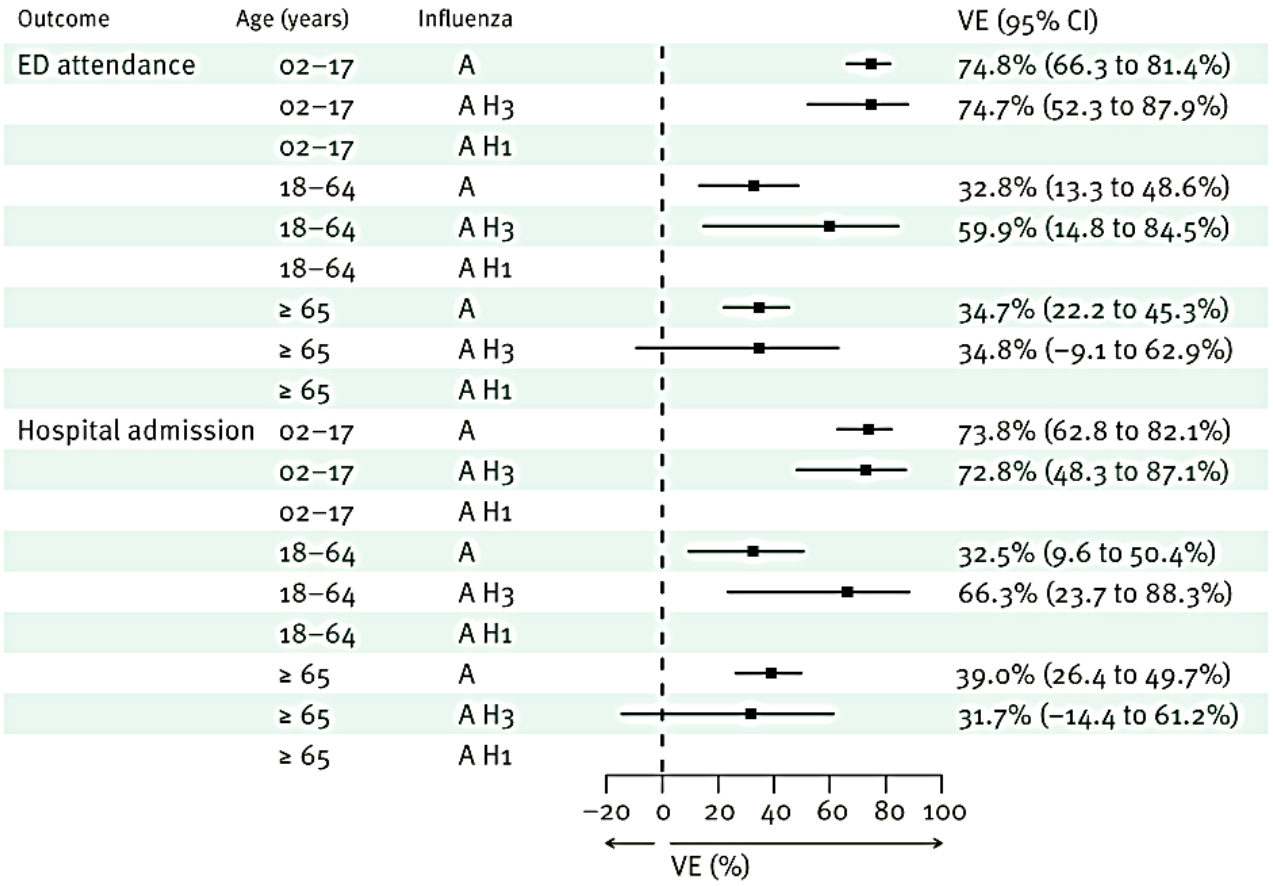
Vaccine effects

https://www.gov.uk/government/statistics/national-flu-and-covid-19-surveillance-reports-2025-to-2026-season/national-flu-and-covid-19-surveillance-report-13-november-2025-week-46

Vaccine effectiveness against emergency department attendance and hospital admission by age group, England, 29 September to 2 November 2025

Euro Surveill. 2025 Nov 20;30(46):2500854. doi: 10.2807/1560-7917.ES.2025.30.46.2500854



Outcome	Age (years)	Influenza	VE (95% CI)
ED attendance	02–17	A	74.8% (66.3 to 81.4%)
	02–17	A H3	74.7% (52.3 to 87.9%)
	02–17	A H1	
	18–64	A	32.8% (13.3 to 48.6%)
	18–64	A H3	59.9% (14.8 to 84.5%)
	18–64	A H1	
	≥ 65	A	34.7% (22.2 to 45.3%)
	≥ 65	A H3	34.8% (−9.1 to 62.9%)
	≥ 65	A H1	
Hospital admission	02–17	A	73.8% (62.8 to 82.1%)
	02–17	A H3	72.8% (48.3 to 87.1%)
	02–17	A H1	
	18–64	A	32.5% (9.6 to 50.4%)
	18–64	A H3	66.3% (23.7 to 88.3%)
	18–64	A H1	
	≥ 65	A	39.0% (26.4 to 49.7%)
	≥ 65	A H3	31.7% (−14.4 to 61.2%)
	≥ 65	A H1	

- How to interpret these data?
- Prepare a 3-line talking point for the minister advisor, who will need to promote the upcoming vaccination campaign in your country.

Vaccine effectiveness

Outcome	Age (years)	Influenza		VE (95% CI)
Hospital admission	≥ 65	A H3		31.7% (−14.4 to 61.2%)

Write a sentence with 31.7% to explain what Vaccine Effectiveness means

Vaccine effectiveness

Outcome	Age (years)	Influenza	VE (95% CI)
Hospital admission	≥ 65	A H3	31.7% (−14.4 to 61.2%)

Influenza vaccination reduced the risk of influenza hospitalization by **31.7% among adults aged ≥65 years**, compared to those not vaccinated.

Influenza Vaccine Effectiveness (VE): What does it mean?

VE measures how much vaccination reduces the risk of an outcome in real-world conditions

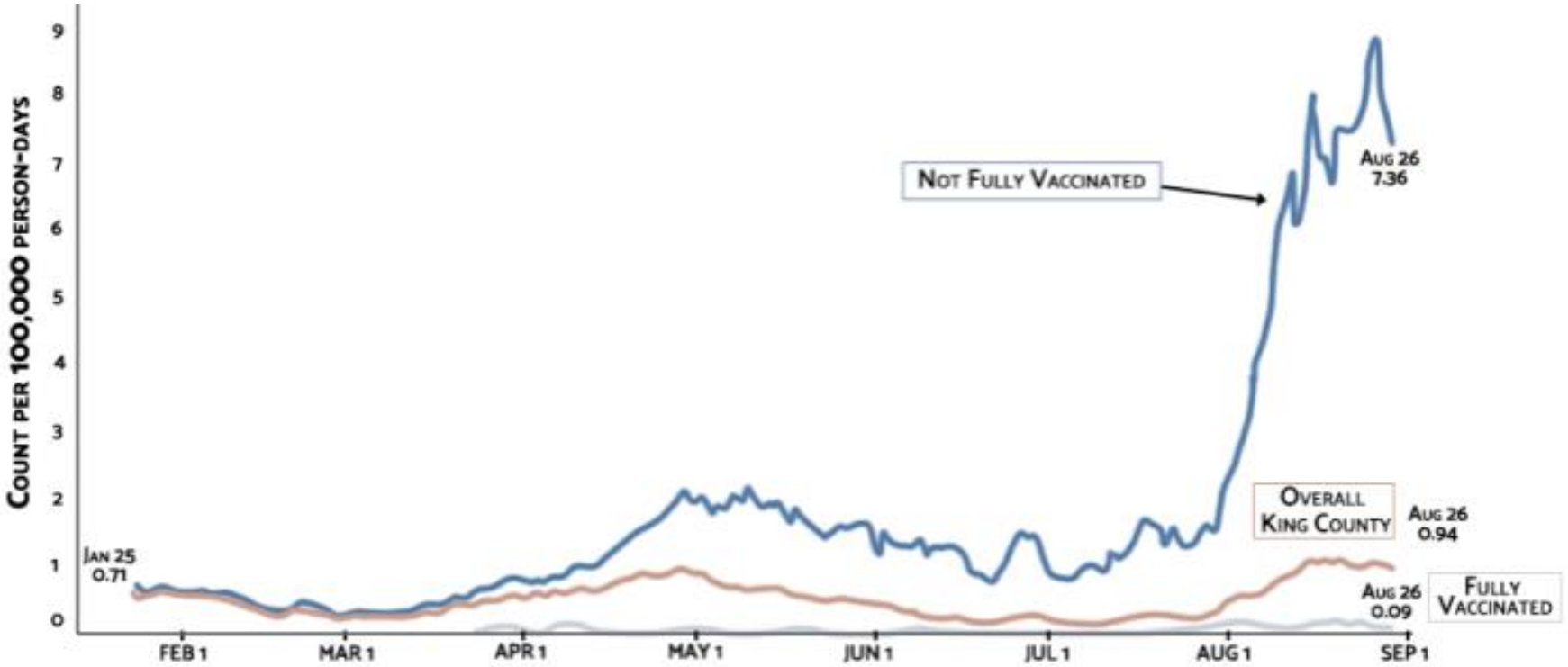
$$VE = 1 - \frac{Risk_{vaccinated}}{Risk_{unvaccinated}}$$

