The Effectiveness and Cost-Effectiveness Analysis of Influenza Vaccination among US Adolescents in 2024

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Research Question

- **What is the cost-effectiveness of influenza vaccination among adolescents? And how does the cost-effectiveness change as the coverage of influenza vaccination changes?**
- **Research scope:**

  Adolescents in the United States from age 10 to 19.
- **Research Hypothesis:**

  Influenza vaccination is cost-effective for adolescents in the US from the age of 10 to 19 in 2024.

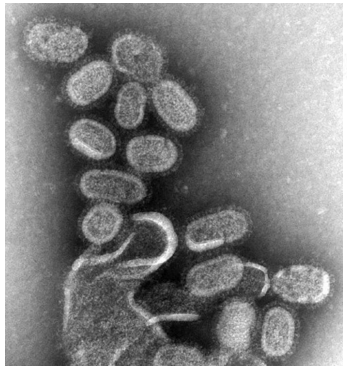
  Influenza vaccination coverage of 100% is the most effective.

Background

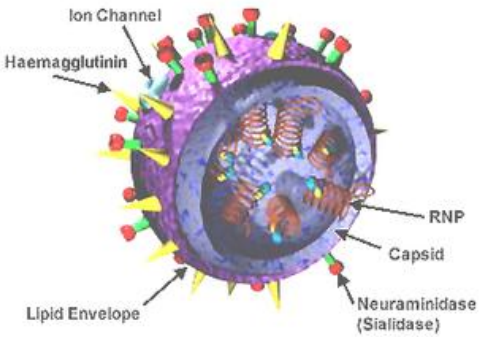
Influenza(flu)

- Infect the nose, throat, and lungs, which belong to the respiratory system
- Cauesd by virus
- Two types(a and b)
- Sometimes can be deadly

Influenza virus under microscope↓



Structure of influenza virus ↓



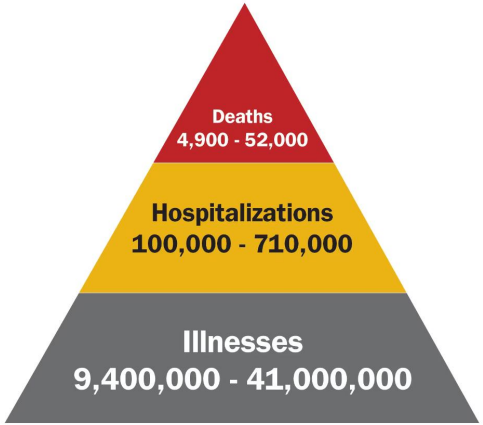
Figures from Wikipedia↑

High-risk group:

1. Young children under age 12
2. Pregnant people
3. Adults older than age 65
4. People live or work with many other residents...

Background

https://www.cdc.gov/flu/about/burden/index.html
Figure from CDC↓



- **Influenza In-season Burden:**

In this flu season in the US, the Centers for Disease Control and Prevention (CDC) estimates that:

