups, assess gender-specific trends, and map seasonal variations in a northern Indian region.

Materials and Methods

Study Design: A prospective observational study was conducted from August 2024 to June 2025 to determine the incidence and pattern of respiratory virus infections among patients presenting with severe acute respiratory infections (SARI) in Punjab, North India. The SARI case definition followed the World Health Organization (WHO) guidelines. For individuals aged ≥2 months, SARI was defined as the presence of cough with onset within the past seven days requiring overnight hospitalization. For infants under 2 months of age, SARI was defined based on a clinical diagnosis by a physician indicative of acute lower respiratory tract infection—such as pneumonia, bronchiolitis, bronchitis, or sepsis—also necessitating hospital admission.

Eligible participants were enrolled after obtaining informed consent. Clinical data were recorded using standardized proformas. Trained healthcare personnel collected respiratory specimens—nasal, throat, or nasopharyngeal swabs—following age-appropriate sampling protocols. Specimens were placed in viral transport medium (VTM) and transported under a maintained cold chain at 4°C to the laboratory within 24 hours to ensure sample integrity.

In total, respiratory samples from 231 SARI patients were collected and tested during the study period. Samples were analyzed including Influenza A [subtypes H1N1 and H3N2], Influenza B [lineages Yamagata and Victoria].

Laboratory Testing: Laboratory investigations were conducted at the Viral Research and Diagnostic Laboratory (VRDL), housed in a tertiary care teaching hospital, from August 1, 2024, to July 31, 2025. For viral detection, an in-house, multiplex real-time reverse transcriptase polymerase chain reaction (rRT-PCR) assay was employed. It allowed for the simultaneous detection of influenza A, influenza B, in a single reaction format. The assay targeted specific gene regions: FAM for influenza A, and Cy5 for influenza B. These targets ensured high analytical sensitivity and specificity, enabling accurate identification of the three viral pathogens. This step allowed for the differentiation of key circulating influenza strains, specifically:

- Influenza A subtypes: FAM: A(H1N1)pdm09 and VIC: A(H3N2)
- Influenza B lineages: FAM: B/Yamagata and VIC: B/Victoria

Data Collection and Analysis: Demographic data including age, gender, and residential location (urban/rural) were extracted from hospital medical records. Data were organized using Microsoft Excel and subjected to descriptive statistical analysis. Parameters evaluated included age-specific distribution, gender-based differences, and temporal trends in viral positivity across the study months.

Results: The current study analyzed the 231 samples to check the prevalence of Influenza post pandemic period**.** Results showed that out of the 231 respiratory samples tested between August 2024 and July 2025, 55 cases (23.8%) were positive for Influenza viruses, representing a substantial portion of respiratory viral infections during the surveillance period as shown in Table 1. Among the positive patients, it was observed that Influenza B (Victoria lineage) was the most commonly circulating infection which was found in **27** samples (11.7%)**.** This was followed closely by Influenza A (H3N2) with 24 cases (10.4%), while Influenza A (H1N1) was detected in only 4 samples (1.7%)**.** Notably, there were no cases of Influenza B (Yamagata lineage) throughout the surveillance period, suggesting either a localized absence or a global reduction in its circulation.

Table 1: Distribution of Influenza Virus Positivity among Tested Samples (n = 231)

Virus Type	Positive (n)	Positive (%)	Negative (n)	Negative (%)
Influenza A (H1N1)	4	1.7%	227	98.3%
Influenza A (H3N2)	24	10.4%	207	89.6%
Influenza B (Victoria)	27	11.7%	204	88.3%
Influenza B (Yamagata)	0	0.0%	231	100.0%

Age-wise Distribution: Table 2 shows the age wise distribution of Influenza virus prevalence pattern. In the present study it was observed that influenza infections exhibited in distinct age-related patterns mainly in younger age groups**.** Influenza A (H3N2) showed a marked predominance among **i**nfants aged 15 days to 1 year, who accounted for 50% (12/24) of all H3N2 positive cases. This was followed by the 1–5 years group (5 cases; 20.8%) and 5–20 years group (4 cases; 16.7%). These findings highlight a significant burden of H3N2 among pediatric populations, especially infants, who may have immature immune systems and higher exposure through daycare or siblings.

