COVID-19 Vaccine Effectiveness by Product and Timing in New York State

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Our earlier approach

- New York State: Population 20 million; 15 million age 18+

- Match of 3 statewide databases
  - Laboratory testing   (ECLRS)
  - Hospital admissions   (HERDS)
  - Vaccine registries   (NYSIIS/CIR)

  Morbidity and Mortality Weekly Report

  New COVID-19 Cases and Hospitalizations Among Adults, by Vaccination Status — New York, May 3–July 25, 2021

  Eli S. Rosenberg, PhD[1,2]; David R. Holtgrave, PhD[2]; Vajeera Dorabawila, PhD[1]; MaryBeth Conroy, MPH[1]; Danielle Greene, DrPH[1]; Emily Lutterloh, MD[1,2]; Bryon Backenson, MS[1,2]; Dina Hoefer, PhD[1]; Johanne Morne, MS[1]; Ursula Bauer, PhD[1]; Howard A. Zucker, MD, JD[1]

- For fully-vaccinated vs. unvaccinated adults…
  - Age-specific rates of cases and hospitalization estimated weekly
  - Compared using VE = 1 – IRR

- **Open cohort** approach
  - Unvaccinated persons can become vaccinated → contribute person-time and outcomes in either vaccine state.
  - Rates computed as aggregate $events/PT$ weekly. Individuals not specifically followed across time steps.
  - Maximally utilizes population and transparent, with potential bias tradeoffs
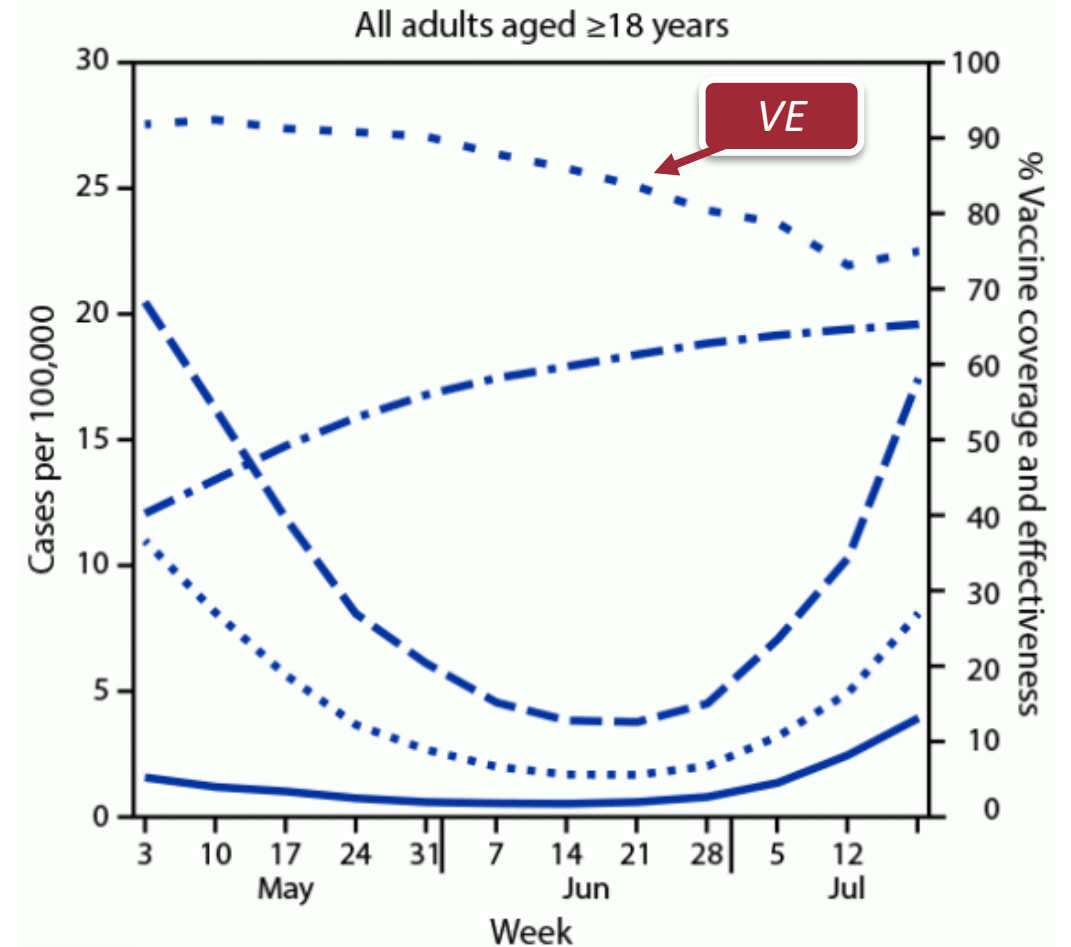
Results from this method

Laboratory-confirmed cases

- May 3 week: VE = 91.8%

- Decline coincides with Delta variant increase to >99%,

- Mid-July minimum, small rebound thereafter

Hospitalization

- Consistent VE between 89.5% and 95.2%

All adults aged ≥18 years

Legend:
- Cases per 100,000: fully vaccinated
- Cases per 100,000: unvaccinated
- Cases per 100,000: all persons
- Fully vaccinated coverage
- Estimated vaccine effectiveness

