COVID-19 Vaccine Effectiveness in the United States

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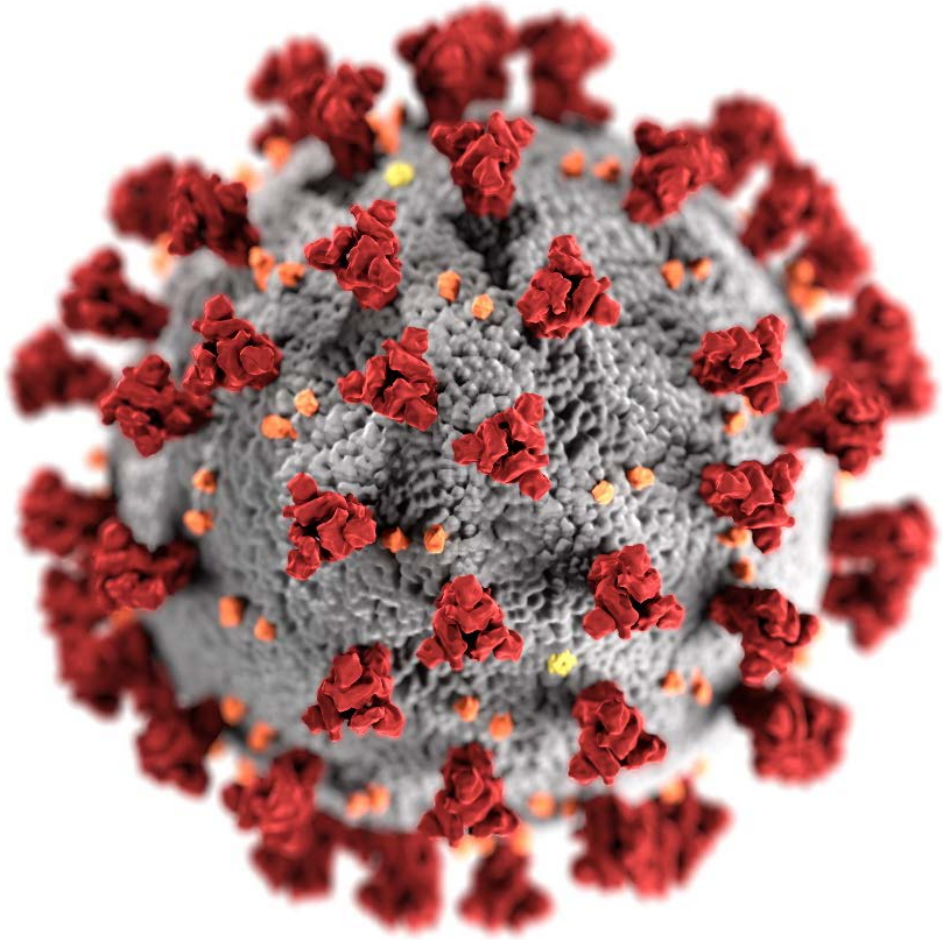
CDC COVID-19 Response
LCDR, US Public Health Service

ACIP Meeting
September 22, 2021



cdc.gov/coronavirus

Monitoring vaccine effectiveness (VE) evidence by risk group, outcome, and product over time

By time since vaccination *and/or* pre-/post-Delta

Risk group X **Outcome** X **Product**

Desired, but often limited by sample size

Increasing Community Access to Testing (ICATT) Partnership

Waning of immunity by Delta predominance in the general population

Increasing Community Access to Testing (ICATT) Partnership: VE analysis for symptomatic infection, March 13–August 31, 2021