Table 2: Age-wise Distribution of Influenza Positivity (n = 231)

Age Group	Inf A (H1N1)	Inf A (H3N2)	Inf B (Victoria)	Inf B (Yamagata)
15 days – 1 yr	0	12	8	0
1 – 5 years	0	5	8	0
5 – 20 years	0	4	8	0
20 – 40 years	1	1	1	0
40 – 60 years	2	2	1	0
> 60 years	1	0	1	0

Influenza B (Victoria) demonstrated a more even age distribution among children. The virus was detected equally in the 15 days–1 year, 1–5 years, and 5–20 years age groups, each contributing 29.6% (8 cases) to the total Victoria detections. A smaller number of cases were observed in the adult population: one each in the 20–40, 40–60, and >60 years groups. Influenza A (H1N1), in contrast, was predominantly detected in adults aged 20–60 years**,** with no cases found in children or the elderly**.** Figure 1 reflects the distinct age predilections among different influenza strains.

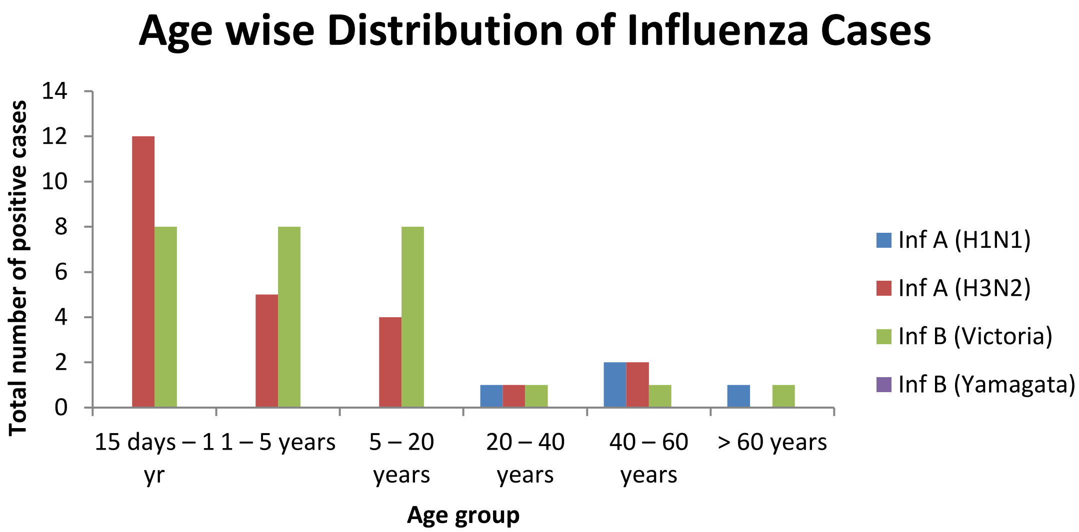

Figure: 1 Bar chart showing Age group Distribution of positive cases for Influenza virus.

Gender-wise Distribution: Among the 55 total positive cases of influenza**, females** 28 (50.9%) **showed higher positivity rate** than males 27(49.1 %) as shown in Table 3**.** Specifically focusing on subtypes of influenza, Influenza A (H3N2) was the most frequently detected virus among males accounting for 13 out of 27 male positive cases (48.1%) whereas Influenza B (Victoria) slightly more prevalent among females with 15 out of the 28 female positives (53.5%)**.** H1N1 showed no gender variation as shown in Table 3. This data suggests that while both genders are comparably affected by influenza, subtle differences exist in strain-specific prevalence, which may be influenced by immune or exposure-related factors.

