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Original Research Article

Burden and seasonal trends of influenza A (H1N1) pdm09 in patients of a tertiary health care centre of South Gujarat

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Abstract

Introduction: Influenza A and its subtypes, classified under the Myxovirus family, are among the primary causes of acute viral respiratory tract infections in humans. Symptoms of influenza-like illness include fever, headache, myalgia, prostration, coryza, sore throat, and cough. This viral infection spreads rapidly worldwide through seasonal epidemics, outbreaks, and pandemics, leading to significant morbidity and mortality. In tropical countries like India, the seasonality of Influenza A (H1N1) pdm09 is less clearly defined. Due to the lack of data on its burden and seasonal trends in the study region, this study aims to address these gaps.

Materials and Methods: This retrospective observational study was conducted using data collected from the Department of Microbiology. Samples received in Microbiology Department for Influenza A (H1N1) pdm09 test from suspected cases of SARI patients of tertiary care hospital from 2016 to September 2024 were selected. Data from patients outside the tertiary care hospital were excluded. SARI was defined as any person having breathlessness, not able to maintain oxygen saturation, positive xray findings or person of > 5 years old presenting with symptoms of acute lower respiratory infection with sudden onset of fever ≥38 °C, and cough or sore throat, AND shortness of breath or difficulty breathing with in the last 7 days, AND requiring hospitalization.

Results: Burden of influenza A (H1N1) pdm09 from patients of a tertiary care institute was 1% in 2016, 22% in 2017, 0.0008% in 2018, 21% in 2019, 20% in 2020, 0% in 2021 and 2022, 4% in 2023 and 22% in 2024 till September month. The seasonal trend of cases was observed in August, September, and October during 2016, 2017, and 2018. However, this pattern shifted to January, February, March, and April in 2019 and 2020. In 2023, cases were detected in September, whereas in 2024, the highest number of cases occurred in July and August.

Discussion: The overall burden of Influenza A (H1N1) pdm09 was found to be 21%, with fewer cases reported in 2016, 2018, 2021, and 2022. The decline in cases during 2021 and 2022 may be attributed to the COVID-19 pandemic and its associated preventive measures. A noticeable shift in seasonality was observed, transitioning from the late fall and winter months to the heavy rainfall season. Understanding influenza burden and seasonal trends is crucial for optimizing vaccination timing and implementing effective preventive measures in the region.

Keywords: Seasonal Flu, H1N1 PDM09, Seasonal Trend, Burden

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1. Introduction

Influenza A viruses, belonging to the *Orthomyxoviridae* family, are responsible for seasonal epidemics, outbreaks, and occasional pandemics worldwide. Among its subtypes, the Influenza A (H1N1) pdm09 strain emerged as a novel reassortant virus in 2009, causing a global pandemic with significant morbidity and mortality.[1,2] This strain was a result of genetic reassortment involving human, avian, and swine influenza viruses, leading to widespread transmission across 214 countries, including India.[3]

In India, the first case of Influenza A (H1N1) pdm09 was reported in May 2009 in Hyderabad, followed by rapid spread across various states.[4] The virus has since transitioned from a pandemic strain to a seasonal influenza virus, continuing to cause annual outbreaks with varying intensity.[5] However, unlike temperate regions, where influenza activity peaks during winter, tropical and subtropical regions like India exhibit diverse seasonal patterns, influenced by climatic factors, population density, and healthcare interventions.[6,7]

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The epidemiology of Influenza A (H1N1) pdm09 in India has evolved over the years, with significant fluctuations in case burden and seasonality. While certain states have reported peak transmission during monsoon and post-monsoon seasons, others have observed increased cases in winter and early spring.[7] The COVID-19 pandemic (2020-2022) further impacted influenza trends, with reduced transmission attributed to widespread mask usage, social distancing, and lockdown measures.[9]

Despite periodic outbreaks, comprehensive data on the burden and seasonal trends of Influenza A (H1N1) pdm09 in different regions of India, particularly in South Gujarat, remain limited. This study aims to analyze the burden and seasonal trends of Influenza A (H1N1) pdm09 in patients from a tertiary healthcare institute in South Gujarat over a span of eight years (2016–September 2024). Understanding these trends is essential for optimizing vaccination strategies, improving surveillance, and implementing timely public health interventions.

2. Materials and Methods

2.1. Study design

The study design described here is a retrospective observational study, it was conducted to analyze the burden and seasonal trends of pandemic Influenza A (H1N1).

2.2. Study Setting

The study was conducted at the Microbiology Department of Government Medical College & New Civil Hospital, Surat, Gujarat.