Challenging to understand sources of VE changes
Products, time since vaccination, time period when variants and behaviors changed …

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Rosenberg ES, Dorabawila V, Easton D, Bauer UE, Kumar J, Hoen R, Hoefer D, Wu M, Lutterloh E, Conroy MB, Greene D, Zucker HA

Enhanced approach to focus on roles of products and timing
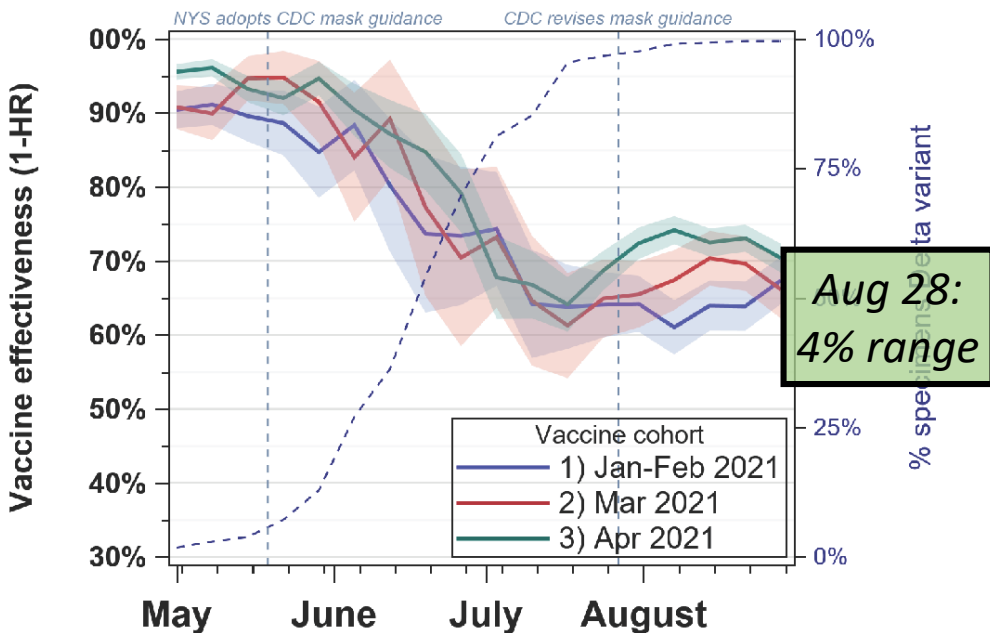
- **Closed cohort** approach
  - Closed cohorts, defined by combinations of:
    - Age   (18-49, 50-64, ≥65 years)
    - Product   (Pfizer-BioNTech, Moderna, Janssen)
    - Time of full-vaccination   (January/February, March, April)
    - <u>Comparison group</u>: Never vaccinated by Sept 23 data freeze (for each age group)

  - **Follow-up**: **May 1** to **September 3** (cases), **August 31** (hospitalization)

- Laboratory-confirmed COVID-19 cases *(1 per person)*
  - Time-to-diagnosis, life-table method (7 day intervals)
    - Cumulative incidence, hazard rates, with 95% CI
    - VE = 1 – HR, with 95% CI

- Laboratory-confirmed COVID-19 hospitalizations *(repeats possible within person, ~9% of admissions)*
  - Aggregate "$events/PT$" rates (1 month intervals)
    - Incidence rates, with exact 95% CI
    - VE = 1 – IRR, with exact 95% CI

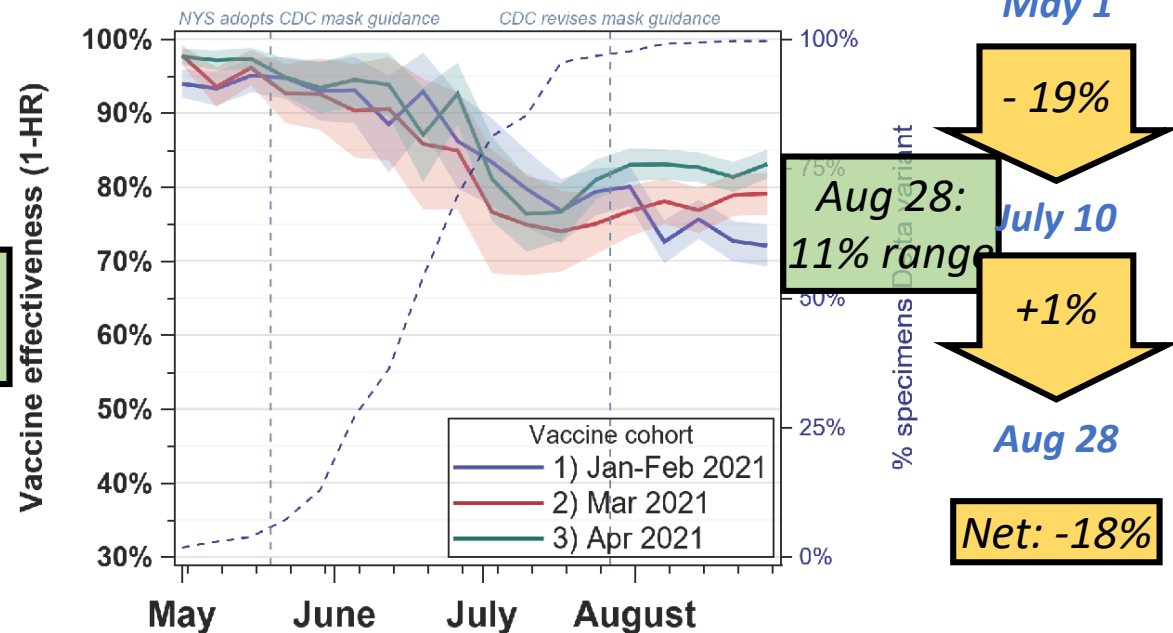# Overview of sample sizes, cases & hospitalizations during follow-up

