

Public Health and Economic Effects of Influenza Vaccination

Zirui Gao

Life Sciences Department, Santa Monica College, Los Angeles, CA, The United States
Corresponding author: gao_zirui01@student.smc.edu

Abstract:

Seasonal influenza constitutes a severe global health challenge, characterized by annual recurrence, millions of infections and substantial mortality each year. Its persistent circulation not only imposes heavy burdens on healthcare systems worldwide but also inflicts notable economic losses. Given the predictable nature of seasonal influenza outbreaks, long-term prevention strategies centered on vaccination have proven more effective in mitigating its impact compared to short-term control measures. This paper studies how vaccination policies work in different regions and how they affect health systems, economic costs, and antiviral resistance. Data from WHO, CDC, and other studies show that higher vaccination coverage clearly lowers infections, hospital stays, and deaths. Even small increases in coverage can prevent many cases. Vaccination also saves medical costs, keeps hospitals less crowded, and slows drug resistance by reducing antiviral use. However, problems such as vaccine hesitancy, low access in rural and low-income areas, and weak global surveillance still limit progress. To solve these issues, countries need clear communication, free or low-cost vaccination, stronger monitoring, and better government support. These actions can raise vaccination rates, make health systems more stable, and help the world prepare for future outbreaks.

Keywords: Influenza vaccination, health systems, economic impact, antiviral resistance.

1. Introduction

Seasonal influenza, as one of the most serious recurrent health threats globally, causes nearly 1 billion infections, 3–5 million severe cases, and 290000 to 650000 respiratory disease-related deaths annually, posing a sustained impact on population health [1]. The economic burden is significant, as low- and

middle-income countries, due to limited healthcare resources, have to bear even heavier pressure on prevention and control [1]. Unlike a one-time public health crisis, the seasonal recurrence of influenza requires that prevention and control rely on long-term, stable prevention strategies rather than temporary emergency measures. This characteristic also makes sustained and effective prevention measures the core

of reducing its harm.

Vaccination is currently a key way to prevent influenza. Compared to antiviral drugs that have limited efficacy and face the threat of drug resistance, vaccines can provide protection for a wider population [2]. However, the high mutation rate of the influenza virus requires vaccines to be updated annually, and maintaining high and stable vaccination coverage is difficult. Even if there is sufficient vaccine supply, problems such as vaccine hesitancy, spread of false information, and logistical barriers will still weaken the actual prevention and control effect of vaccines and continue to hinder the reduction of global influenza burden.

There are limitations to existing research on influenza vaccination. Most studies analyze vaccination efficacy in isolation, focusing on coverage or short-term effectiveness, but neglecting the systemic benefits of vaccines. In fact, reducing influenza infection can have a chain positive effect, including reducing outpatient visits, hospitalization rates, and ICU admission pressure, while reducing the prescription of antiviral drugs. The reduction in drug use can also slow down the development of drug resistance, achieve long-term cost savings, and maintain drug efficacy. These findings together suggest that the value of vaccines goes beyond direct clinical protection and also contributes to the stability of the healthcare system and the overall economy [2].

In terms of exploring the potential of vaccines, Goodfellow et al. found through modeling research that if 50% of children under 18 years old are vaccinated against influenza each year, existing vaccines can prevent 1.3 billion infections, improved vaccines can prevent 2.6 billion infections, and universal vaccines can prevent 3 billion infections [3]. If a universal vaccine becomes available, it could help save large medical costs every year and make hospitals less overloaded, while cutting the need for antiviral drugs. This study further confirms that improving vaccination coverage and developing more efficient vaccines are key paths to protecting healthcare systems and enhancing global preparedness for influenza prevention and control [3]. Because every country has its own health policy and level of resources, their ways of organizing vaccination are not identical. High-income countries often provide free vaccines through public health services to improve coverage, while low- and middle-income countries often have low coverage due to self-funded vaccination models. This difference also provides practical reference for subsequent research.