2.3. Ethical considerations

The study was conducted after obtaining ethical clearance from the Institutional Ethics Committee of Government Medical College, Surat.

2.4. Inclusion criteria

Clinically, suspected cases belonging to Category C as per the guidelines on the categorisation of H1N1, between 2016 and September 2024 were included in the study. Only samples from patients of tertiary care institute were included in the study.

2.5. Exclusion criteria

Samples received from private hospital were excluded.

2.5.1. Definition of severe acute respiratory syndrome (SARI)

Severe acute respiratory syndrome (SARI) was defined as any person having breathlessness, chest pain, fall in blood pressure, sputum mixed with blood, bluish discoloration of nails/ Children with influenza-like illness who had a severe disease as manifested by the red flag signs (inability to feed well, convulsions, difficulty in breathing, etc.)/ Worsening of underlying chronic conditions AND require the hospitalization.[5]

2.6. Sample collection

Throat, nasal, or nasopharyngeal swabs/aspirates were collected by the treating physician in a viral transport medium and transported to the Department of Microbiology at 4°C. Samples were stored at 4°C until further processing.

2.6.1. Processing of samples

Samples were tested using real-time reverse transcription polymerase chain reaction (RT-PCR). RNA extraction was performed using QIAmp® viral RNA Mini Kit (Qiagen, USA) with a column-based extraction method. For Mastermix preparation, the following components were used: Nuclease-free water, 2X SuperScript III Master Mix, Primer-probe mix, TaqMan Polymerase Enzyme and Extracted RNA.

RT-PCR was conducted using the StepOnePlus™ Real-Time PCR System (Applied Biosystems, Thermo Fisher Scientific) or the Himedia Real-Time PCR machine, Reverse transcription at 50°C for 30 minutes followed by Taq inhibitor inactivation at 95°C for 10 minutes and PCR amplification (45 cycles) at 95°C for 15 seconds (denaturation) and at 55°C for 30 seconds (annealing/extension).

Results were interpreted based on the Cycle Threshold (CT) values. A sample was considered positive if the target gene crossed the threshold at or before 35 cycles. All samples were assessed for RNase P, which serves as an internal quality control marker. A sample was considered valid if it showed a positive curve for RNase P, confirming the presence of sufficient human RNA. A sample was classified as positive for Influenza A H1N1pdm09 if, the target gene (Inf A, H1N1pdm09) had a CT value of less than 35 along with RNase P. Different epidemiological parameters and seasonal trends were analyzed in all positive cases.

3. Results

A total of 1,001 samples from Category C suspected cases were received from the tertiary care hospital setting between 2016 and September 2024 for Influenza A (H1N1) pdm09 RT-PCR testing at the Department of Microbiology. Of these, 150 samples (14%) tested positive for Influenza A (H1N1) pdm09.

As shown in **Table 1**, the highest number of cases was recorded in 2017 (21/95 cases, 22%), 2019 (10/47 cases, 21%), 2020 (20%), and 2024 (111/486 cases, 23%). In contrast, lower positivity rates were observed in 2016 (2/203 cases, 1%), 2018 (3/25 cases, 12%), and 2023 (1/24 cases, 4%). No positive cases were reported in 2021 and 2022.

Regarding gender distribution, overall positivity was higher among females than males in 2016 (male/female: 0%/100%), 2018 (33%/67%), 2019 (30%/70%), 2020

(0%/100%), and 2023 (0%/100%). However, in 2017, male cases were higher (male/female: 62%/38%). In 2024 (data till September), both genders had equal positivity rates (male/female: 50%/50%).

Age-wise analysis categorized patients into five groups: Group 1: 0–10 years, Group 2: 11–20 years, Group 3: 21–40 years, Group 4: 41–60 years and Group 5: ≥61 years. Most positive cases were reported in Group 2 and 3, except in 2019, when Group 4 had the highest number of cases.

For seasonal analysis, months were classified as follows: Winter: December–February, Summer: March–May, Monsoon: June–September and Post-monsoon: October–November.