	Cohort	Persons	Incident cases	Incident hospitalizations
18-49 years	Pfizer-BioNTech	980,353	10,738	95
	Moderna	752,322	5,658	60
	Janssen	276,481	3,307	38
	Unvaccinated	2,070,251	85,667	4,689
50-64 years	Pfizer-BioNTech	846,664	5,602	228
	Moderna	624,226	2,723	104
	Janssen	184,120	1,406	92
	Unvaccinated	606,411	20,175	3,380
≥65 years	Pfizer-BioNTech	984,464	5,302	972
	Moderna	1,023,748	3,291	545
	Janssen	115,439	751	229
	Unvaccinated	370,125	10,472	4,430
Total		**8,834,604**	**155,092**	**14,862**

Cases: Hazard rates and VE

Weekly hazard rates for Laboratory-confirmed COVID-19 cases by Vaccine Product, Age, and Timing of Vaccination

Pfizer-BioNTech, 18-49 years

May 1
- 28%
July 10
+3%
Aug 28

Net: -25%

Aug 28: 4% range

Moderna, 18-49 years

May 1
- 19%
July 10
+1%
Aug 28

Net: -18%

Aug 28: 11% range

Janssen, 18-49 years

May 1
- 38%
July 10
+19%
Aug 28

Net: -19%

Aug 28: 5% range
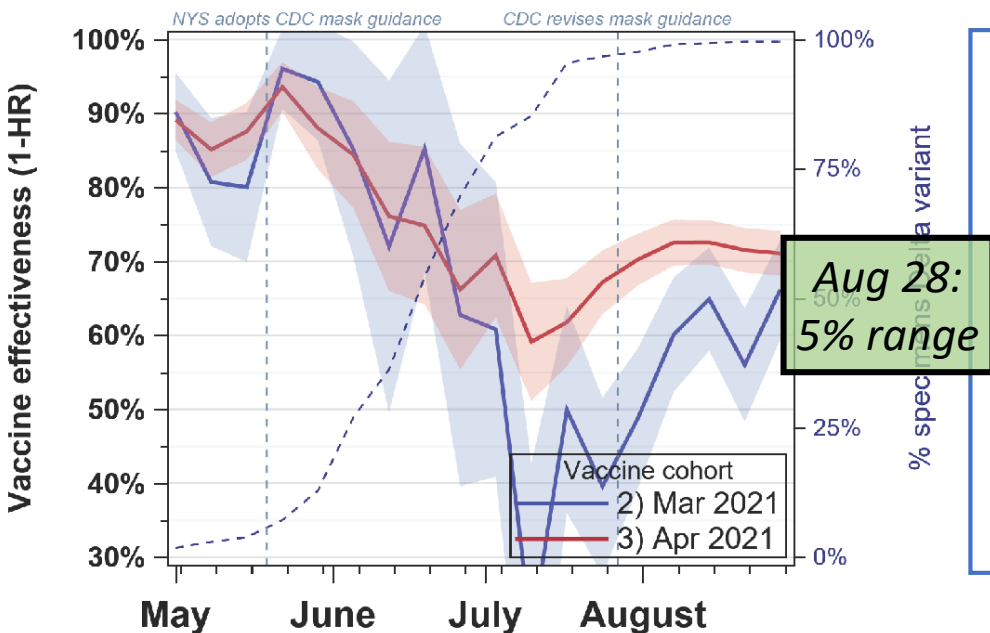
- **Simultaneous drop-off in VE against cases for all cohorts**
  - When Delta increased & mask guidance changed
  - Not ~1 month offset, consistent with waning

  - Drop-off ceased when Delta reached >90%, followed by revised mask guidance

- Gradient by time-cohort in August, supportive of waning, but lesser magnitude than earlier drop