The core motivation of this study is that existing research lacks sufficient attention to the systemic benefits of vaccines and fails to fully reveal the role of vaccination in reducing burden, economic savings, and drug resistance

management in the healthcare system. Secondly, there is a lack of integrated analysis on the differences in vaccination policies, coverage improvement paths, and efficient vaccine research and development directions in different regions, making it difficult to form a complete strategy to support long-term global influenza prevention and control. Based on this, this study aims to fill the research gap mentioned above and provide a scientific basis for optimizing the influenza vaccine prevention and control system.

2. Vaccine Policies, Coverage and Public Health Differences

The World Health Organization sets the global standard for influenza vaccination. It recommends annual vaccination for high-risk groups, such as the elderly, children, pregnant women, and people living with chronic illnesses. WHO also points out that broad and steady coverage is important because it reduces virus transmission, prevents seasonal surges, and protects health systems from loading too many people [1]. These guidelines create a common standard. But each country adapts them in its own way, depending on health systems, national budgets, and local priorities. In practice, the same global advice can turn into very different policies. Some countries focus on free provision through public health services, others rely more on private delivery, and outreach strategies also change. These choices later shape who gets vaccinated, how many people are covered, and what health outcomes follow.

Across regions, vaccination policies take different forms. In Europe, influenza vaccination is often part of public health services and is usually free for priority groups. This reduces out-of-pocket costs and makes access easier at the point of care. Many countries report higher uptake among older adults, supported by stable primary care, reminder systems, and public campaigns. Coverage in younger groups is less consistent, since policies differ and perceived risk is lower. In the United States, the Centers for Disease Control and Prevention recommends vaccination for everyone older than six months [4]. Supply is broad—clinics, hospitals, pharmacies, and sometimes workplaces all provide vaccines—but gaps remain. In the 2023–2024 season, 55.4% of children and 44.9% of adults were vaccinated, with clear differences between states and communities [4]. Problems such as rural access, hesitancy in some groups, and cost or insurance barriers all limit uptake. In China, vaccination is recommended but not part of the national immunization program, which means most people must pay out of pocket. This payment model keeps national coverage very low: between 2004 and 2014, the average was only 1.5–2.0%, far below levels in high-in-

come countries, though a few cities that provide subsidies report higher local uptake [5]. These examples show that vaccination rates are influenced by how strong the public system is, how much people need to pay at clinics, and how clearly the advice about vaccines is delivered.

Policy design affects who gets vaccinated, and the overall coverage then determines how much protection vaccines can bring to the population. Offering free vaccination to high-risk groups increases willingness to get vaccinated and reduces the number of missed doses. When vaccination is built into routine primary care, it becomes easier to send reminders and to keep people coming back for seasonal updates. In the United States, broad recommendations only translate into high uptake when vaccine supply is stable and communication efforts are consistent [4]. In China, where many people still pay out of pocket, vaccination rates remain low even when doses are available [5]. Because of these differences, two countries using the same vaccine may see very different outcomes. A vaccine with 50% efficacy can prevent many more infections if 60% of the population is vaccinated than if only 10% receive it [3]. Higher coverage also improves timing, since more people are protected before the seasonal peak, which further slows transmission.

The health system nowadays shows the effect of these policy choices. In countries with higher coverage, seasonal influenza waves cause fewer outpatient visits, fewer hospital stays, and less ICU pressure. Staff keep routine care running and turn over beds more quickly. In countries with lower coverage, seasonal strain is heavier, and health systems rely more on antivirals to manage complications. This reliance adds cost and may still not ease the burden during peak weeks. In short, policy decisions do more than set targets on paper. They shape access to vaccines, acceptance among people, and the ability of health systems to respond to seasonal influenza. Following WHO guidance while improving delivery, lowering costs at the point of care, and keeping broad but practical recommendations can all raise coverage and improve outcomes across countries.

3. Public Health Impact at the Medical Resource Level

Seasonal influenza vaccination lowers the pressure on medical services. By reducing infections, it also reduces outpatient visits, hospital stays, and intensive care admissions. Data from the United States show this effect clearly. During the 2023–2024 season, vaccination was estimated to prevent about 9.8 million illnesses, 4.8 million medical visits, 120,000 hospitalizations, and 7,900 deaths [6].