Key points:

- Comparison between:
  - **Vaccinated individuals**
  - vs **Unvaccinated individuals**
- Measured **within the same population and time period**
- VE = **relative reduction in risk**

Vaccine effectiveness

COVID-19 hospitalization age-adjusted rate over time, King County, Washington State, 2021

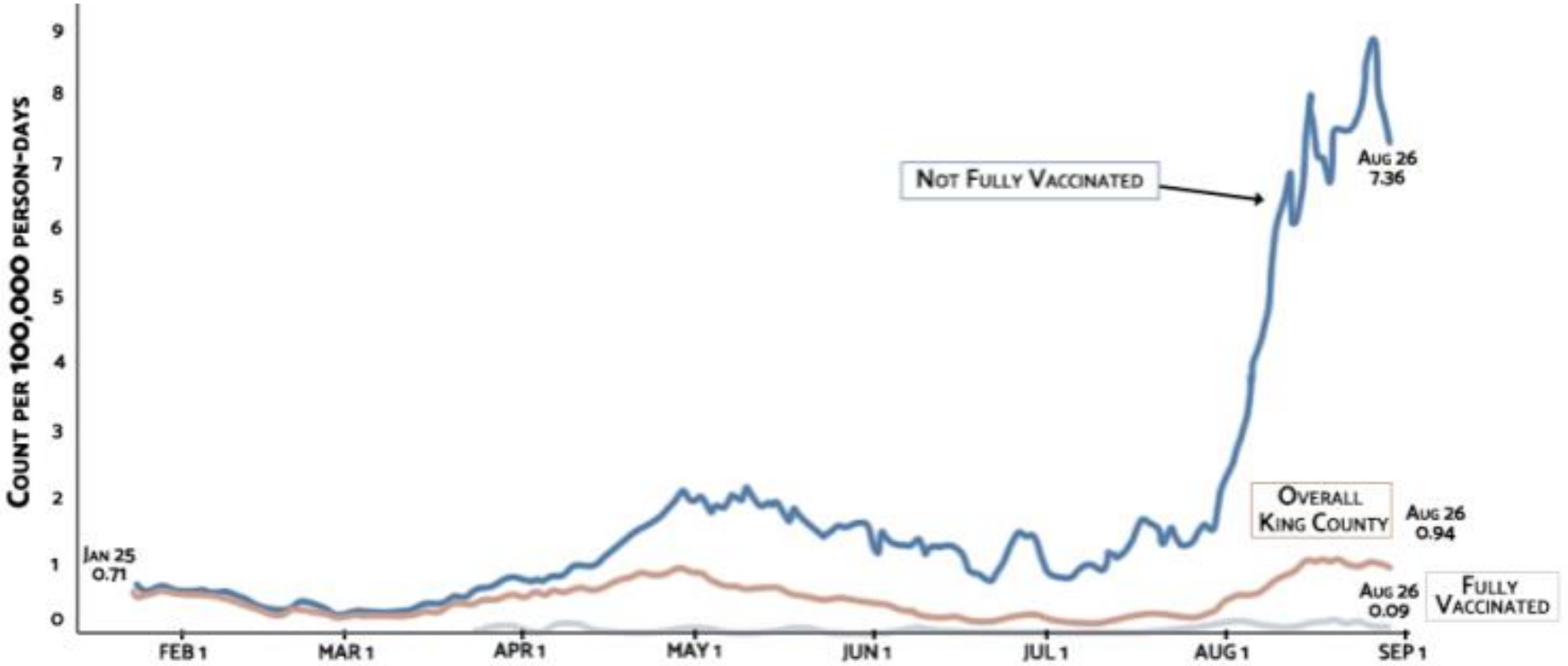


Vaccine Effectiveness on August 26?

https://publichealthinsider.com/2021/09/03/new-data-dashboard-tracks-covid-19-risk-for-unvaccinated-people-compared-to-vaccinated-people/

Vaccine effectiveness

COVID-19 hospitalization age-adjusted rate over time, King County, Washington State, 2021

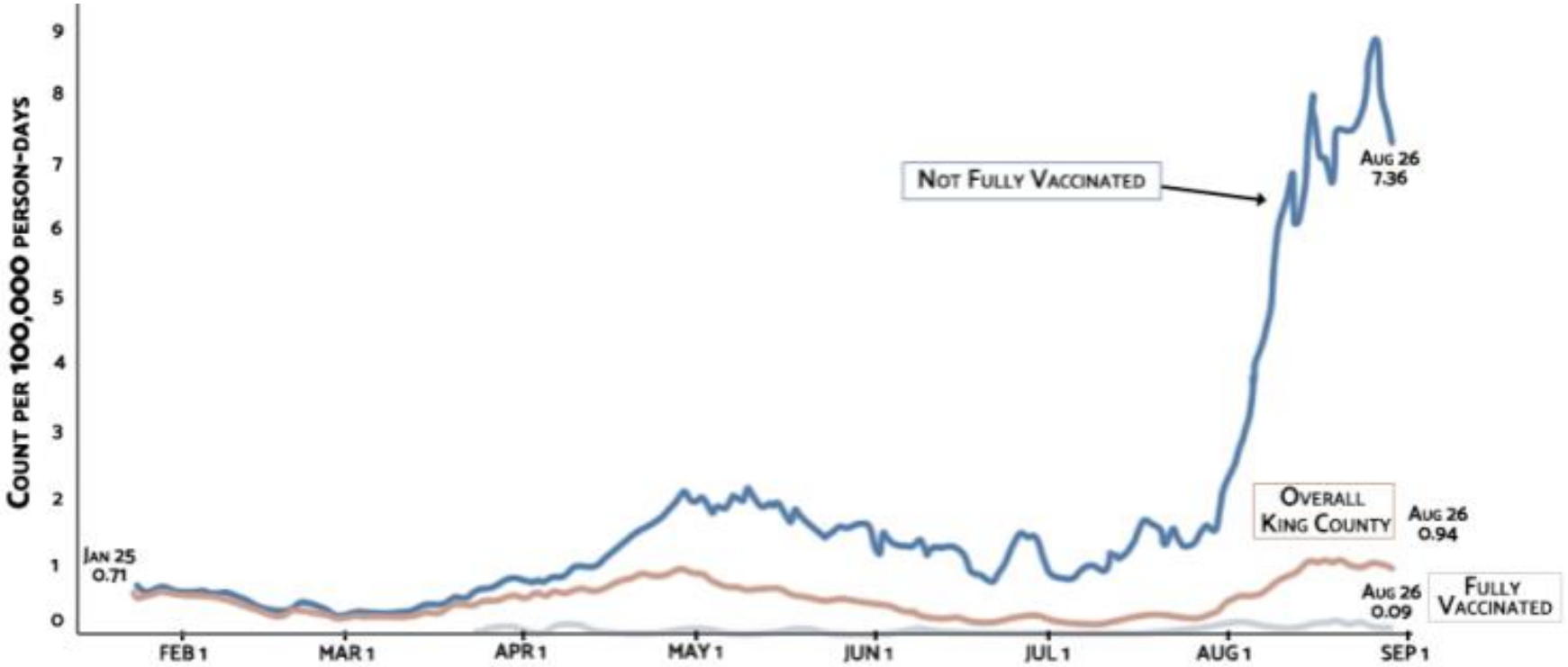


Vaccine Effectiveness on August 26= $1 - \frac{\text{Risk hospitalization among vaccinated}}{\text{Risk hospitalization among unvaccinated}}$

https://publichealthinsider.com/2021/09/03/new-data-dashboard-tracks-covid-19-risk-for-unvaccinated-people-compared-to-vaccinated-people/

Vaccine effectiveness

COVID-19 hospitalization age-adjusted rate over time, King County, Washington State, 2021