Pfizer-BioNTech, 50-64 years
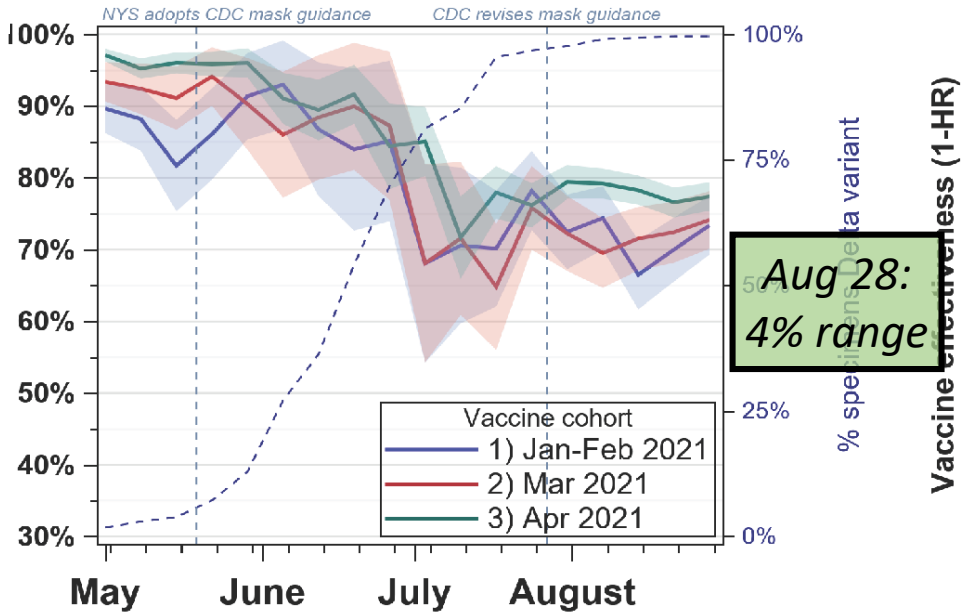
May 1
− 24%
July 10
+5%
Aug 28
Net: -19%

Aug 28: 4% range

Moderna, 50-64 years
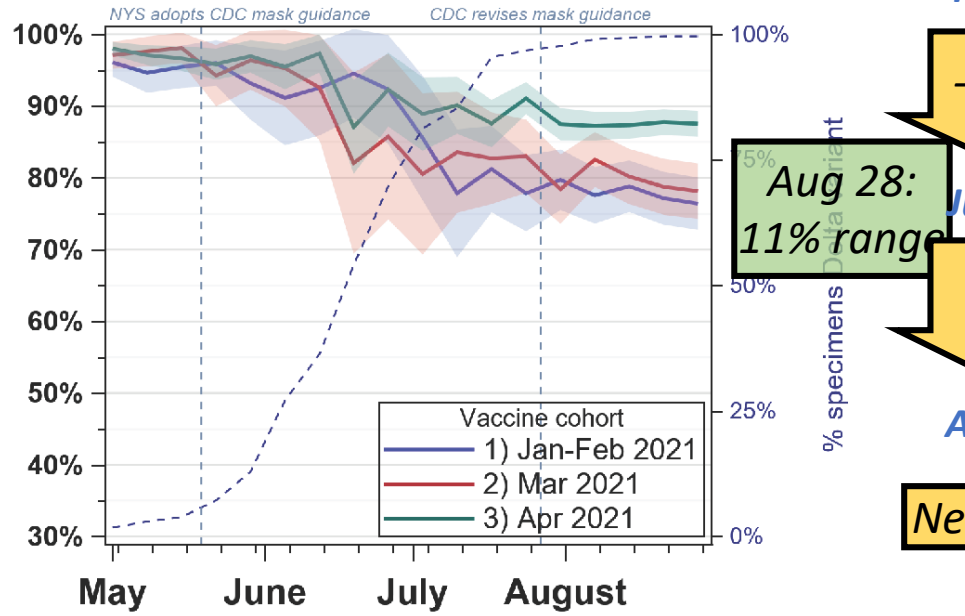
May 1
− 12%
July 10
− 3%
Aug 28
Net: -14%