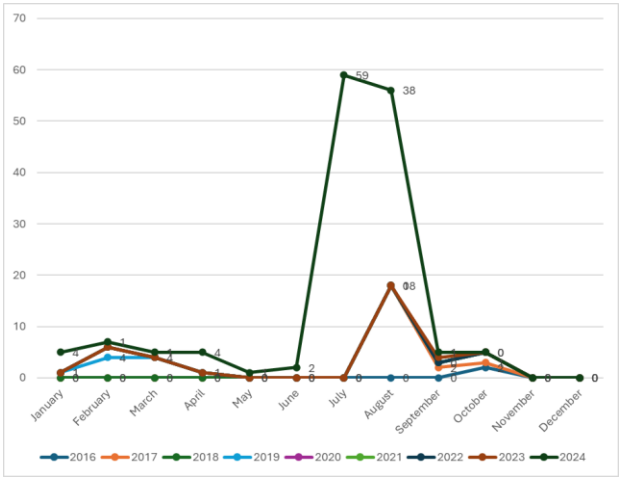
The peak of cases was predominantly observed in the monsoon and post-monsoon seasons during 2016, 2017, 2018, 2023, and 2024. However, a shift in seasonality was observed in 2019 and 2020, with more cases reported in the winter season. Additionally, some cases were found in the summer season in 2019 and 2024, along with cases in winter and monsoon months.

Table 1: Year-wise distribution of influenza a (H1N1) pdm09 cases with positivity rate, gender-wise distribution, and most affected age groups (2016–September 2024)

Year	Total samples received with category C	Positive cases (%)	Male Positivity (%)	Male Positivity (%)	Average Age (Years)	Most Affected Age Group
2016	203	2(1%)	0(0%)	2(100%)	27	2
2017	95	21(22%)	13(62%)	8(38%)	39	3
2018	25	3(12%)	1(33%)	2(67%)	27	3
2019	47	10(21%)	3(30%)	7(70%)	58	4
2020	10	2(20%)	0%	2(100%)	33	3
2021	39	0%	0%	0%	0	0
2022	72	0%	0%	0%	0	0
2023	24	1(4%)	0%	1(100%)	0	0
2024 till September	486	111(23%)	55(50%)	56(50%)	37	3

Table 2: Comparison of influenza a H1N1 pdm09 epidemiological data across different regions of India

Author Name	Year of publication	Area analysed	Year of data collection for H1N1 pdm09	Predominant age group affected in the study	Gender analysis	Seasonality
Present study	--	Western Indian region	2-16-sep 2024	21-40	Female>Male	June to September in each year and Jan-May in 2019 and 2024
Raut et al[1]	2020	Central India	Oct-2015 to Sep-2019	21-40 41-60	Female>Male	August-November in all years and Feb to June in one year
Nagraja Madhigeti et al[5]	2020	Andhra Pradesh	2017-2018	<5 year and 6-18 years	Male=Female	July-Nov and March-May
Ambika Sharma et al[6]	2019	Western India	March 2015 to April 2016	Mean age - 51.4 years	Male>Female	-
Prasad et al[7]	2018	Kochi,Kerala	2018	51-60,>60 years	Female>Male	-
Shobha broor et al[7]	2012	Delhi	2007-2010	5-18 years 18-25 years	-	Sep-Nov till 2009 and Aug-Sept in 2010
K.N Bhatt et al[9]	2010	Surat	2009-2010	14-50	Male>Female	June-March
Ganesh Nandhini et al[10]	2015	Puducherry	2009-2013	20-49	Male>Female	2010:Sep-Oct 2011: Aug-December 2012:March-June
Siddharth et al[11]	2012	Chandigarh	2009-2010	18-40 years	Female>Male	Nov-Feb



Graph 1: Seasonal trend of H1N1 positive cases during 2016-2024.

4. Discussion

The present study is aimed to analyze the burden and seasonal trends of Influenza A (H1N1) pdm09 in patients of a tertiary healthcare institute in South Gujarat from 2016 to September 2024. The findings revealed an overall positivity rate of 14% among the suspected cases, with the highest burden observed in 2017, 2019, 2020, and 2024. A significant observation was the absence of cases in 2021 and 2022, likely due to the impact of the COVID-19 pandemic and associated public health measures. The study also highlighted variations in gender distribution, age groups affected, and seasonal trends over the years.

4.1. Burden of influenza A (H1N1) pdm09

The study found an overall burden of 14% across the years, with peak positivity rates in 2017 (22%), 2019 (21%), 2020 (20%), and 2024 (23%). The resurgence of cases in 2024 suggests a return to pre-pandemic influenza circulation patterns following the decline observed during the COVID-19 era. The absence of cases in 2021 and 2022 is consistent with global trends where a reduction in influenza activity was reported due to widespread mask usage, social distancing, school closures, and travel restrictions implemented to control SARS-CoV-2 transmission.[9,10] Similar findings have been reported in studies from India and other countries, indicating a near-disappearance of influenza cases during this period.[11,12]