These numbers show that vaccination takes away much of the yearly medical burden and helps keep the health system steady. Modeling studies also support this point. Hughes et al. projected that even a 5% rise in coverage could stop about 785,000 illnesses and 11,000 hospitalizations in the United States during a bad season [7]. They also estimated that if national coverage went up to 70%, more than 39,000 hospitalizations could be avoided [7]. These results suggest that even small increases in coverage protect people and lower the strain on hospitals.

Vaccination also helps hospitals manage their resources more efficiently. When influenza admissions decline, beds and staff can be reassigned to patients with urgent needs such as cardiac events or injuries. This improves bed turnover, as hospital stays become shorter and each bed can serve more patients within the same period. Staff time is also used more evenly, allowing them to focus on routine treatment rather than constant emergency overflow. In systems where capacity is already tight, even a small decrease in influenza cases can free up considerable space for other patients. Over time, consistent vaccination coverage keeps hospital operations more balanced and reduces the seasonal strain that weighs on both staff and medical equipment.

The COVID-19 pandemic showed the risk of medical overload. During peak waves, hospitals were crowded, beds were full, and staff worked under heavy pressure. Seasonal influenza is not as severe, but in years with low vaccination, big surges can still strain hospitals. By lowering hospital and ICU admissions, vaccination prevents overcrowding and helps keep healthcare services stable. In this way, vaccination protects individuals and also supports the efficient use of medical resources.

4. Economic Impact of Influenza Vaccination at the Country Level

Seasonal influenza places a heavy economic burden on countries each year. This burden comes from direct medical costs, such as treatment and hospital care, and from indirect costs linked to lost productivity. Vaccination reduces these costs and provides economic benefits at the national level. First, vaccination reduces direct medical costs. Treating influenza cases costs more than preventing them. In the United States, the average direct medical cost per case has been estimated at about \$87–\$300, while one vaccine dose costs about \$20–\$30 [2]. By preventing illness and lowering the number of doctor visits and hospital stays, vaccination proves more cost-effective than treatment alone. Molinari et al. estimated that seasonal influenza causes about \$10.4 billion in direct medical costs

in the United States each year. Much of this expense could be avoided if vaccination rates were higher [8].

Second, vaccination reduces indirect costs by lowering productivity losses. Each influenza season leads to millions of missed workdays and school days. These absences reduce income and interrupt the normal function of companies and schools. In the United States, productivity losses linked to influenza have been estimated at \$16.3 billion every year [8]. By preventing infections, vaccination lowers absenteeism, helps schools and companies stay open, and supports steady economic activity. Together, these findings show that influenza vaccination saves both lives and money. By lowering direct medical costs and reducing productivity losses, vaccination supports economic stability. This effect is especially important at the national level, where even small gains in coverage can bring large savings for health systems and the wider economy.

5. Antiviral Resistance Management at the Future Level

Influenza vaccination also plays a role in managing antiviral resistance. By reducing infections, vaccines lower the demand for antiviral drugs. With fewer patients receiving these drugs, the virus has fewer chances to adapt under drug pressure. This lowers the risk of resistant strains appearing and spreading. Higher vaccine coverage, therefore, limits resistance at its origin by reducing the overall need for medication [9]. Recent trends show that most influenza viruses are still susceptible to neuraminidase inhibitors, but resistance mutations continue to appear. The global spread of oseltamivir-resistant influenza A(H1N1) in 2008–2009 revealed how rapidly resistance can appear and move through populations. Hurt and Kelly noted that isolated resistant cases continue to occur, often among patients who have received antiviral treatment [10]. Although current resistance rates remain low, the continued presence of these mutations suggests that close monitoring is still needed. Ongoing surveillance of circulating strains helps identify early shifts in drug sensitivity before they grow into broader resistance.

A combined approach that links vaccination with careful antiviral use remains the most effective way forward. Vaccination reduces the number of infections and limits how many people require treatment. At the same time, thoughtful prescribing helps prevent the virus from being repeatedly exposed to drug pressure. Data from surveillance programs provide early signs of resistance, allowing timely adjustments in both antiviral use and vaccine formulation. When these efforts work together, vaccines lower the disease burden, and responsible drug management

helps preserve the effectiveness of existing antivirals.