Aug 28: 11% range
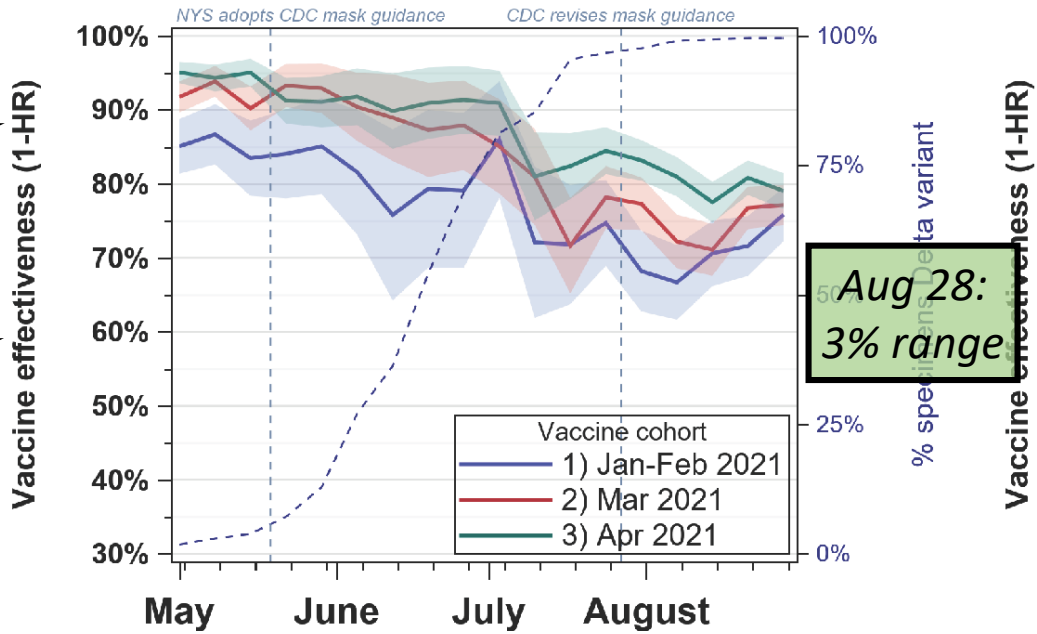
Janssen, 50-64 years
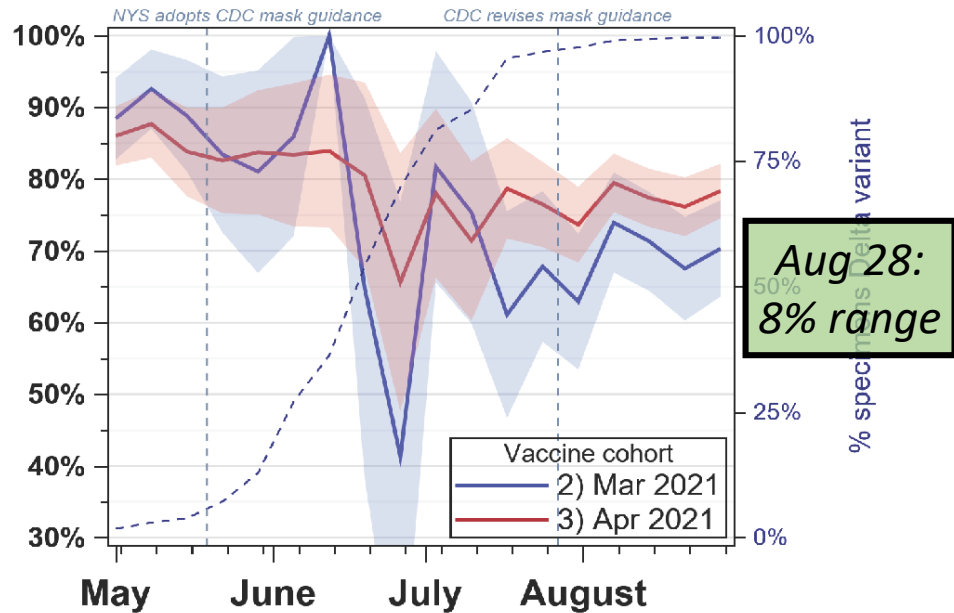
May 1
− 14%
July 10
+3%
Aug 28
Net: -11%