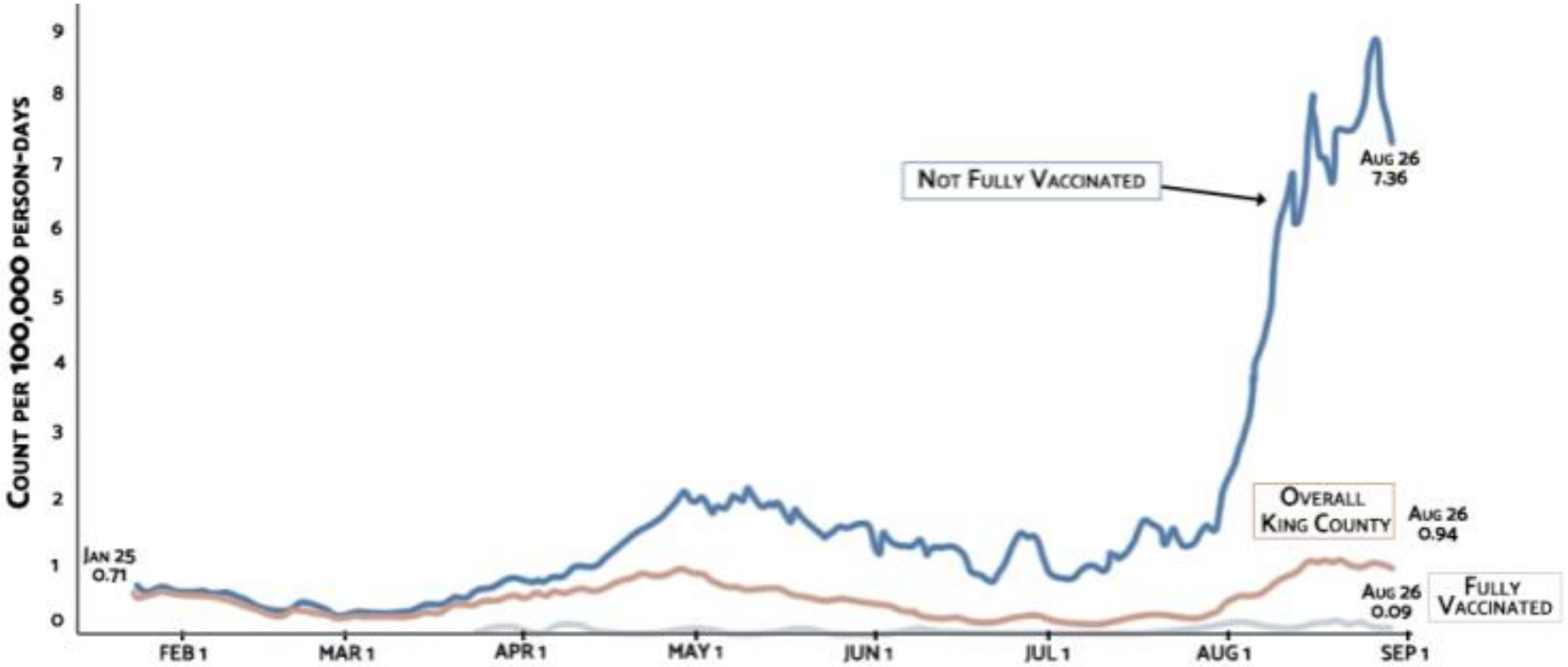


Vaccine Effectiveness on August 26= $1 - \frac{0.09}{7.36}$

https://publichealthinsider.com/2021/09/03/new-data-dashboard-tracks-covid-19-risk-for-unvaccinated-people-compared-to-vaccinated-people/

Vaccine effectiveness

COVID-19 hospitalization age-adjusted rate over time, King County, Washington State, 2021



Vaccine Effectiveness on August 26= $0.99 = 99\%$

https://publichealthinsider.com/2021/09/03/new-data-dashboard-tracks-covid-19-risk-for-unvaccinated-people-compared-to-vaccinated-people/

Who are we comparing vaccinated individuals to?

Unvaccinated individuals are **NOT** immunologically naïve

Unvaccinated individuals may have:

- Immunity from **previous influenza infections**
- Immunity from **prior vaccination**
- **Cross-protection** from related strains

We are not comparing **"immune vs non-immune"**, but
we are comparing **"vaccinated individuals vs unvaccinated individuals" with varying baseline immunity**

We are not comparing **"protected vs unprotected" —**
we are comparing **"differently protected groups."**

What does influenza VE actually reflect?

VE estimates the additional protection provided by vaccination on top of existing immunity

It combines:

- Biological effect of the vaccine
- Background population immunity
- Exposure patterns and transmission intensity

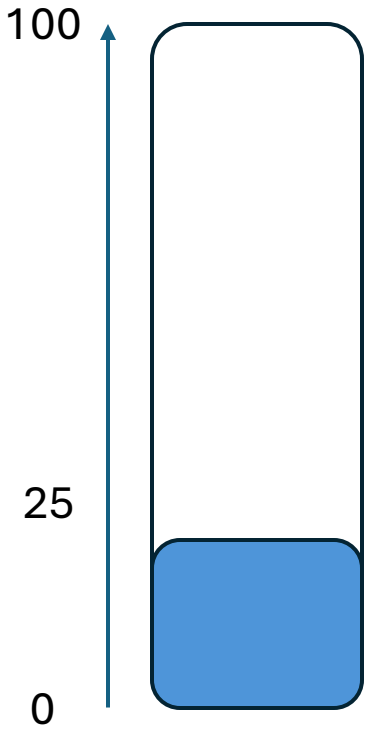
If **VE = 40% against influenza hospitalization**

Vaccinated individuals have a **40% lower risk** than unvaccinated individuals to be hospitalized due to influenza **in the same population and season**

Why influenza VE is moderate (and still important)

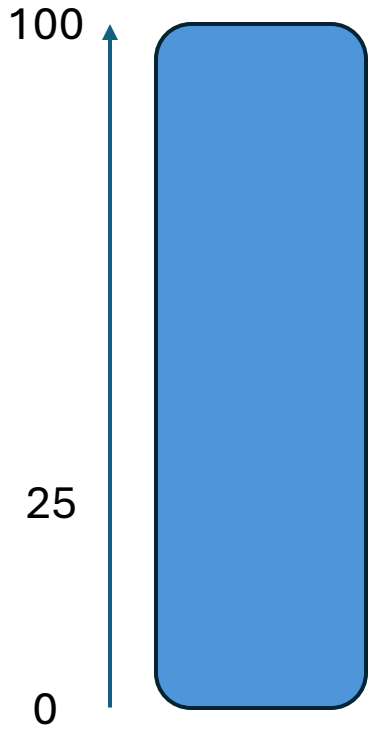
Risk of severe outcome in unvaccinated population

Influenza



- *Likely previous infection (~20% of the population is sick due to influenza every year)*
- *Potential previous vaccination*

Yellow fever



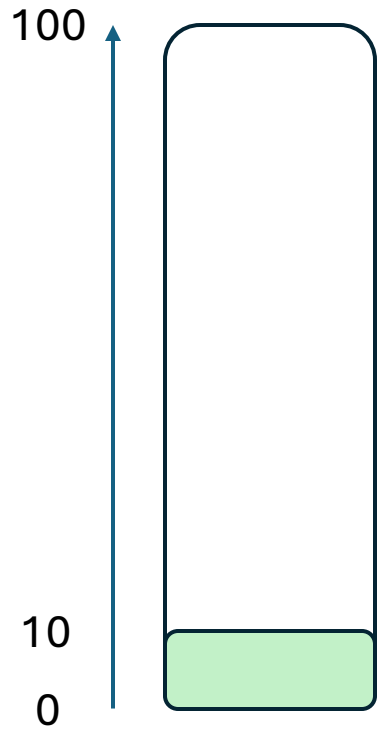
Negligeable portion of population previously exposed to yellow fever virus

hypothetical numbers

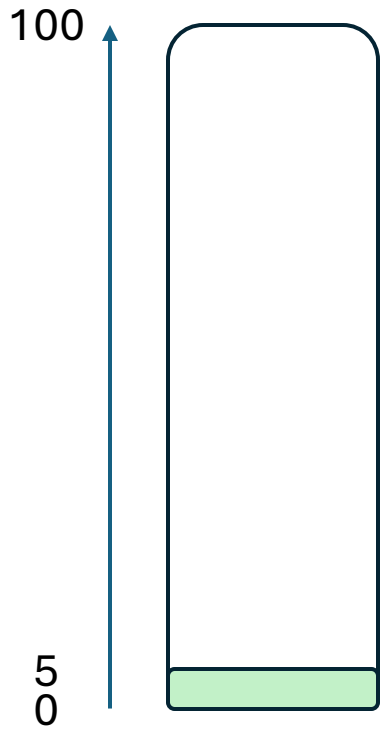
Why influenza VE is moderate (and still important)

Risk of severe outcome in vaccinated population (theoretical scale)