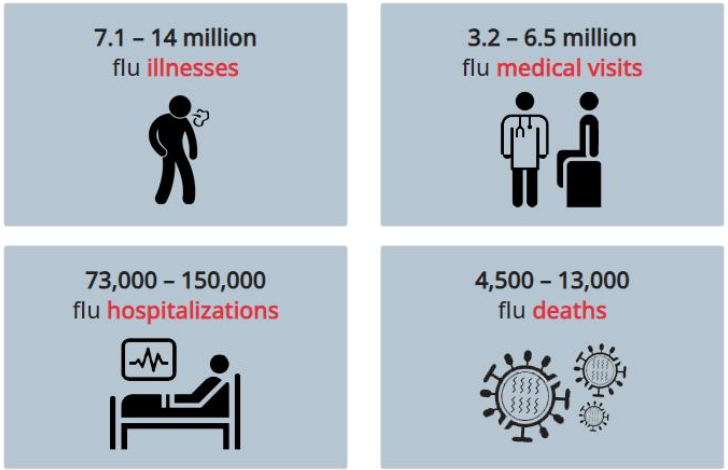


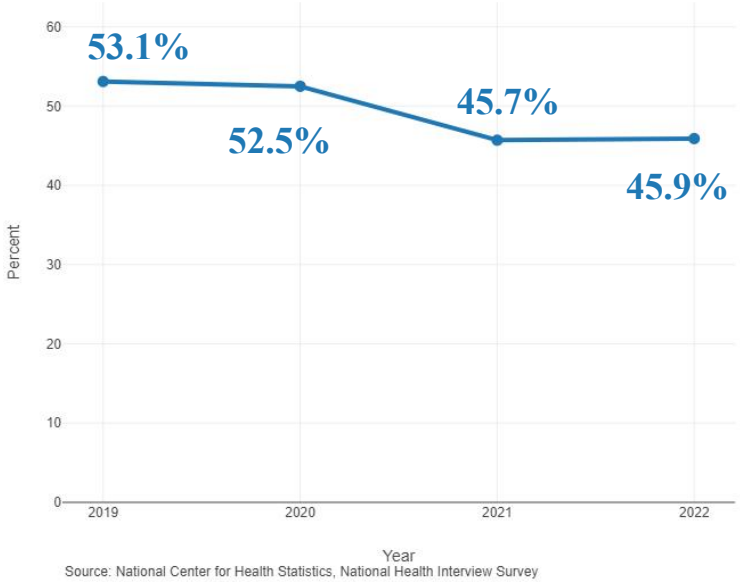
Figure from CDC↑
https://www.cdc.gov/flu/about/burden/preliminary-in-season-estimates.htm

CDC estimates that flu has resulted in **9.4 million – 41 million illnesses**, **100,000 – 710,000 hospitalizations**, and **4,900 – 52,000 deaths** annually between 2010 and 2022.

Background

- **Influenza Vaccination:**

The percentage of children under the age of 18 from 2019 to 2022:



CDC states that:

"The best way to reduce the risk of flu and its potentially serious complications is by getting vaccinated each year."

Literature Review

There is a consensus that influenza vaccination is either cost-saving or cost-effective for children.

Current Research Gaps：

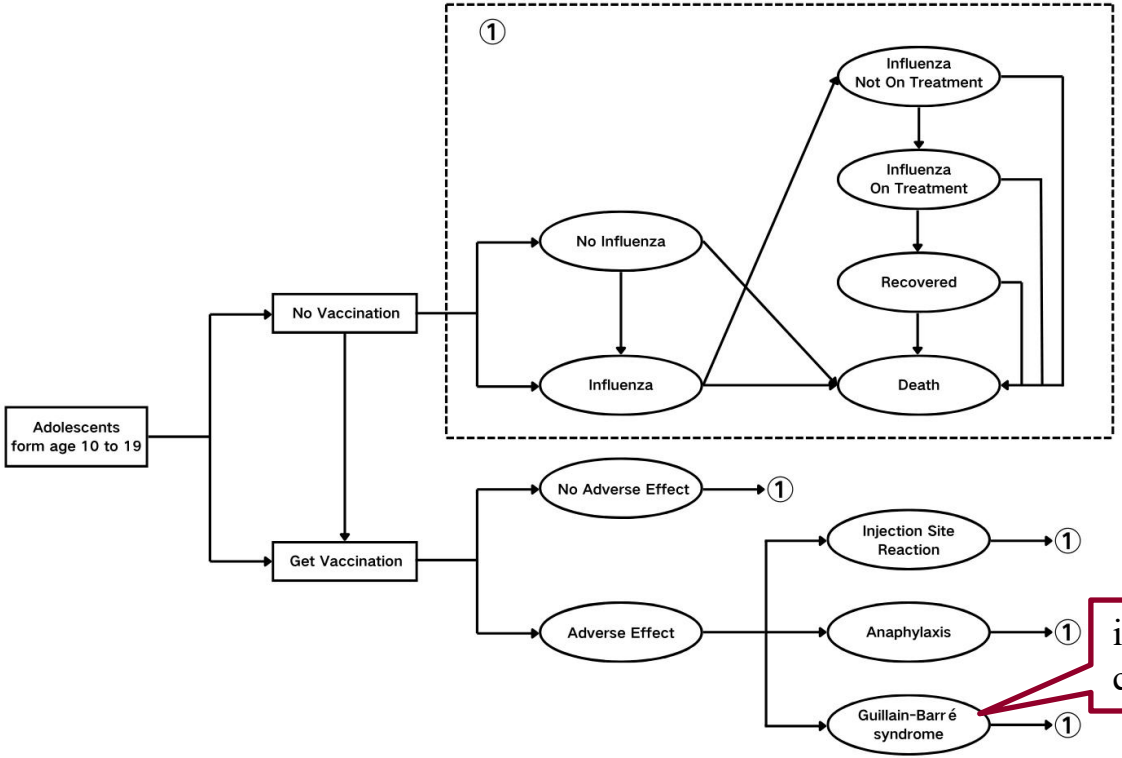
- Some study generalizing the results from different regions and countries, which may be constrained by regional factors.
- The reviews are not based on the most recent datas.
- The age group(for all age, for 2-8 years old...)

