International Journal of Innovative Technologies in Social Science

e-ISSN: 2544-9435

Scholarly Publisher
RS Global Sp. z O.O.
ISNI: 0000 0004 8495 2390

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ARTICLE TITLE	CURRENT PREVENTION STRATEGIES FOR INFLUENZA VIRUS INFECTION: EVIDENCE, PRACTICE, AND THE ROLE OF MATERNAL VACCINATION
DOI	https://doi.org/10.31435/ijitss.3(47).2025.3976
RECEIVED	26 July 2025
ACCEPTED	13 September 2025
PUBLISHED	22 September 2025
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CURRENT PREVENTION STRATEGIES FOR INFLUENZA VIRUS INFECTION: EVIDENCE, PRACTICE, AND THE ROLE OF MATERNAL VACCINATION

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ABSTRACT

Background: Seasonal influenza remains a major cause of morbidity and mortality in Europe. Prevention relies primarily on vaccination, supported by non-pharmaceutical interventions (NPIs) and surveillance. Pregnant women are a key target group, as maternal immunization protects both mother and infant.
Methodology: A narrative review of recent PubMed-indexed studies, complemented by European Centre for Disease Prevention and Control (ECDC) reports and national data from Poland, was undertaken. Evidence on vaccine effectiveness, safety of maternal immunization, vaccination coverage, and the role of NPIs was synthesized.
Results: Influenza vaccine effectiveness in Europe has been moderate, ranging from 32–55% depending on subtype and season, with highest protection against influenza B and lowest against A(H3N2). Maternal vaccination provides significant protection for infants under six months, particularly when administered in the third trimester, and shows no association with adverse pregnancy outcomes. Despite strong evidence, vaccine uptake in Poland remains among the lowest in Europe, with only about 10% coverage in older adults and minimal uptake among pregnant women. NPIs, including mask use and hand hygiene, reduce transmission and are particularly valuable in seasons of poor vaccine match.
Discussion: Vaccination is the cornerstone of influenza prevention, yet insufficient coverage undermines its impact. Maternal immunization remains underutilized, while NPIs provide important complementary protection. Barriers include cost, misinformation, and logistical challenges.
Conclusions: Effective influenza prevention requires higher vaccine uptake, integration of maternal immunization into routine prenatal care, selective use of NPIs, and stronger surveillance. Without systemic improvements, the potential of influenza prevention cannot be fully realized.

KEYWORDS

Influenza, Vaccine Effectiveness, Maternal Immunization, Pregnancy, Non-pharmaceutical Interventions

CITATION

Szlęzak Ksawery, Tomaszewska Zuzanna, Zielińska Anna, Sobczak Anna. (2025) Current Prevention Strategies for Influenza Virus Infection: Evidence, Practice, and the Role of Maternal Vaccination. *International Journal of Innovative Technologies in Social Science*. 3(47). doi: 10.31435/ijitss.3(47).2025.3976

Introduction

Influenza remains one of the most common viral respiratory infections globally, with seasonal epidemics producing substantial healthcare and economic burdens. The disease disproportionately affects older adults, individuals with chronic comorbidities, young children, and pregnant women, who are at elevated risk of severe complications. Although influenza is generally self-limiting, it can lead to pneumonia, cardiovascular events, hospitalization, and death, particularly in high-risk groups.

In Europe, influenza epidemics occur annually, with varying intensity depending on the antigenic characteristics of circulating strains. The COVID-19 pandemic altered patterns of influenza activity and shifted public health responses, increasing awareness of respiratory viruses but also complicating vaccination programs.

Pregnant women represent a critical target group for prevention. Physiological changes during pregnancy, including altered immune and cardiopulmonary function, increase susceptibility to severe infection. Vaccination during pregnancy protects not only the mother but also the newborn, who benefits from transplacental antibody transfer during the first months of life, when direct immunization is not possible. Despite longstanding recommendations from WHO and ECDC, vaccination uptake in pregnancy remains low in several European countries, including Poland.

This review synthesizes current knowledge on influenza prevention, with an emphasis on recent vaccine effectiveness data, maternal immunization, and contextual challenges in Poland and Europe**.**

Methodology

This narrative literature review was conducted using PubMed, Embase, and ECDC publications. The search strategy included combinations of the terms *influenza vaccine effectiveness*, *maternal immunization*, *pregnancy*, *non-pharmaceutical interventions*, and *Poland influenza*.

The inclusion criteria were peer-reviewed studies published between 2019 and 2025, articles evaluating vaccine effectiveness, maternal immunization outcomes, vaccine coverage, or NPIs, and studies conducted in European populations, with global evidence considered where European data were limited (e.g., maternal vaccination safety). Data were selected thematically, focusing on vaccine performance by subtype, safety in pregnancy, vaccination coverage, determinants of uptake, and the effectiveness of NPIs.