Influenza



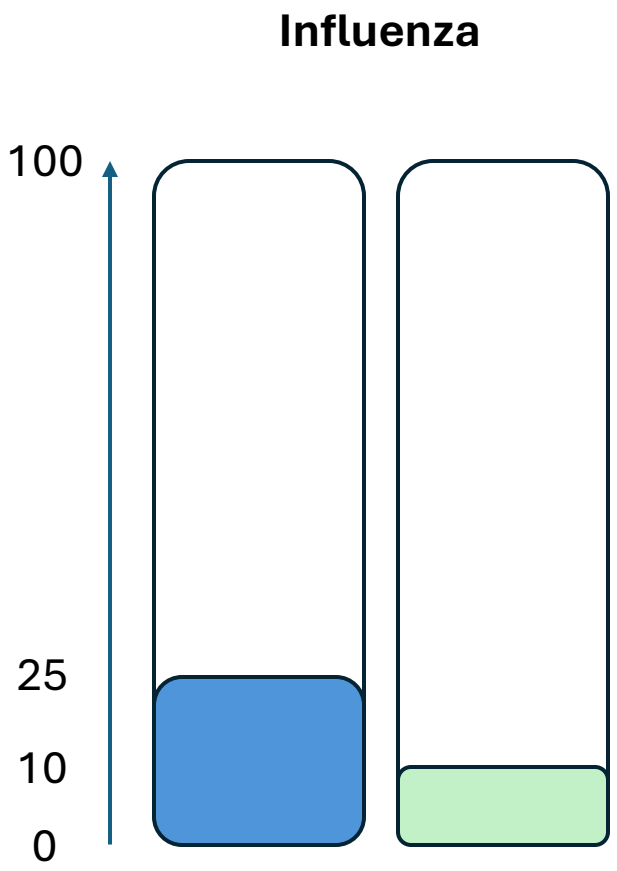
Yellow fever

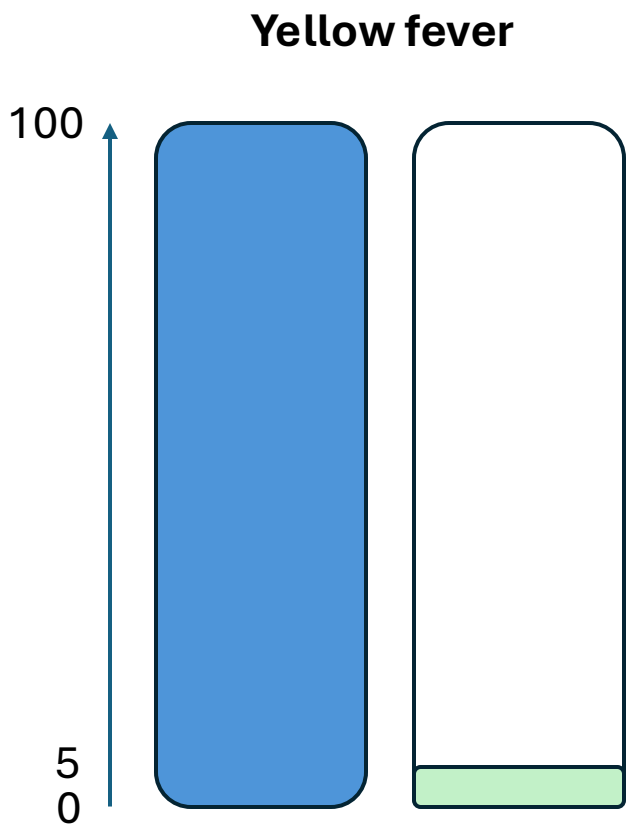


hypothetical numbers

Why influenza VE is moderate (and still important)

Risk of severe outcome in unvaccinated and vaccinated population (theoretical scale)



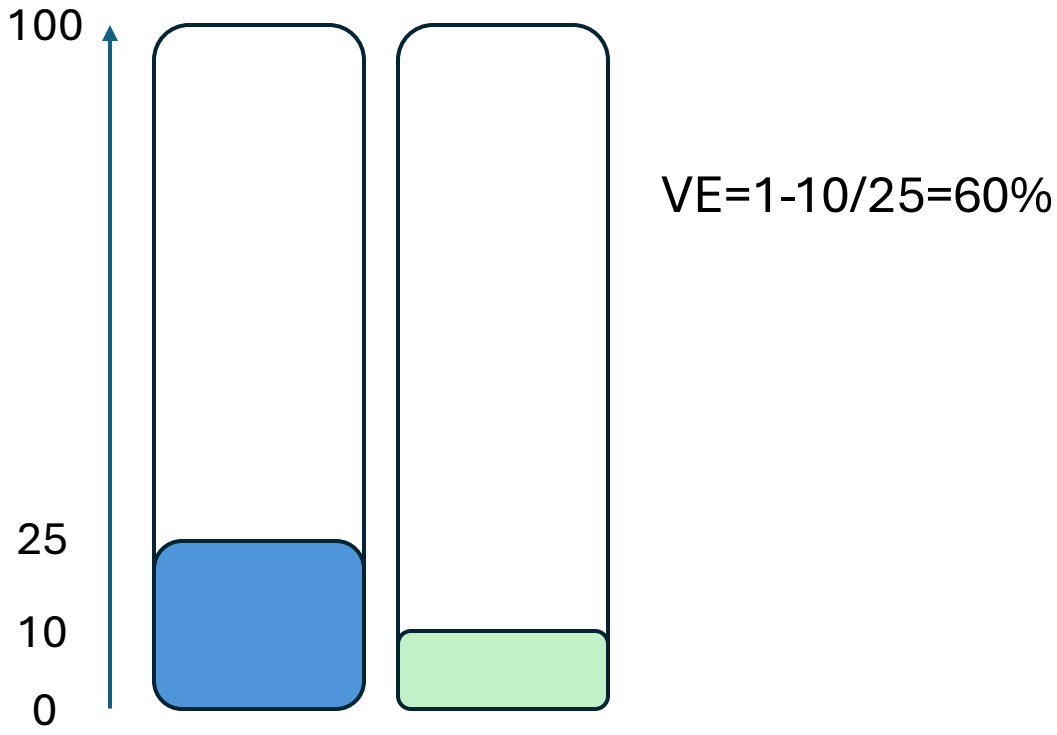


hypothetical numbers

Why influenza VE is moderate (and still important)

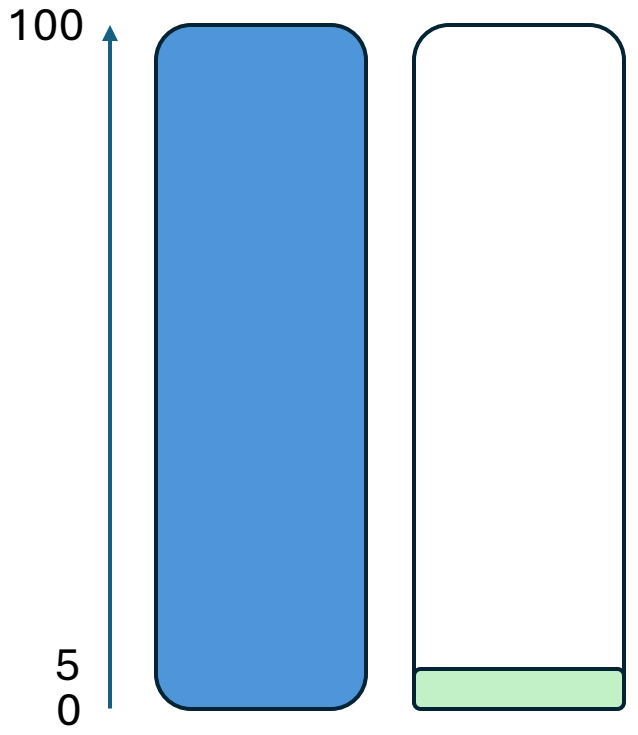
$$VE = 1 - \frac{Risk_{vaccinated}}{Risk_{unvaccinated}}$$

Influenza



VE=1-10/25=60%

Yellow fever



VE=1-5/100=95%

hypothetical numbers

Why influenza VE is moderate
Compared to other vaccines (e.g. yellow fever)

Context	Influenza	Yellow fever
1. Prior immunity in unvaccinated group	Often substantial	Usually minimal
2. Repeated natural exposure	Frequent	Rare
3. Prior vaccination history	Common in many groups	Less relevant to routine annual comparison
4. Virus characteristics	Rapid evolution, strain mismatch possible	More antigenically stable
5. Observed VE	Often moderate	Often very high

Influenza VE is not "low because the vaccine does not work."
It is often moderate because the comparison is made in a population where:

- the unvaccinated group is already partly protected, and
- the virus changes over time.