Aug 28: 8% range

- **Similar patterns observed for persons 50-64 years as for 18-49 years**

Pfizer-BioNTech, >=65 years
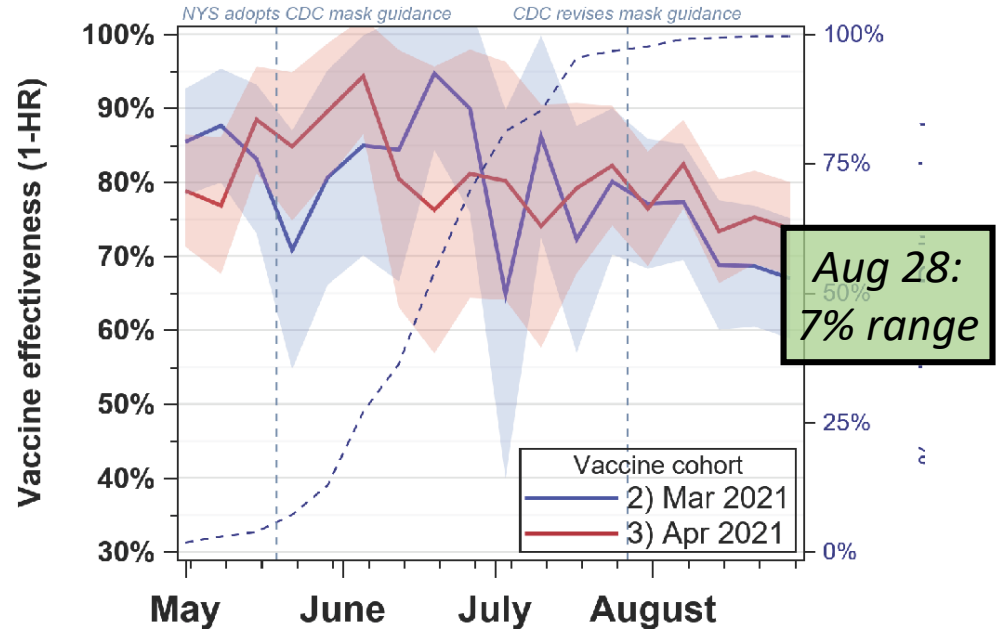
May 1

– 13%

July 10

– 1%

Aug 28

Net: -14%

Aug 28:
3% range

Moderna, >=65 years

May 1

– 9%
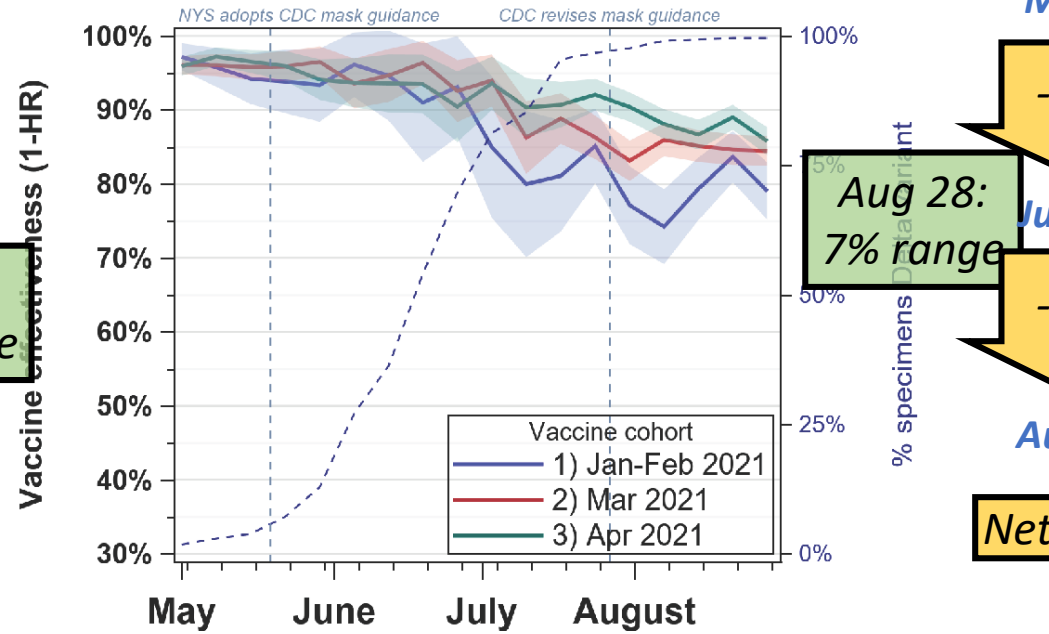
July 10

Aug 28:
7% range

– 3%

Aug 28

Net: -12%

Janssen, >=65 years

May 1

– 2%

July 10

– 8%

Aug 28

Net: - 11%

Aug 28:
7% range