Results

1. Vaccine Effectiveness

Influenza vaccine effectiveness has varied across recent European seasons, reflecting antigenic drift and subtype distribution. In the 2023–2024 season, vaccine effectiveness against influenza A(H1N1)pdm09 reached 53% in primary care and 44% in hospital settings, while effectiveness against A(H3N2) was much lower, at 30% and 14% respectively. Effectiveness against influenza B exceeded 60% [1]. Interim estimates for the 2024–2025 season showed similar patterns, with effectiveness ranging from 32 to 53% in outpatient settings and from 33 to 56% in hospitalized populations, with influenza B again demonstrating the highest protection [2]. In the 2022–2023 season, the VEBIS network reported vaccine effectiveness of 46% for A(H1N1)pdm09, 36% for A(H3N2), and 76% for influenza B [3]. Effectiveness tended to be higher among younger individuals and children, while reduced responses were consistently observed among older adults, likely due to immunosenescence.

2. Maternal Vaccination

Maternal influenza immunization has demonstrated substantial benefit for both mothers and infants. A 2020 study demonstrated that influenza vaccination during pregnancy confers substantial protective benefits, reducing the incidence of influenza infection by approximately two-thirds in infants and by over one-third in pregnant individuals. Additionally, vaccination was associated with a decreased risk of severe disease in both mothers and their infants [4]. A multicenter study conducted during the 2022–2023 season reported a 34% reduction in influenza-associated hospitalizations or emergency visits in infants younger than six months. When vaccination was administered in the third trimester, effectiveness increased to 53% in infants under three months of age [5].

Another study highlights that the choice of influenza vaccine platform during pregnancy plays a critical role in shaping the magnitude and durability of maternal antibody responses. Live-attenuated and adjuvanted recombinant vaccines were found to confer greater protection to offspring than inactivated vaccines. These

results emphasize the need to consider vaccine formulation when designing maternal immunization strategies aimed at maximizing infant protection via both prenatal and postnatal antibody transfer [6].

Safety studies reinforce confidence in maternal vaccination. A 2023 systematic review of more than 20 studies concluded that influenza vaccination during pregnancy is not associated with increased risk of adverse birth outcomes, including stillbirth, preterm birth, congenital anomalies, or spontaneous abortion [7]. A large cohort study published in 2024 demonstrated that repeated influenza vaccination across successive pregnancies was not linked to increased perinatal risk, even when intervals between pregnancies were short [8].

Acknowledging the proven efficacy and safety of these vaccines, many countries have implemented vaccination programs for pregnant women. The United Kingdom's program stands out for its comprehensive approach, including healthcare provider training, integration of vaccination into routine prenatal care, public awareness campaigns, free vaccine access, and reminder systems. While most European countries recommend influenza vaccination during pregnancy, program implementation and coverage vary widely [9]. Countries like the UK and the Netherlands have well-established national programs with coverage rates around 45–50%. However, many nations continue to face challenges such as limited access and vaccine hesitancy. Despite ongoing efforts, vaccination rates remain suboptimal, highlighting the urgent need for enhanced strategies to boost uptake among pregnant women across Europe [10].

3. Vaccination Coverage and Attitudes in Poland

Despite strong evidence supporting vaccination, uptake in Poland remains critically low. A 2023 survey of high-risk adults revealed that only 32% had received influenza vaccination during the previous season, although lifetime uptake was reported by 52% of participants [11]. Among adults aged 65 years and older, coverage remains at approximately 9–10%, one of the lowest rates in Europe [12].

Barriers to vaccination in Poland include financial costs, limited accessibility, and misinformation, particularly surrounding vaccine safety during pregnancy. Determinants of higher uptake include previous vaccination experience, physician recommendation, and higher education levels [13].

4. Non-Pharmaceutical Interventions

Non-pharmaceutical interventions provide additional protection, particularly in seasons with suboptimal vaccine performance. A 2024 systematic review confirmed that hand hygiene and mask use reduce influenza transmission within households, with combined approaches more effective than single measures [14]. During the COVID-19 pandemic, widespread implementation of NPIs coincided with a dramatic reduction in laboratory-confirmed influenza cases, positivity rates, and related hospitalizations, underscoring their value in reducing viral transmission [15].

Discussion

The evidence shown in this review highlights both the progress and persistent challenges in preventing influenza in Europe. Vaccination remains the most effective preventive measure, consistently reducing the risk of medically attended influenza and severe outcomes, even when effectiveness is moderate. The recurring difficulty in achieving strong protection against A(H3N2) underscores the challenge of antigenic drift and the need for ongoing development of improved vaccines, including high-dose and adjuvanted formulations, as well as research toward a universal influenza vaccine.