What really matters: vaccine impact at population level

Vaccine effectiveness (VE) tells us how well the vaccine works —
but what really matters for a vaccination programme is its **impact**.

VE = **relative reduction in risk** among vaccinated vs unvaccinated
Impact = number of cases, hospitalizations, or deaths **prevented in the population**

Impact depends on:

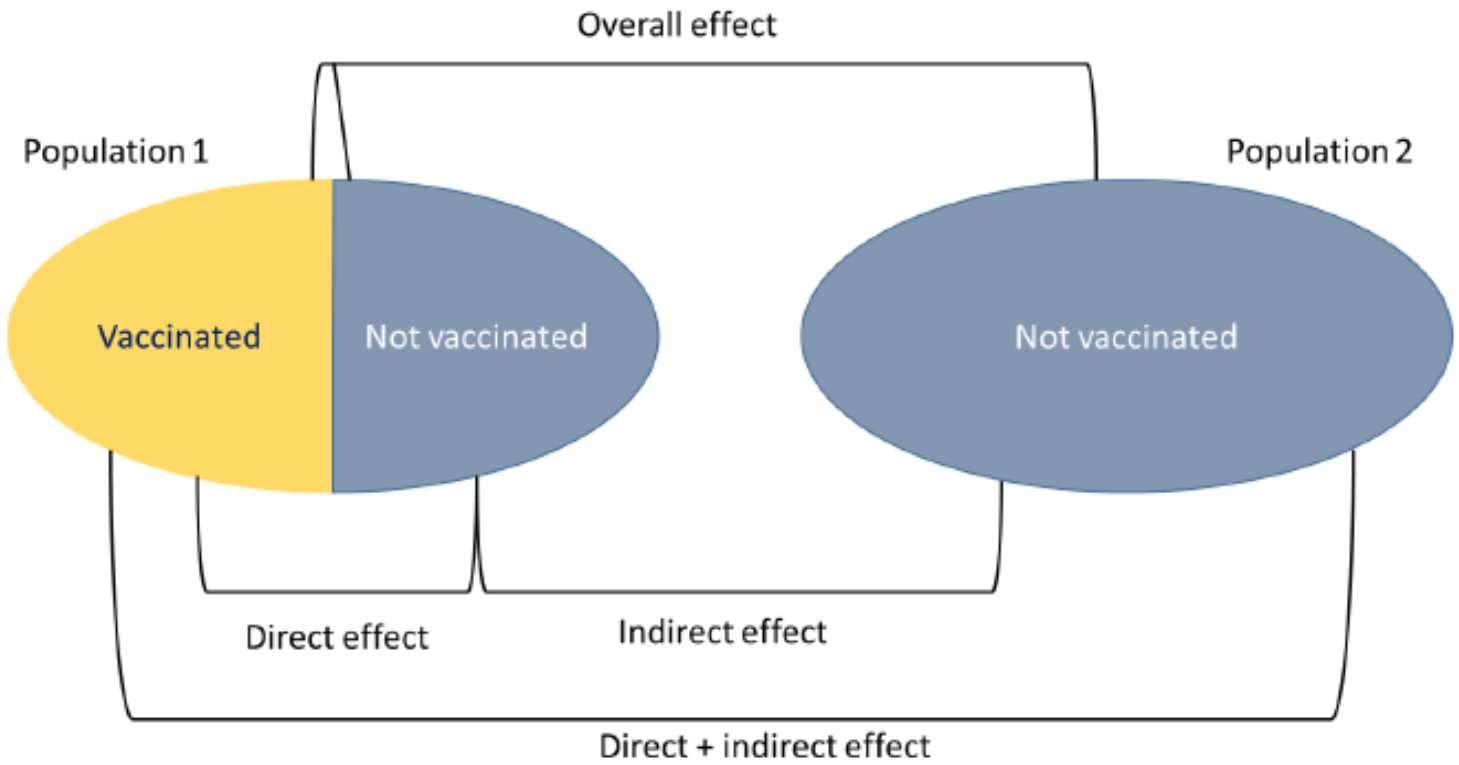
- **Burden of disease**
- **Vaccination coverage**
- **Size and risk profile of the population**
- **Vaccine effectiveness**
- **Indirect effects (herd protection)**

A vaccine with **high VE but low disease burden → limited impact**
A vaccine with **moderate VE but high disease burden → large impact**

Influenza → High burden diseases → many people at risk every year
Even with **moderate VE (e.g., 40%)**
Large number of hospitalizations and deaths prevented

Vaccine effects: beyond individual protection

Effect	Comparison	Meaning
Direct effect (VE)	Vaccinated vs unvaccinated (same population)	Individual protection
Indirect effect	Unvaccinated in vaccinated vs unvaccinated in non-vaccinated population	Herd protection
Total effect	Vaccinated vs unvaccinated in absence of program	Direct + indirect
Overall effect	Population with vs without vaccination program	Population impact



Halloran conceptual framework for vaccine effects

Halloran ME, Struchiner CJ, Longini IM Jr. (1997). *Study designs for evaluating different efficacy and effectiveness aspects of vaccines*. **American Journal of Epidemiology**, 146(10):789–803.

Vaccine effects

Existing contexts in terms of vaccination exposure

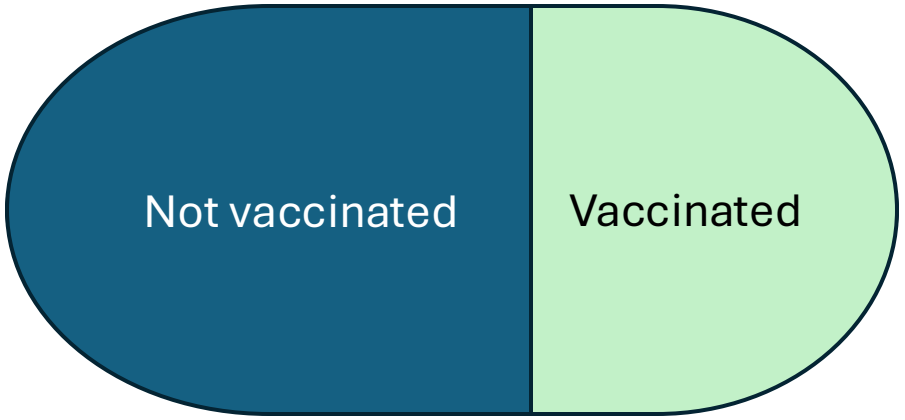
No vaccination program

Vaccine effects

Existing contexts in terms of vaccination exposure

No vaccination program

Vaccination program

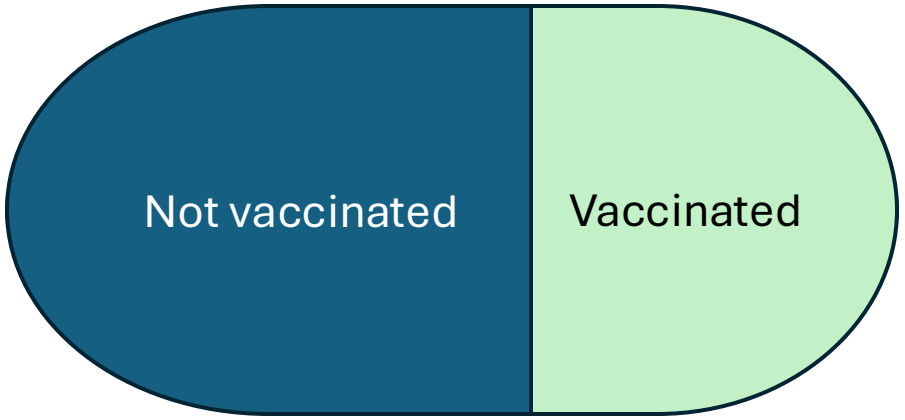


Vaccine effects

Which groups can we compare?