Originality of the research：

- Focus on the age group of adolescents which are from age 10 to 19.
- Consider the CEA of influenza vaccination from a healthcare perspective

Research Design/Method

- **Model Structure: Decision Tree and Markov Model**



Divide into 2 cohort groups:

Younger age group → 10-14 years old

Elder age group → 15-19 years old

is a very rare and serious condition that affects the nerves

Research Design/Method

- **Database:**
  - ✓ NHIS （Study population）
  - ✓ IHME （Utilities of influenza and side effects）
  - ✓ Relative medical literature （Parameter table↓）

Table 1. Parameter table of the influenza cost-effectiveness model

Variable	Base Case	Range of Sensitivity Analysis
Influenza Vaccination Coverage in 2022-2023		
Children under the age 18 years	0.459	0.444-0.474
Probability of Adverse Effect of Vaccination		
Injection Site Reaction	0.0003	0-0.001
Anaphylaxis	0.00000025	0-0.00000025
Guillain-Barré syndrome	0.0000016	0-0.000010
Vaccination-related Adverse Effect Costs		
Injection Site Reaction	$61	$30-683
Anaphylaxis	$2700	$52-13754
Guillain-Barré syndrome	$23360	$6700-78900
Influenza Infection Rates		
5-17years	0.096	0.029-0.193
18-49years	0.071	0.022-0.144
Influenza Vaccine Effectiveness		
5-11years	0.44	0.33-0.53
12-17years	0.42	0.28-0.54
18-49years	0.35	0.24-0.45
Influenza-attributable Deaths(per 100000 Population)		
5-17years	0.173	0.000-1.373
18-49years	0.285	0.027-1.199
Influenza-related Medical Costs		
Ⅰ Outpatient visit		
5-17years	$208	$28-758
18-49years	$293	$23-1295
Ⅱ Hospitalization		
5-17years	$16644	$1816-66009
18-49years	$25113	$2287-1060
Vaccination Costs		
Per Dose IIV	$6.86	
Per Dose LAIV	$12.89	$10-25
Administration Costs	$25	$10-40
Parent Time Costs	$32	$0-$64

Research Design/Method

- **Cost-Effectiveness Analysis: Competing choice analysis**

  There are 3 intervention strategies:

  influenza vaccination **coverage of 50%, 80%, and 100%**

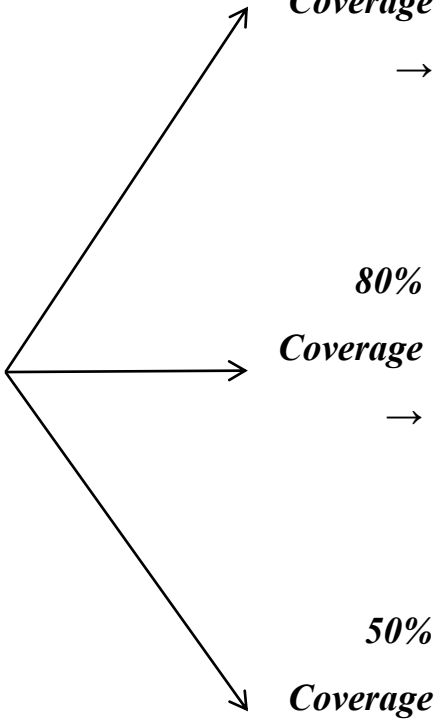
  Steps:

  1. Estimate the **net costs** (from a healthcare perspective) and **net QALYs** in 2024 using a 3% discounting rate.

  2. Compare the **incremental CE ratios (ICER)**.

Results

Tables



Age	Death averted	Infection averted	Net Costs (in billion)	Net QALYs (in million)	ICER
10-14 years	44987.8 (14972, 153307)	1038242351 (370011623, 2164887716)	1752 (1564, 1955)	26.9 (7.6, 58.9)	85489 (30407, 221392)
15-19 years	42204.5 (17118, 80266)	915247277 (276639085, 1861313679)	1613 (1421, 1813)	16.8 (4.6, 39.3)	131510 (41316, 364898)

Age	Death averted	Infection averted	Net Costs (in billion)	Net QALYs (in million)	ICER
10-14 years	40489 (1339, 137976)	934418116 (333010461, 1948398944)	1401.281 (1251.257, 1564.151)	24.2 (6.8, 52.8)	75991 (27028, 196792)
15-19 years	37140 (15064, 70634)	805417604 (243442395, 1637956037)	1290.204 (1137.191, 1450.121)	14.8 (4.2, 34.6)	119555 (37551, 339073)

Age	Death averted	Infection averted	Net Costs (in billion)	Net QALYs (in million)	ICER
10-14 years	15745.7 (521, 53657)	363384823 (129504068, 757710700)	875.8 (782.0, 977.6)	9.7 (2.9, 21.2)	117324.13 (40766.38, 310276.96)
15-19 years	13506 (5478, 25685)	201354401 (60860599, 409489009)	806.4 (710.7, 906.3)	5.4 (1.4, 12.6)	205997.85 (63179.54, 609271.21)