4.2. Gender distribution

A higher positivity rate was observed in females compared to males in most years, except for 2017, when male cases were predominant. Several studies have reported variations in gender susceptibility, with some findings suggesting that females may be at a higher risk of severe influenza infections due to immunological and hormonal factors.[13] However, other studies have shown mixed results, indicating that gender-based differences may be influenced by socio-cultural and healthcare-seeking behavior patterns.[14]

4.3. Age distribution

Most of the positive cases were reported in the 11–40 years age group (Groups 2 and 3). This is consistent with studies indicating that young adults and middle-aged individuals are more susceptible to H1N1 infections due to higher mobility, increased exposure, and lower pre-existing immunity compared to older individuals.[15] The exception observed in 2019, where the highest cases were reported in the 41–60 years age group, may be attributed to the changing immunological landscape of the population and increased susceptibility in this age group during specific outbreaks.

4.4. Seasonal trends and shift in patterns

Seasonal variations in influenza activity are well-documented, but in tropical and subtropical regions, including India, these trends are more complex and region-dependent.[7] The present study observed a shift in seasonality over the study period:

1. Monsoon and Post-Monsoon Peaks (2016, 2017, 2018, 2023, and 2024): Influenza activity was predominantly observed from June to September in these years, aligning with findings from other Indian studies that report peak activity during the monsoon season.[6,7] High humidity and temperature fluctuations during this period may facilitate viral transmission.
2. Winter Peaks (2019 and 2020): A shift in seasonality was noted in these years, with more cases reported between December and April. This pattern is more commonly seen in temperate regions and has also been reported in some parts of India, such as northern states.[16] The reason for this shift remains unclear but may be related to changes in viral circulation, population immunity, or environmental factors.
3. Unusual Summer Cases (2019 and 2024): A few cases were detected in summer months, which is atypical but not unprecedented. Similar findings have been reported in studies from tropical regions where sporadic summer activity has been linked to travel-associated introductions and localized outbreaks.[17]

4.5. Impact of COVID-19 on influenza trends

The absence of cases in 2021 and 2022 corresponds with the global suppression of influenza during the COVID-19 pandemic. This phenomenon was attributed to the widespread adoption of non-pharmaceutical interventions (NPIs), including lockdowns, travel restrictions, and universal masking.[18,19] However, as these measures were gradually lifted, influenza cases resurged in 2023 and 2024, a trend observed globally. This resurgence may also indicate waning population immunity due to reduced exposure to influenza viruses during the pandemic years.

4.6. Comparison with other Indian studies

The findings of the present study align with other regional studies but also highlight variations in burden, gender distribution, and seasonality across different geographic regions. A study by Chadha et al. (2015) reported that influenza circulation in India varies widely, with peaks observed in different seasons depending on the region.[7] Another study by Broor et al. (2020) found that southern and western states, including Gujarat, typically experience monsoon peaks, whereas northern states exhibit winter peaks.[7] These discrepancies underscore the influence of geographic, climatic, and demographic factors on influenza epidemiology.

4.7. Public health implications

Understanding the burden and seasonal trends of Influenza A (H1N1) pdm09 is critical for optimizing influenza prevention and control strategies. The observed monsoon peak in most years suggests that vaccination programs should be scheduled accordingly, with pre-monsoon immunization campaigns recommended for high-risk populations. The shift in seasonality observed in some years also emphasizes the need for continuous surveillance and adaptive vaccination strategies. Additionally, the impact of COVID-19 on influenza epidemiology highlights the effectiveness of NPIs, which could be selectively implemented during severe influenza outbreaks to reduce transmission.

5. Conclusion

The study findings indicate that Influenza A (H1N1) pdm09 remains an important public health concern, with seasonal variations and periodic resurgences. The overall positivity rate was 14%, with the highest burden observed in 2017, 2019, 2020, and 2024. A shift in seasonality was noted, with most cases occurring in monsoon and post-monsoon seasons, but winter peaks were observed in certain years. The absence of cases in 2021 and 2022 suggests a strong impact of COVID-19-related preventive measures on influenza circulation. These findings emphasize the need for region-specific surveillance, timely vaccination, and adaptive public health policies to mitigate the burden of influenza in South Gujarat.

6. Limitations

Being a single-center study, the findings may not be generalizable to the entire region. Additionally, excluding private healthcare data may underestimate the true burden of Influenza A (H1N1) pdm09. The study does not include clinical outcomes, severity, or mortality data, nor does it account for patients' influenza vaccination status, which could impact burden estimates. The absence of cases in 2021 and 2022 may be influenced by reduced influenza testing during the COVID-19 pandemic when healthcare resources were largely focused on COVID-19 management. Future studies with a multicentric approach, prospective design, and inclusion of vaccination and clinical outcome data are recommended for a more comprehensive understanding.