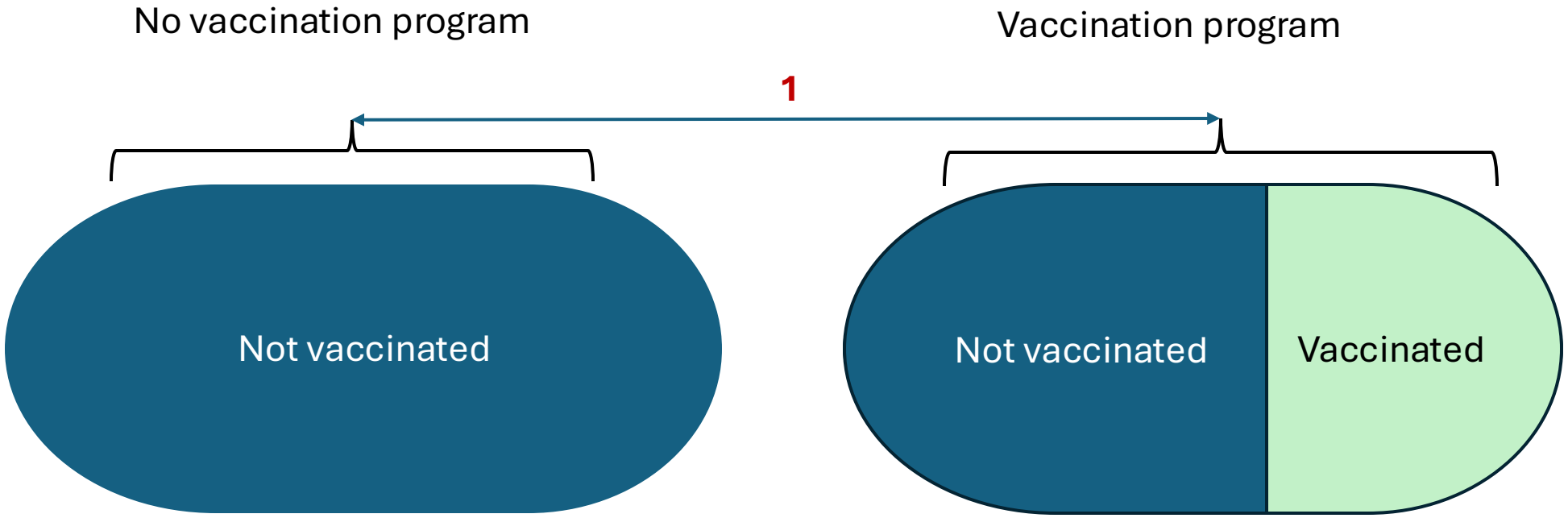
No vaccination program

Vaccination program



Vaccine effects

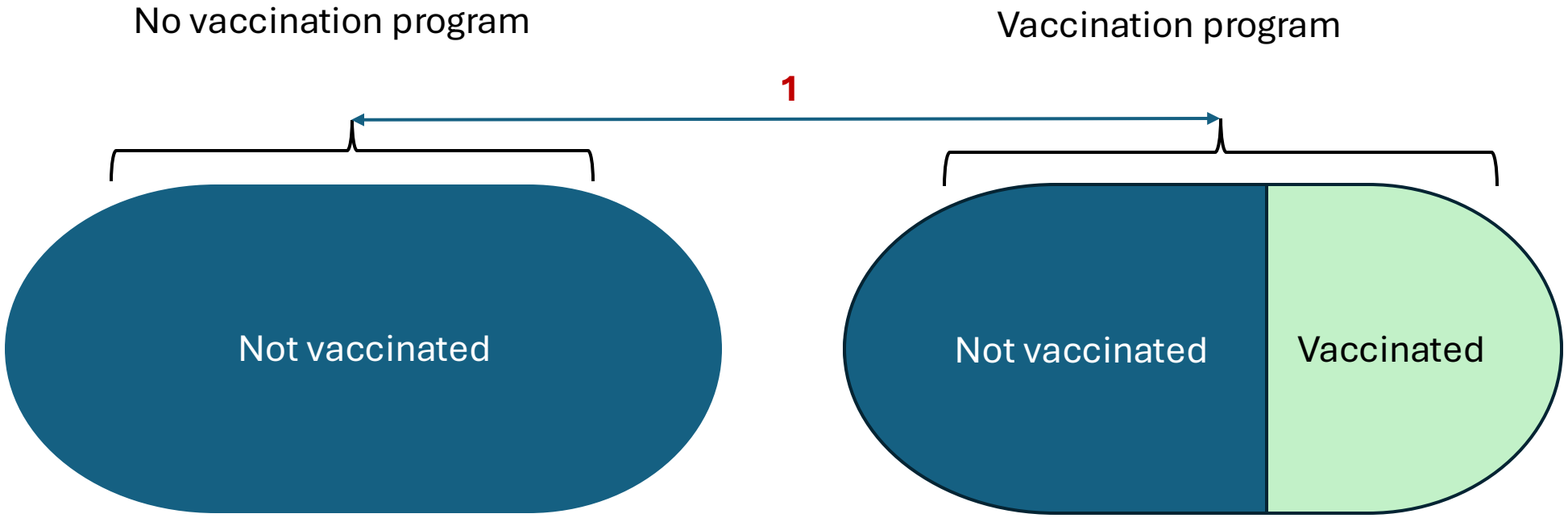
Which groups can we compare?



1. Population with vaccination program vs population without vaccination program

Vaccine effects

Which groups can we compare?



1. Population with vaccination program vs population without vaccination program
= overall effect = impact of the vaccination program

This influenza vaccine programme has a **20% impact on influenza hospitalization**

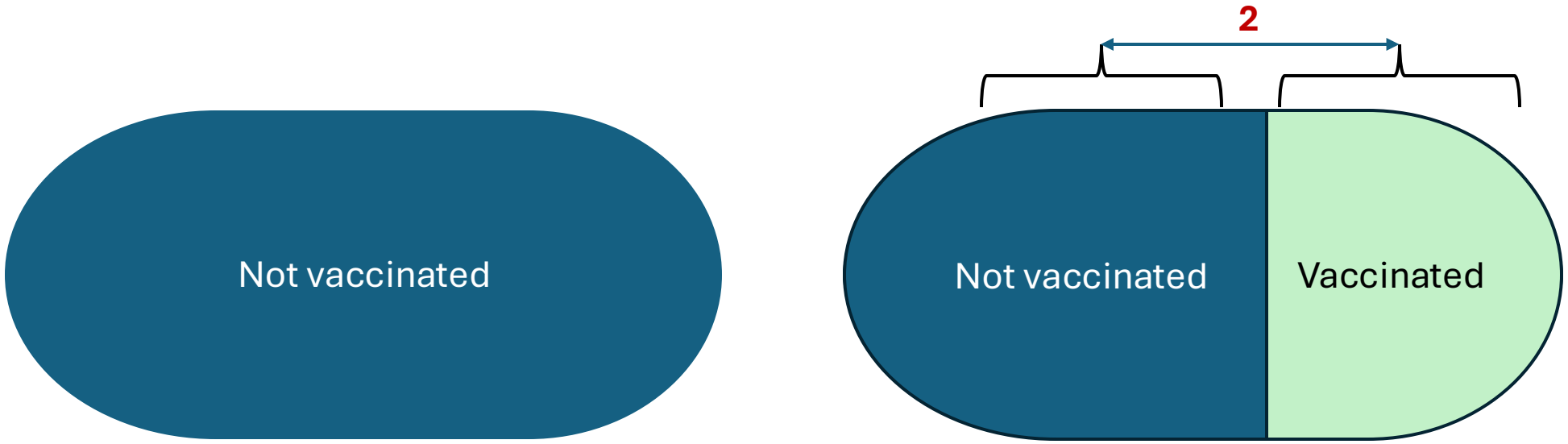
*"Compared with a comparable population **without an influenza vaccination programme**, we observe a **20% lower rate of influenza hospitalization in the population where the vaccination programme is implemented**"*

Vaccine effects

Which groups can we compare?

No vaccination program

Vaccination program



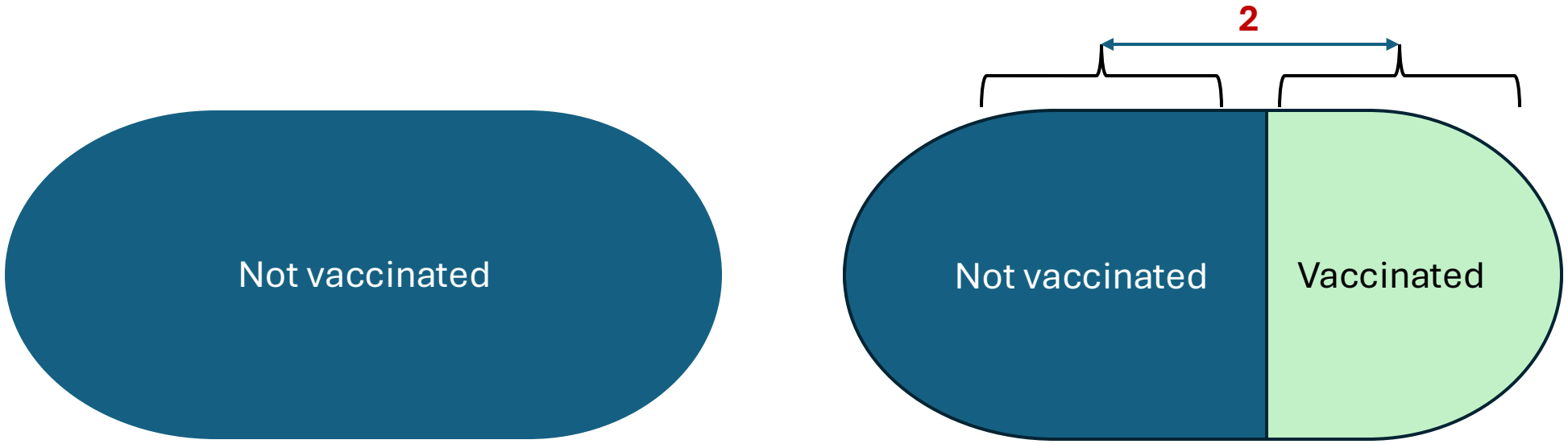
2. Vaccinated individuals vs unvaccinated individuals within the same vaccinated population

Vaccine effects

Which groups can we compare?