Overall, vaccination is not only a preventive measure but a long-term safeguard for keeping influenza treatments effective. It reduces infections and lowers the need for antiviral drugs, which limits the rise and spread of resistant strains. Existing antivirals can then stay reliable in future outbreaks. Steady vaccination also saves healthcare costs and helps maintain stability in medical systems, showing how its impact extends across health, economics, and resistance management.

6. Solutions after Challenges

Influenza vaccination works well, but its full impact is still held back by some ongoing problems. These include vaccine hesitancy, low access in marginalized communities, weak tracking of resistance, and limited policy support. To make real progress, each of these problems needs direct solutions, and they also have to work together to raise coverage and build public trust. The first challenge is vaccine hesitancy and misinformation. Uptake among young adults and pregnant women is still lower than in other groups. Studies show that hesitancy in these groups can reach 20–30%, mostly because of safety worries, low sense of personal risk, and false claims spread on social media [11]. These problems lower confidence and make vaccination campaigns less effective. Solutions should focus on clear communication and building trust. Social media, while often used to spread false claims, can also be a tool to share correct and open information. Fact-checking and working with trusted community leaders can raise credibility. Training medical staff to answer questions simply and consistently is also important. When doctors and nurses explain benefits and risks clearly and with support, people are more likely to accept vaccination.

The second challenge is unequal access in marginalized communities. Vaccination rates are lower in rural, low-income, and migrant groups, often because of poor transport, limited information, and cost barriers. Schmid et al. found that in these groups, rates are often below 20%, while in urban and higher-income groups they are closer to 50–60% [12]. This gap shows how structural problems make access less fair. Solutions should make vaccines easier to get. Services can grow through community clinics and mobile health teams that reach remote areas. Free or low-cost vaccines help reduce cost worries. Campaigns in local languages make information clearer and closer to people's culture. These steps improve fairness and raise coverage in the groups that need it most.

The third challenge is the weak monitoring of antiviral resistance. Vaccination lowers infections and reduces the need for drugs, which slows the rise of resistant strains.

But resistance tracking is not the same across countries. In some regions, data arrive late or remain incomplete, which makes it hard to act quickly. The system still needs stronger monitoring. Using genetic sequencing and regular drug tests more often could help find resistance sooner and make the results clearer. If countries share this data as it comes in, they can adjust treatments faster and keep the drugs we already have working longer.

Finally, governments and the public both play key roles in long-term progress. Governments can support vaccination in direct ways such as covering the cost for high-risk groups, rewarding communities that reach high coverage, and giving tax relief to companies that encourage their workers to get vaccinated. Public education also matters. Schools can include health lessons that help children and families see vaccination as part of normal care. Social media can spread clear messages through short videos or posts from doctors and trusted figures, making vaccination feel closer and easier to trust. In summary, governments and health systems can take four connected steps to make vaccination more stable in the long run. They can reduce hesitancy through clear communication, expand access in marginalized areas, monitor resistance more closely, and strengthen policy support. These efforts raise coverage, close unfair gaps, and keep both vaccines and antiviral drugs effective. Together, they create a steady path toward a more reliable influenza vaccination system for the future.

7. Conclusion

Seasonal influenza remains a major health concern worldwide, and vaccination is still the most reliable way to control it. This paper examines how vaccination influences health systems, the economy, and drug resistance across different countries. The findings show that higher vaccination rates lead to fewer infections and less strain on hospitals. Fewer people need outpatient care, hospital beds, or intensive care, which allows hospitals to use their staff and equipment more efficiently and keep routine services running during flu seasons. Economically, vaccination plays an important role in reducing overall costs. It prevents illness and lowers direct medical spending, while also reducing losses from missed work or school. By keeping more people healthy, vaccination further decreases the need for antiviral drugs and helps maintain a stable demand for healthcare services. This slows the development of resistant virus strains and helps keep existing medicines effective. Together, these effects show that influenza vaccination supports not only health but also economic stability and the long-term success of treatment. These findings prove that vaccination is not only about individu-

al protection but also about protecting society as a whole. It connects medical, economic, and resistance benefits in one system. However, this study also has some limits. The discussion uses existing data and models, which may not cover all countries or social differences. In the future, combining more real-world data and local surveys could make results stronger. Future work can also look at how government policy, education, and public communication influence vaccine use. If global cooperation improves and coverage rises, influenza vaccination can become more effective and fair for everyone.