Table: 3 Gender Residential Distribution of Influenza cases

Categories	**Inf (H1N1)**		**Inf (H3N2)**		**Inf (Yamagata)**		**Inf (Victoria)**	
	Positive	**Negative**	**Positive**	**Negative**	**Positive**	**Negative**	**Positive**	**Negative**
Male	2	126	13	114	0	128	12	116
Female	2	101	11	93	0	103	15	88

Rural	0	101	11	90	0	101	12	89
Urban	4	126	13	117	0	130	15	115

A comparison of rural and urban residence showed slight difference of geographical disparity in infection rates. Of the total 231 cases, 101 (43.7%) were from rural areas, while 130 (56.3%) were from urban areas as shown in **Figure 2.** The positivity rate among rural samples was 22.7% (23/101) compared to 24.6% (32/130) in urban samples. This near-equal distribution suggests that respiratory viral infections were equally prevalent across both settings during the surveillance period, and geographical location did not significantly influence transmission dynamics.

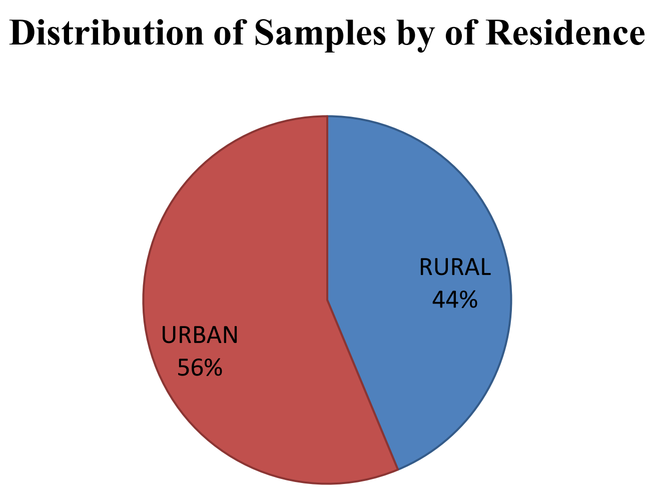

Figure 2: Distribution of Respiratory Samples by Place of Residence (n = 231)

Seasonal Distribution: Month-wise analysis revealed a distinct seasonal pattern in influenza virus circulation (Table 4). In the year 2024, 4 cases of Inf A was observed during Aug 2024 to Sept 2024 whereas no influenza cases were reported in October to December 2024**.** A notable increase in positive detections began in January 2025**,** with peak activity observed in February

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2025, when 33 influenza cases were reported 18 of H3N2 and 15 of Victoria marking February as the epicenter of the influenza season during the study period.

Table 4: Seasonal Distribution of Influenza Detections (Aug 2024 – June 2025)

Month	Inf A (H1N1)	Inf A (H3N2)	Inf B (Victoria)	Inf B (Yamagata)
Aug 2024	1	0	0	0
Sept 2024	3	0	0	0
Oct–Dec 2024	0	0	0	0
Jan 2025	0	2	7	0
Feb 2025	0	18	15	0
Mar 2025	0	4	4	0
Apr-2025	0	0	1	0
May-June-2025	0	0	0	0

January 2025 recorded a moderate number of Victoria cases (7) but (2) H3N2 cases. A sharp decline was observed from March 2025 onwards**,** with only a few influenza detections (Victoria: 4; H3N2: 4). From April 2025 to June 2025**,** detections dropped significantly with only one isolated case of Victoria as shown in figure 3.