No vaccination program

Vaccination program



2. Vaccinated individuals vs unvaccinated individuals within the same vaccinated population
= Direct effect
= Vaccine effectiveness

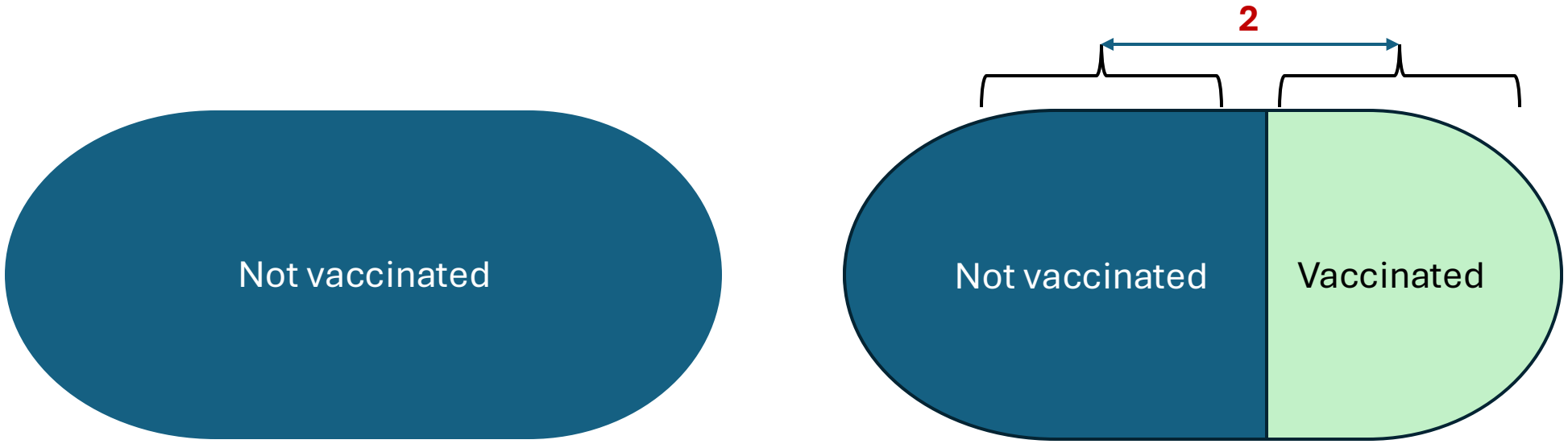
This influenza vaccine is **30% effective against influenza hospitalization**.

Vaccine effects

Which groups can we compare?

No vaccination program

Vaccination program



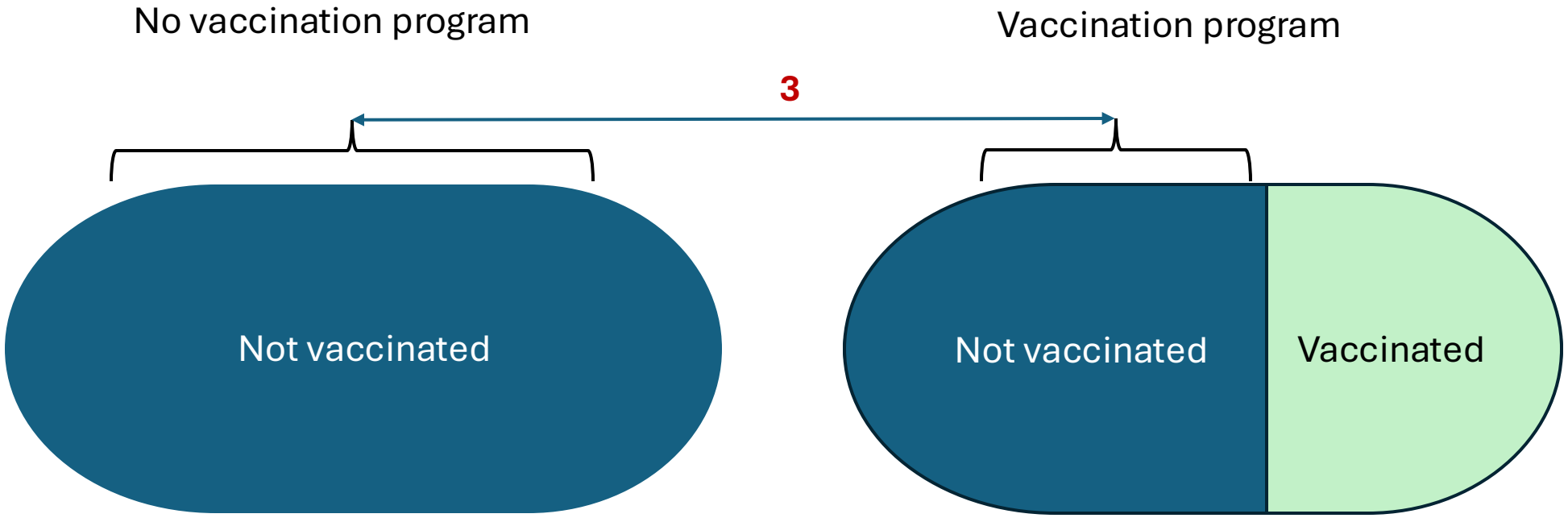
2. Vaccinated individuals vs unvaccinated individuals within the same vaccinated population
= Direct effect
= Vaccine effectiveness

This influenza vaccine is **30% effective against influenza hospitalization**.

"Among individuals living in a population with a vaccination programme, ***vaccinated persons have a 30% lower risk of influenza hospitalization compared with unvaccinated persons"***

Vaccine effects

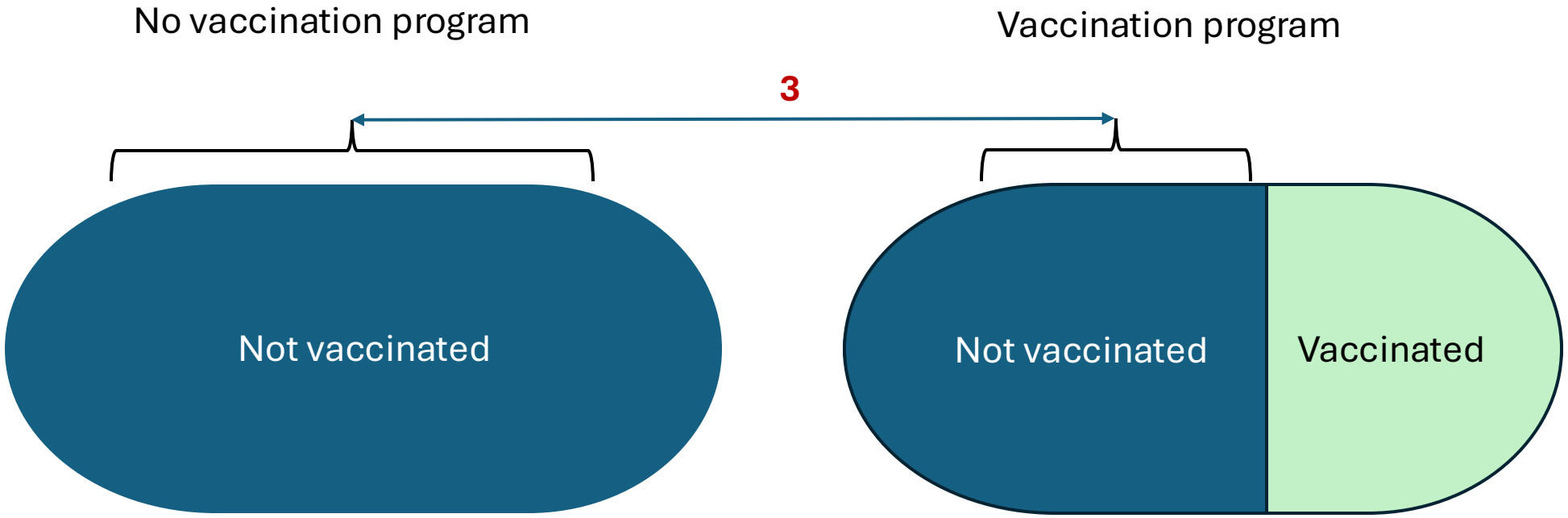
Which groups can we compare?