Maternal vaccination provides a particularly strong case for prioritization. By protecting both mothers and infants, it addresses two highly vulnerable groups simultaneously. The consistency of safety data across observational studies and meta-analyses supports routine administration during pregnancy, regardless of trimester. Yet, maternal vaccination coverage in Poland remains low, suggesting that evidence alone is insufficient to change practice without supportive infrastructure and communication. Incorporating influenza vaccination into routine antenatal care, ensuring availability at no cost, and strengthening physician recommendation could substantially increase uptake.

The persistently low coverage in Poland illustrates broader systemic issues that extend to older adults and other high-risk populations. While awareness of influenza risk is relatively high, barriers such as financial cost, logistical inconvenience, and skepticism toward vaccines prevent consistent uptake. Previous vaccination strongly predicts future uptake, suggesting that initiatives focused on first-time vaccination could have lasting impact. Addressing misinformation through transparent public health campaigns and leveraging trusted healthcare professionals as advocates are essential to rebuilding confidence.

Non-pharmaceutical interventions remain an important complement to vaccination. Although it is unlikely that pandemic-level restrictions will be acceptable or sustainable in the long term, targeted NPIs such as mask use in healthcare settings, reinforcement of hand hygiene, and improvements in indoor ventilation can contribute to reducing transmission during peak influenza activity. Framing NPIs as complementary rather than alternative measures to vaccination may improve public acceptance and maximize their preventive effect.

Finally, the importance of surveillance cannot be overstated. Continuous monitoring of circulating strains, vaccine effectiveness, and coverage trends provides essential data for vaccine composition and policy decisions. Stronger national surveillance in Poland, integrated into European networks, would not only improve domestic responses but also contribute to continent-wide preparedness.

Conclusions and Future Directions

Influenza remains a significant public health challenge in Europe, and current evidence reaffirms the central role of vaccination in mitigating its impact. Seasonal vaccines provide moderate but meaningful protection, particularly against influenza B and A(H1N1)pdm09, while effectiveness against A(H3N2) remains more limited. Maternal vaccination offers a unique dual benefit, protecting both mother and infant, and is consistently shown to be safe.

Despite these benefits, vaccination coverage in Poland is among the lowest in Europe, especially in older adults and pregnant women. This gap reflects financial, logistical, and cultural barriers that must be addressed through systemic policy changes. Providing free vaccines for all high-risk groups, integrating vaccination into antenatal care, and reinforcing physician-led recommendations could substantially improve uptake.

Non-pharmaceutical interventions serve as valuable adjuncts, particularly during outbreaks or seasons with poor vaccine match. The COVID-19 pandemic demonstrated their effectiveness in reducing influenza circulation, and selective adoption of such measures remains relevant.

Looking ahead, robust surveillance systems and ongoing research into enhanced and universal vaccines will be essential to strengthening influenza prevention. A comprehensive, multi-layered approach—combining vaccination, maternal immunization, non-pharmaceutical measures, and effective communication—offers the greatest potential to reduce the burden of influenza in Europe. Healthcare systems should adopt strategies from high-performing pertussis and influenza vaccination programs in the UK, US, and Spain, focusing on awareness, efficient delivery, provider engagement, and monitoring. These approaches increase vaccine uptake in pregnancy, improve protection for mothers and infants, and reduce disease burden, ultimately enhancing public health outcomes [16]. Without significant progress in vaccination uptake, particularly in Poland, the full potential of these strategies will remain unrealized.

Disclosure

Author's contribution

- Conceptualization: Ksawery Szlęzak, Anna Zielińska
- Methodology: Zuzanna Tomaszewska, Ksawery Szlęzak
- Software: Anna Zielińska, Anna Sobczak
- Check: Zuzanna Tomaszewska
- Formal analysis: Anna Sobczak
- Investigation: Anna Zielińska
- Data curation: Ksawery Szlęzak
- Writing - rough preparation: Zuzanna Tomaszewska
- Writing - review and editing: Anna Zielińska
- Visualization: Zuzanna Tomaszewska
- Supervision: Zuzanna Tomaszewska, Anna Sobczak
- Project administration: Anna Zielińska, Ksawery Szlęzak
- Receiving funding: Not applicable.

All authors have read and agreed with the published version of the manuscript.

Funding: This research received no external funding.
Institutional Review Board Statement: Not applicable.
Informed Consent Statement: Not applicable.
Data Availability Statement: Not applicable.
Acknowledgements: Not applicable.
Conflicts of Interest: No conflicts of interest to declare.

Declaration of the use of generative AI and AI-assisted technologies in the writing process.

In preparing this work, the authors used ChatGPT for the purpose of improving language and readability. After using this tool, the authors have reviewed and edited the content as needed and accept full responsibility for the substantive content of the publication.

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