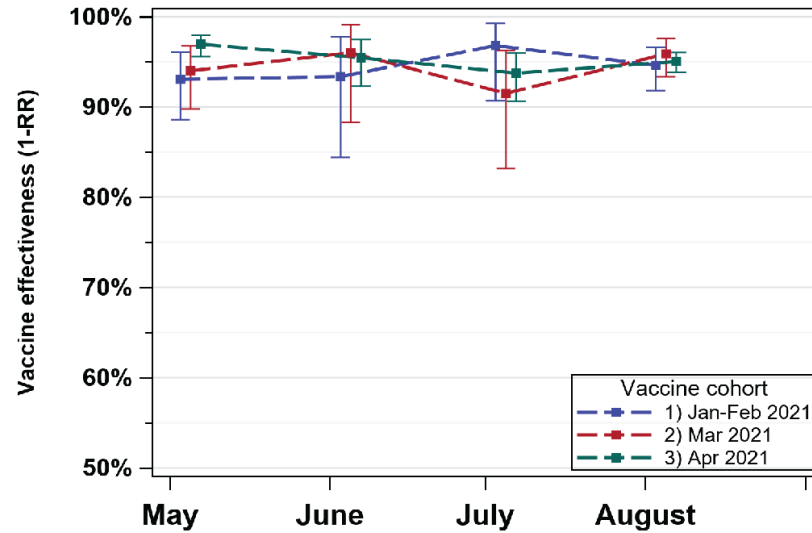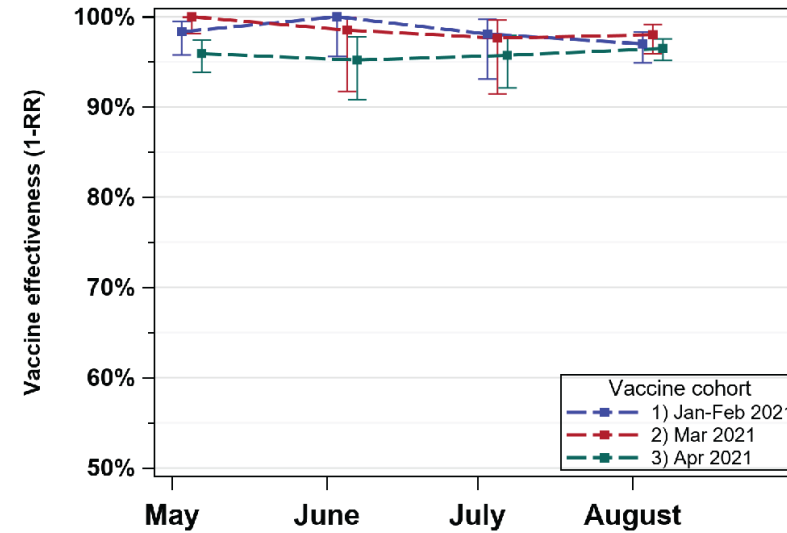
Hospitalizations: VE
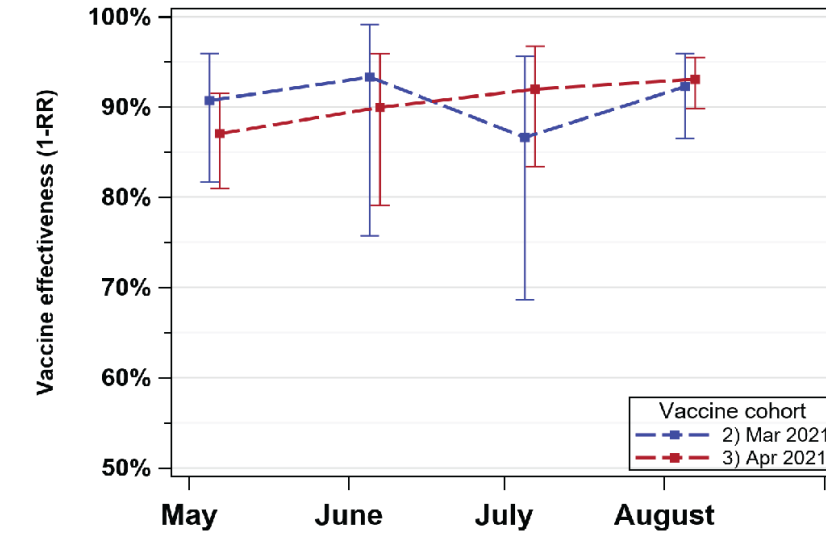
- **Pfizer-BioNTech, Moderna**: >90% hospitalization VE each month, age, and time-cohort, but one (87%)
- **Janssen**: >86% for every month, age, and time-cohort, but one (54%)

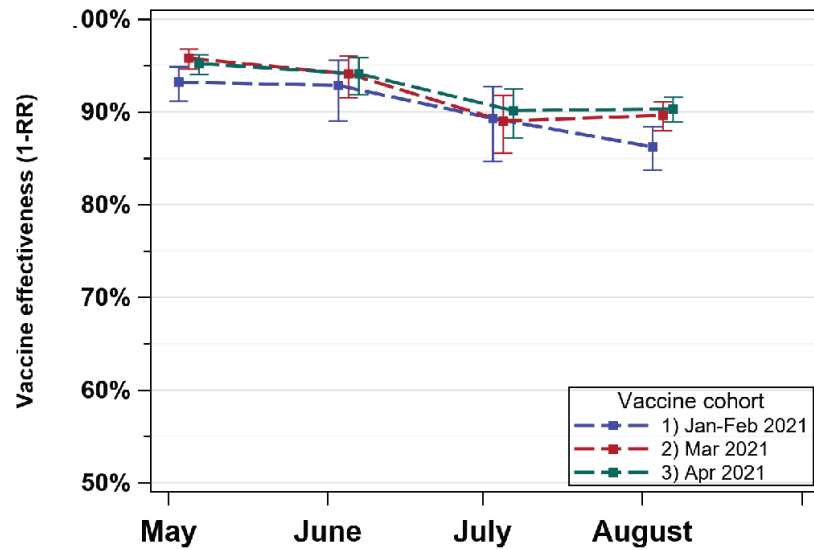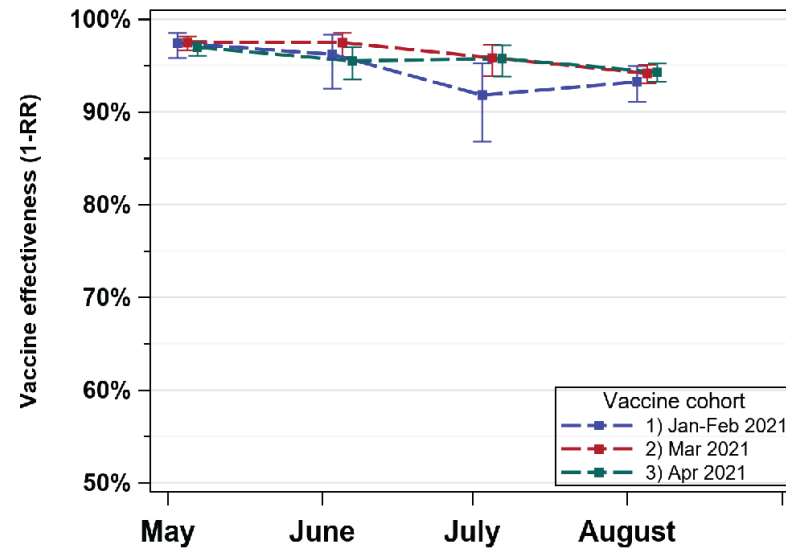**Pfizer-BioNTech, >=65 years** — Moderna, >=65 years — Janssen, >=65 years