7. Ethical Approval

The study was approved by the Institutional Ethics Committee (GMCS/STU/RRC-1/APPROVAL23946/24).

8. Source of Funding

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9. Conflict of Interest

None declared.

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References

1. Dawood FS, Jain S, Finelli L, et al. Emergence of a novel swine-origin influenza A (H1N1) virus in humans. *N Engl J Med*. 2009;360(25):2605–15.
2. WHO. Pandemic (H1N1) 2009—Update 112. World Health Organization. 2010.
3. Garten RJ, Davis CT, Russell CA, Shu B, Lindstrom S, Balish A et al. Antigenic and genetic characteristics of swine-origin 2009 A(H1N1) influenza viruses circulating in humans. Science. 2009;325(5937):197–201.
4. Choudhry A, Singh S, Khare S, et al. Emergence of pandemic 2009 influenza A (H1N1), India. *Indian J Med Res*. 2012;135(4):534–7.
5. Ministry of Health and Family Welfare. Guidelines on Categorization of Influenza A H1N1 Cases During Screening for Home Isolation, Testing Treatment, and Hospitalization. India: Ministry of Health and Family Welfare; 2016. Available from: http://www.mohfw.nic.in/ showfile.php?lid=3071.
6. Viboud C, Alonso WJ, Simonsen L. Influenza in tropical regions. *PLoS Med*. 2006;3(4):e89. doi: 10.1371/journal.pmed.0030089.
7. Chadha MS, Potdar VA, Saha S, PA Koul, Broor S, Dar L et al. Dynamics of influenza seasonality at sub-regional levels in India and implications for vaccination timing. *PLoS One*. 2015;10(5):e0124122. doi: 10.1371/journal.pone.0124122..
8. Broor S, Shama P, Bharaj P, Prasad VS, Srinivasulu KN, Sumanth KM et al. A prospective three-year cohort study of the epidemiology and virology of acute respiratory infections of children in rural India. J Infect Public Health. 2020;13(1):124–33.
9. Olsen SJ, Azziz-Baumgartner E, Budd AP, Brammer L, Sullivan S, Pineda RF et al. Decreased influenza activity during the COVID-19 pandemic—United States, Australia, Chile, and South Africa, 2020. *MMWR Morb Mortal Wkly Rep*. 2020;69(37):1305–9.
10. Sakamoto H, Ishikane M, Ueda P. Seasonal influenza activity during the SARS-CoV-2 outbreak in Japan. *JAMA*. 2020;323(19):1969-71.
11. Dhanasekaran V, Sullivan S, Edwards K, et al. Human seasonal influenza under COVID-19 and the potential consequences of influenza lineage elimination. Nat Commun. 2022;13(1):1721.
12. WHO. Influenza Update—COVID-19 and influenza co-circulation. World Health Organization. 2023.
13. Klein SL, Flanagan KL. Sex differences in immune responses. *Nat Rev Immunol*. 2016;16(10):626–38.
14. Giurgea LT, Cervantes-Medina A, Walters KA, Scherler K, Han A, Czajkowski LM et al. Sex Differences in Influenza: The Challenge Study Experience. *J Infect Dis*. 2022;225(4):715-22. doi: 10.1093/infdis/jiab422.
15. Johansson MA, Apfeldorf KM, Dobson S, Devita J, Buczak AL, Baugher B et al. An open challenge to advance probabilistic

forecasting for dengue epidemics. Clin Infect Dis. 2019;69(2):189-98.

16. Ministry of Health and Family Welfare, Government of India. Influenza Surveillance Reports. 2023. https://pib.gov.in/PressReleasePage.aspx?PRID=1905602#:~:text=In%20the%20first%209%20days,9%20days%20of%20March%202023.
17. Choudhry A, Singh S, Khare S, Rai A, Rawat DS, Aggarwal RK et al. Emergence of pandemic 2009 influenza A H1N1, India. *Indian J Med Res*. 2012;135(4):534–7.
18. WHO. Influenza and COVID-19: Co-circulation trends. 2023. https://www.who.int/teams/global-influenza-programme/influenza-covid19
19. Couture A, Iuliano AD, Chang HH, Patel NN, Gilmer M , Steele M et al. Estimating COVID-19 Hospitalizations in the United States With Surveillance Data Using a Bayesian Hierarchical Model: Modeling Study. *JMIR Public Health Surveill*. 2022;8(6):e34296. doi: 10.2196/34296.

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