References

- [1] World Health Organization. (2025, February 28). Influenza (seasonal). World Health Organization. [https://www.who.int/news-room/fact-sheets/detail/influenza-\(seasonal\)](https://www.who.int/news-room/fact-sheets/detail/influenza-(seasonal)).
- [2] Peasah, S. K., Azziz-Baumgartner, E., Breese, J., Meltzer, M. I., & Widdowson, M. A. (2013). Influenza cost and cost-effectiveness studies globally: A review. *Vaccine*, 31(46), 5339–5348. <https://doi.org/10.1016/j.vaccine.2013.09.013>.
- [3] Goodfellow, L., Patel, R., Chen, Y., & Alvarez, M. (2025). The potential global health impact and cost-effectiveness of next-generation influenza vaccines. *PLOS Medicine*, 22(4), e1004655. <https://doi.org/10.1371/journal.pmed.1004655>.
- [4] Centers for Disease Control and Prevention. (2024, September 20). Flu vaccination coverage, United States, 2023–24 influenza season. U.S. Department of Health and Human Services. <https://www.cdc.gov/fluview/coverage-by-season/2023-2024.html>.
- [5] Yang, J., Atkins, K. E., Feng, L., Pang, M., Zheng, Y., Liu, X., Cowling, B. J., & Yu, H. (2016). Seasonal influenza vaccination in China: Landscape of diverse regional reimbursement policy, and budget impact analysis. *Vaccine*, 34, 5724–5735. <https://doi.org/10.1016/j.vaccine.2016.10.013>.
- [6] Centers for Disease Control and Prevention. (2025). Flu burden prevented by vaccination: 2023–2024 flu season. U.S. Department of Health and Human Services. <https://www.cdc.gov/flu-burden/php/data-vis-vac/2023-2024-prevented.html>.
- [7] Hughes, M. M., Reed, C., Flannery, B., Garg, S., Singleton, J. A., Fry, A. M., & Rolfes, M. A. (2020). Projected population benefit of increased effectiveness and coverage of influenza vaccination on influenza burden in the United States. *Clinical Infectious Diseases*, 70(12), 2496–2502. <https://doi.org/10.1093/cid/ciz676>.
- [8] Molinari, N.-A. M., Ortega-Sanchez, I. R., Messonnier, M. L., Thompson, W. W., Wortley, P. M., Weintraub, E., & Bridges, C. B. (2007). The annual impact of seasonal influenza in the United States: Measuring disease burden and costs. *Vaccine*, 25(27), 5086–5096. <https://doi.org/10.1016/j.vaccine.2007.03.046>.
- [9] Hayden, F. G., & de Jong, M. D. (2011). Emerging influenza antiviral resistance threats. *Journal of Infectious Diseases*,

203(1), 6–10. <https://doi.org/10.1093/infdis/jiq012>.

[10] Hurt, A. C., & Kelly, H. (2016). Debate regarding oseltamivir use for seasonal and pandemic influenza. *Emerging Infectious Diseases*, 22(6), 949–955. <https://doi.org/10.3201/eid2206.151037>.

[11] Dubé, E., Vivion, M., & MacDonald, N. E. (2015). Vaccine hesitancy: An overview. *Human Vaccines &*

Immunotherapeutics, 9(8), 1763–1773. <https://doi.org/10.4161/hv.24657>.

[12] Schmid, P., Rauber, D., Betsch, C., Lidolt, G., & Denker, M. L. (2017). Barriers of influenza vaccination intention and behavior – A systematic review of influenza vaccine hesitancy, 2005–2016. *PLOS ONE*, 12(1), e0170550. <https://doi.org/10.1371/journal.pone.0170550>.