Discussion

- **Bold Red text** → 2 strong intervention strategies lower than the willingness-to-pay (WTP = $100,000)
- 100% coverage averted the largest count of death and infection
- Younger adolescents have higher cost-effectiveness for influenza vaccination
- The ICERs of 80% and 100% coverage are relatively low

100% Coverage →

Age	Death averted	Infection averted	Net Costs (in billion)	Net QALYs (in million)	ICER
10-14 years	44987.8 (14972, 153307)	1038242351 (370011623, 2164887716)	1752 (1564, 1955)	26.9 (7.6, 58.9)	**85489 (30407, 221392)**
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80% Coverage →

Age	Death averted	Infection averted	Net Costs (in billion)	Net QALYs (in million)	ICER
10-14 years	40489 (1339, 137976)	934418116 (333010461, 1948398944)	1401.281 (1251.257, 1564.151)	24.2 (6.8, 52.8)	**75991 (27028, 196792)**
15-19 years	37140 (15064, 70634)	805417604 (243442395, 1637956037)	1290.204 (1137.191, 1450.121)	14.8 (4.2, 34.6)	119555 (37551, 339073)

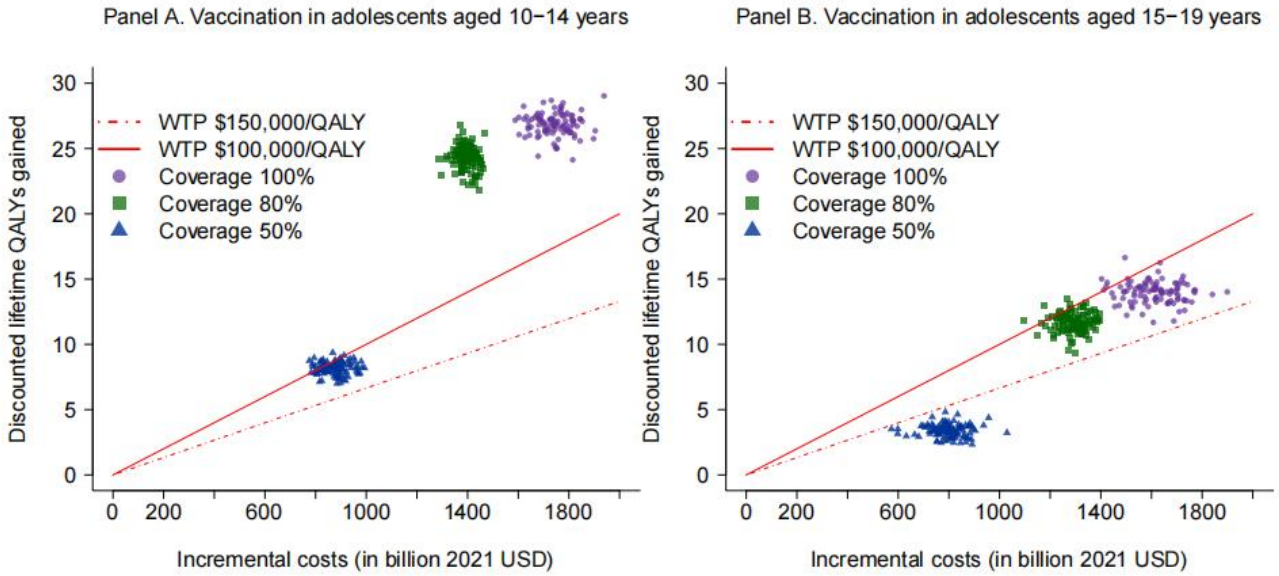
50% Coverage →

Age	Death averted	Infection averted	Net Costs (in billion)	Net QALYs (in million)	ICER
10-14 years	15745.7 (521, 53657)	363384823 (129504068, 757710700)	875.8 (782.0, 977.6)	9.7 (2.9, 21.2)	117324.13 (40766.38, 310276.96)
15-19 years	13506 (5478, 25685)	201354401 (60860599, 409489009)	806.4 (710.7, 906.3)	5.4 (1.4, 12.6)	205997.85 (63179.54, 609271.21)

Discussion

- 80% coverage for younger adolescents dominated the other 2 strategies.

  Cause: vaccination shield.



Discussion

- **Limitaions:**

Discount other factors that could affect the probability and cost of influenza vaccination and adverse effects.

Different outcomes may occur when the cohort groups are infected by different types of influenza virus or take different brands of vaccination

Conclusion

80% coverage of influenza vaccination is the most cost-effective strategy.

100% coverage of influenza vaccination produces the largest health benefits.

This strategy is affordable for developed countries such as the US.

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