3. Unvaccinated individuals in vaccinated population vs unvaccinated individuals in non-vaccinated population

Vaccine effects

Which groups can we compare?



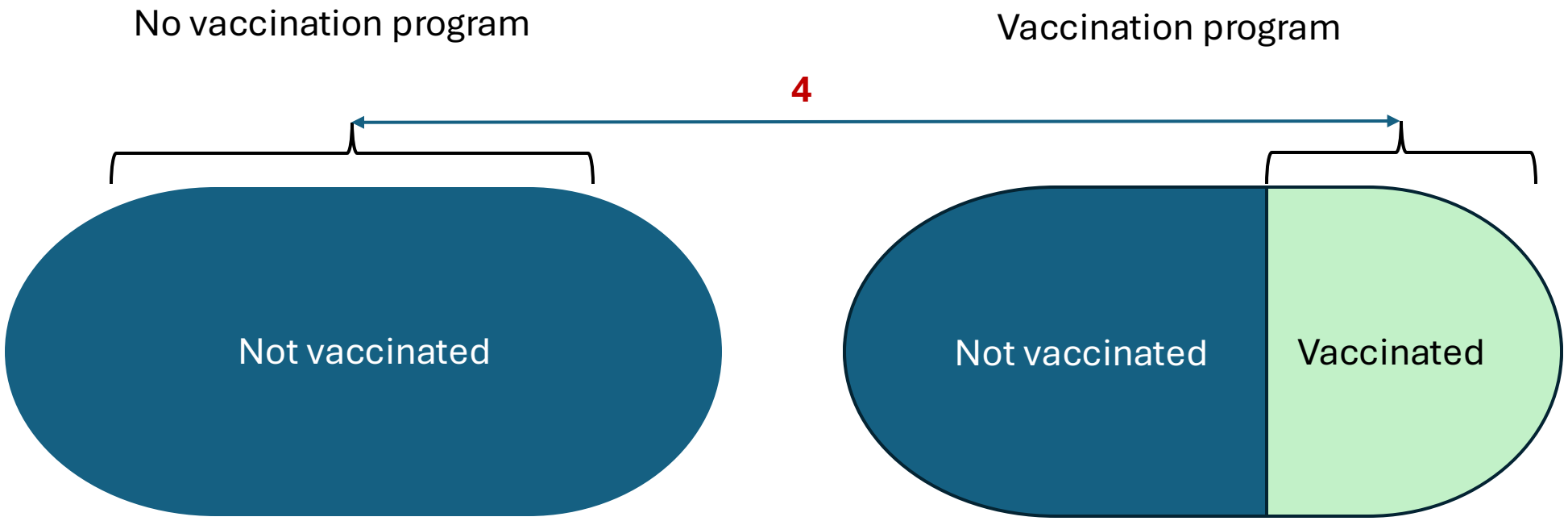
3. Unvaccinated individuals in vaccinated population vs unvaccinated individuals in non-vaccinated population
= Indirect effect = herd protection

The influenza vaccination programme provides **10% indirect protection against influenza hospitalization**.

*"Among individuals who are **not vaccinated**, those living in a population with a vaccination programme have a **10% lower risk of influenza hospitalization compared with unvaccinated persons living in a population without vaccination.**"*

Vaccine effects

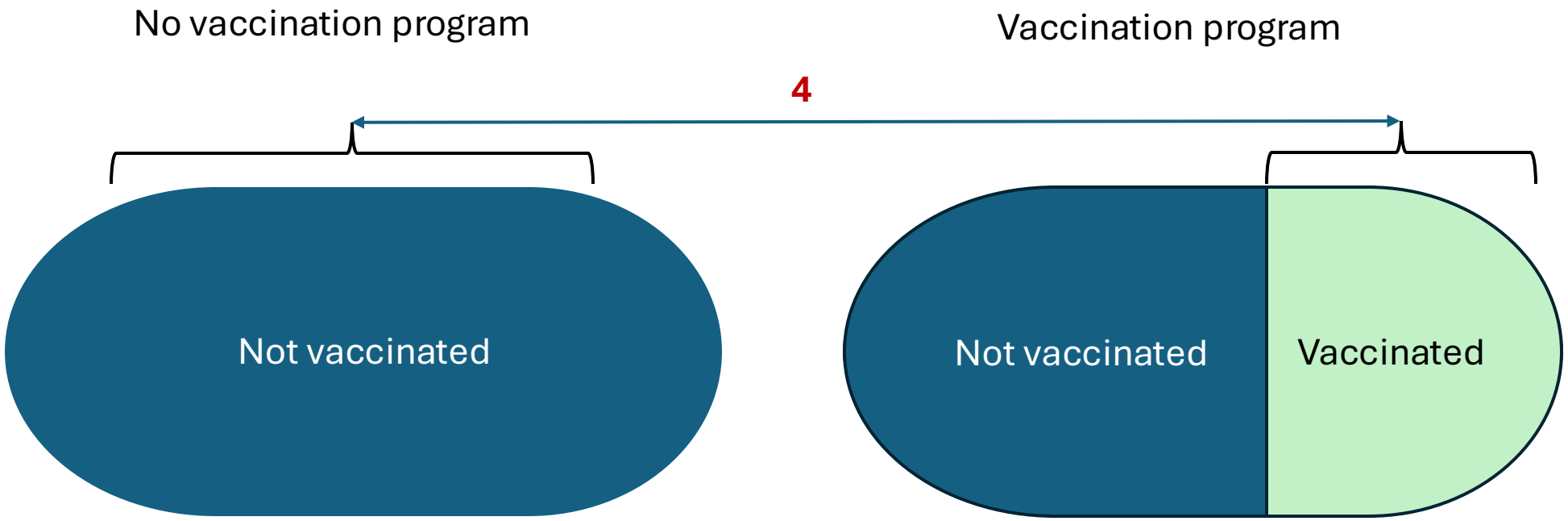
Which groups can we compare?



4. Vaccinated individuals in vaccinated population vs unvaccinated individuals in non-vaccinated population

Vaccine effects

Which groups can we compare?

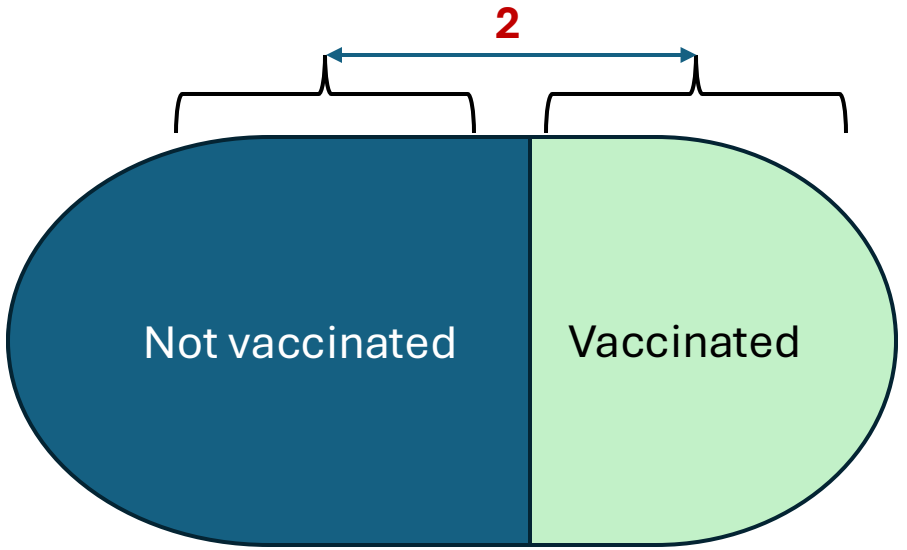


4. Vaccinated individuals in vaccinated population vs unvaccinated individuals in non-vaccinated population
= Total effect = direct + indirect effect

The influenza vaccination programme provides a **40% total protective effect against influenza hospitalization**.

*"Vaccinated individuals living in a population with a vaccination programme have a **40% lower risk of influenza hospitalization compared with unvaccinated individuals living in a population without vaccination.**"*

Vaccine effectiveness



Vaccine effectiveness (VE) measures the **reduction in risk of an outcome (e.g., hospitalization)** among vaccinated individuals compared to unvaccinated individuals:

$$VE = 1 - \frac{\text{Risk hospitalization among vaccinated}}{\text{Risk hospitalization among unvaccinated}}$$