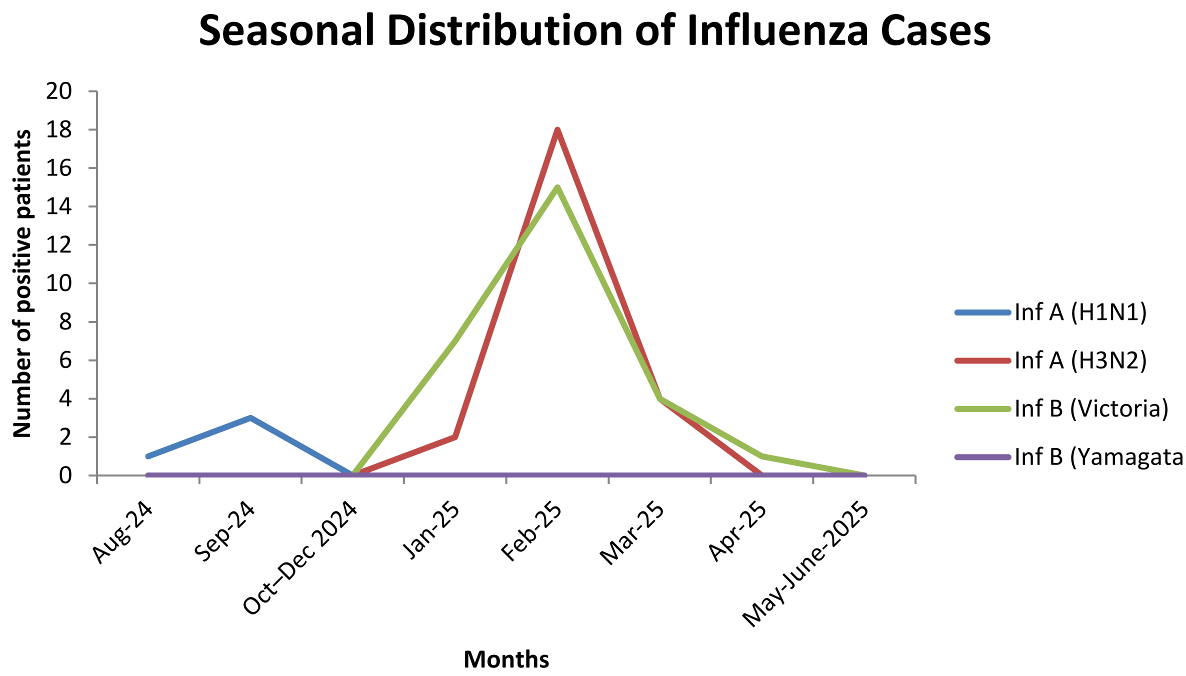

Figure: 3 Seasonal distribution of Influenza Virus among Tested cases (n=231)

Discussion: The present study highlights the circulation dynamics of influenza viruses during surveillance period in Northern India, revealing significant seasonal and demographic patterns. Among the 231 respiratory samples tested, Influenza B (Victoria lineage) and Influenza A (H3N2) emerged as the dominant strains, with detection rates of 11.7% and 10.4% respectively. A clear seasonal peak was observed in February 2025, accounting for over 60% of all influenza detections, which aligns with typical winter-peak patterns reported in temperate regions.

The findings from this study align closely with previous literature documenting the seasonal behavior and demographic impact of circulating influenza viruses in India and globally [10-12]. The predominance of Influenza B (Victoria) and Influenza A (H3N2) during the surveillance period mirrors national trends reported by the Integrated Disease Surveillance Programme

(IDSP) and National Influenza Surveillance reports, which have consistently observed these two subtypes as dominant during post-monsoon and winter months in northern India [13,14].

Historically, Influenza A (H1N1) has been a prominent cause of influenza-related hospitalizations in India. However, the present study (Punjab, Aug 2024–Jun 2025) reveals a marked shift towards Influenza A (H3N2) dominance, accompanied by Influenza B (Victoria), with H1N1 circulation dropping to minimal levels. Earlier Indian surveillance data from 2009 to 2019 [15,16] indicated repeated waves of H1N1 dominance, particularly following the 2009 pandemic as shown in Table 5. In contrast, studies during 2016–2018 noted periodic surges in H3N2 activity, often associated with more severe illness among young children and the elderly [17]. The present findings align with the WHO Global Influenza Surveillance and Response System (GISRS) reports for 2023–2024, which documented a broader shift toward H3N2 dominance across many regions in Asia, with reduced H1N1 activity [18]. The low rate of H1N1 observed here reflects its decreasing circulation in India post-2019, as reported by Singh et al. (2025) [17]. However, ongoing surveillance remains vital due to the virus's potential for genetic reassortment.