Vaccine effectiveness (1-RR) plots from May to August 2021 for three vaccine cohorts: 1) Jan-Feb 2021, 2) Mar 2021, 3) Apr 2021.
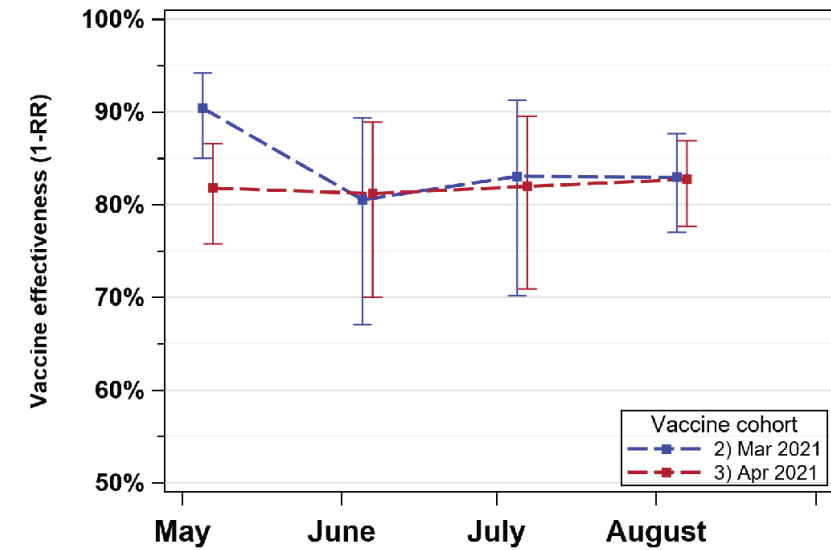
- **Pfizer-BioNTech**
  - May to August hospitalization VE declines 5-7%; August VE >86%
  - Greatest declines for January-February cohort. Group enriched for long-term care residents.
- **Moderna**
  - May to August VE declines 2-4%; August VE >93%
- **Janssen**
  - Little time trend. VE range 81-90%

Conclusions

Cases

- Declines in VE observed across product, age, timing-cohort
  - Slowed in August when Delta reached >85%, guidance changed
  - May be more linked to Delta increase, behavioral, or other changes than time-since-vaccination

Hospitalizations

- 18-49, 50-64 years: consistently high VE across age & products
- For ≥65 years
  - Modest declines evident for both Pfizer and Moderna
  - Lowest VE for Janssen, but no decline

Sensitivity analyses, remaining limitations, strengths

Sensitivity analyses: VE estimates re-estimated for scenarios addressing
- Uncertainty in population census
- Restriction of hospitalization to "for COVID-19"
- Other scenarios for denominator uncertainty

Limitations remain
- Unmeasured confounding due to behavioral, medical, exposure, testing differences between groups
- Ongoing work demonstrating potential impact
- Potential for indirect effects

Strengths to consider
- Very large population → finer view of time, analyses with fewer assumptions
- Consistency of temporal patterns across subgroups and sensitivity analyses
- Although early prioritization by age/setting/occupation/comorbidities, broad expansion of eligibility in early months studied

New York's Population Curveball

Census Bureau estimates had New York losing population since the middle of the decade, but the official 2020 Census count showed modest growth and a population that surpassed 20 million.

2020 Census

20m

Annual Estimates

19m

2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020
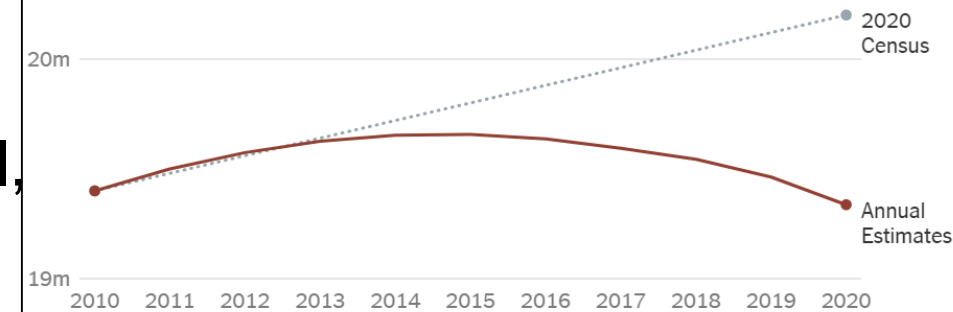
Source: U.S. Census Bureau • By The New York Times

Thank you!

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With much thanks to co-authors

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Delia Easton	Dina Hoefer	Danielle Greene
Ursula Bauer	Meng Wu	Howard Zucker
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