Table 5: Comparison of Current Findings with Previous Published Studies

Parameter	Present Study (Punjab, 2024–2025)	Previous Studies	References
Dominant Influenza A	H3N2 (10.4%), H1N1 minimal (1.7%)	H1N1 dominance during 2009–2015; periodic H3N2 peaks in	[15, 16]

subtype		later years	
Seasonal Peak	February 2025 (late winter)	Dec–Mar peaks in Northern India	[17, 19]
Age groups most affected	H3N2: Infants (<1 yr) & children <5 yrs; H1N1: scattered older age cases	H1N1: Middle-aged adults & some pediatric cases; H3N2: elderly & young children	[17, 20]
H1N1 activity	Very low circulation	High during 2009–2015; resurgence in 2017	[21]
Possible drivers	Post-pandemic immunity shift, antigenic drift in H3N2	Pandemic introduction (2009) drove H1N1 dominance; periodic antigenic changes in H3N2	[18]
Public health note	Need for H3N2-targeted vaccination; pediatric focus	Broader vaccine coverage including both subtypes	[22]

The seasonal spike in February 2025 also matches earlier Indian surveillance studies, which documented peak influenza activity between December and March, particularly in regions with cooler climates [23]. A study by Broor et al. in Delhi (2012) reported a similar rise in Influenza B circulation in early spring, coinciding with our findings of a February peak dominated by the Victoria lineage [15].

Importantly, our observation of the complete absence of Influenza B (Yamagata) throughout the surveillance period is noteworthy and mirrors global reports suggesting its near disappearance, possibly due to altered transmission dynamics and competition with co-circulating lineages. Studies from Europe and East Asia have similarly reported no Yamagata detections since 2020 likely due to restricted virus circulation during pandemic-related lockdowns and international travel bans [24]. This trend has sparked discussions on excluding the Yamagata component from future quadrivalent influenza vaccines.

The burden of H3N2 was particularly high among infants and young children, with 70.8% of all H3N2 cases occurring in the under-5 age group. Ruf et al. (2014) highlighted the seasonal clustering of H3N2 and its significant burden among infants and children echoed in this study, where over 70% of H3N2 cases occurred in children below five years of age [25]. The prior studies indicating that, H3N2 excessively affects pediatric populations due to immature immune responses and increased exposure. Influenza B (Victoria), on the other hand, demonstrated a more even age distribution within children, affecting all pediatric strata almost equally. These findings are consistent with earlier research suggesting that Influenza B may circulate more uniformly in younger populations, unlike H3N2, which often shows age-specific clustering [26-28].

Gender-wise analysis indicated a mild male predominance, especially in H3N2 cases, while Victoria cases were marginally higher among females. These differences, though not statistically significant, warrant further exploration in larger population-based studies.

The uniform spread across rural and urban regions suggests community-level circulation and calls for equitable vaccine access. These data support regional tailoring of influenza vaccination schedules and reinforce the necessity of year-round surveillance.

Conclusion

This surveillance study from August 2024 to June 2025 highlights key epidemiological features of circulating influenza viruses in a tertiary healthcare setting in Northern India. Influenza B (Victoria) and A (H3N2) were the most prevalent, with February 2025 marking the seasonal peak. The age groups most affected included infants and children, emphasizing the need for pediatric-targeted immunization efforts. These findings advocate for continued influenza monitoring, timely vaccination policies, and tailored interventions for vulnerable populations.

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