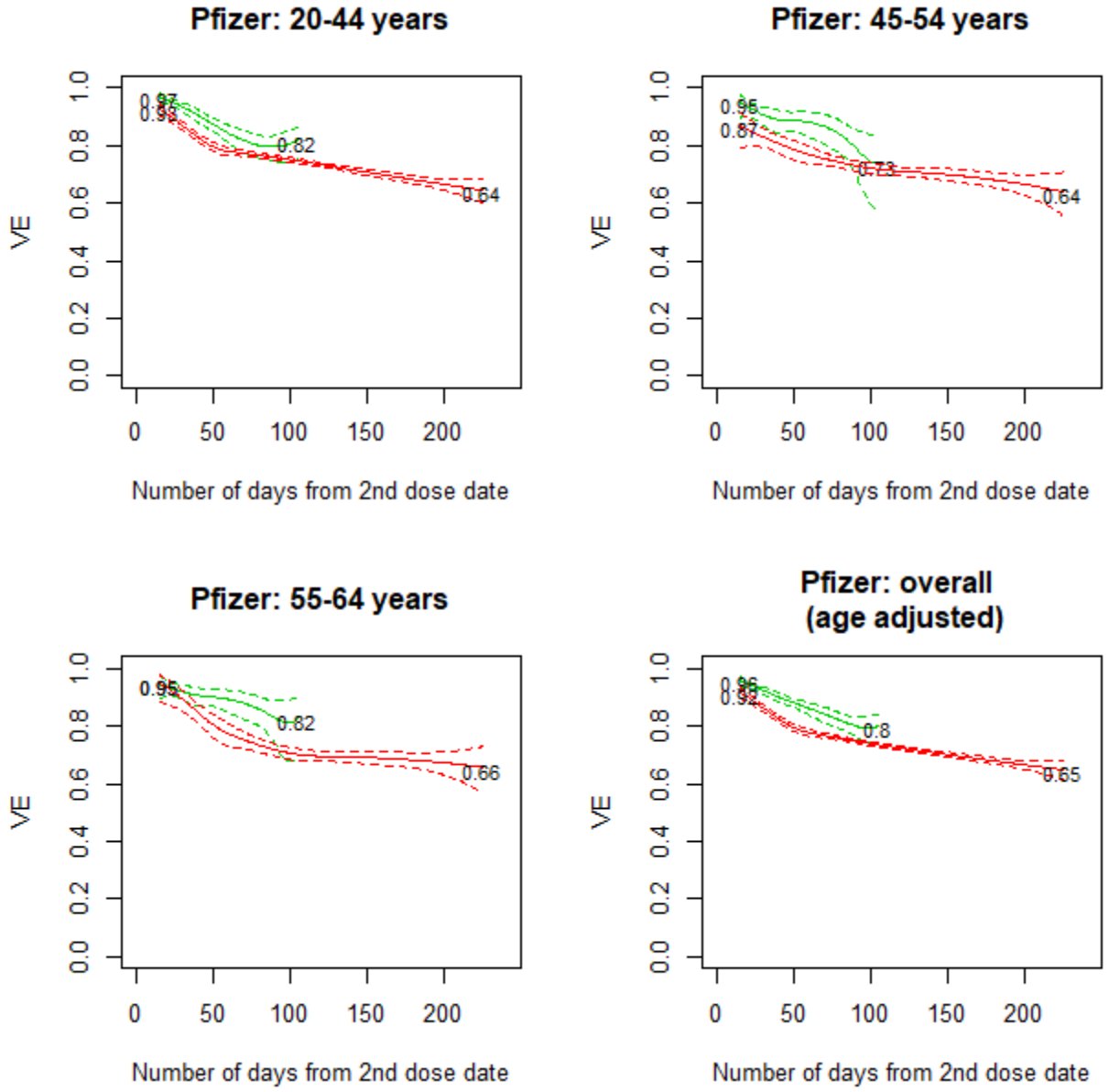
- Nationwide community-based COVID-19 testing via pharmacies and partners
- Self-reported vaccine history at time of registration for COVID-19 testing; excluded those who did not report vaccination status (18%)
- **Design**: Test-negative, case-control assessment
- **Period**: Pre-Delta: March 13–May 29 (N=255,519); Delta: July 18–August 31 (N=519,699)
- **Population**: Persons aged 20–64 years of age with COVID-like illness (CLI) and laboratory-based nucleic acid amplification testing (NAAT)
- **Adjusted for**:
  - Calendar day, race, ethnicity, gender, site's HHS region and state, site census tract's social vulnerability index (SVI)
  - **Not** adjusted for underlying conditions or prior infection

Pfizer-BioNTech VE against symptomatic infection by age group and time since vaccination in pre-Delta vs Delta periods

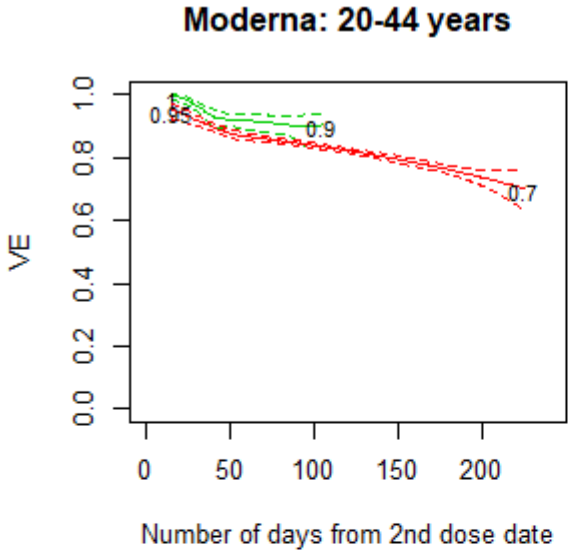
- Significant waning of VE in both time periods
- VE is lower during Delta period at all time points
- Curves look similar across age groups

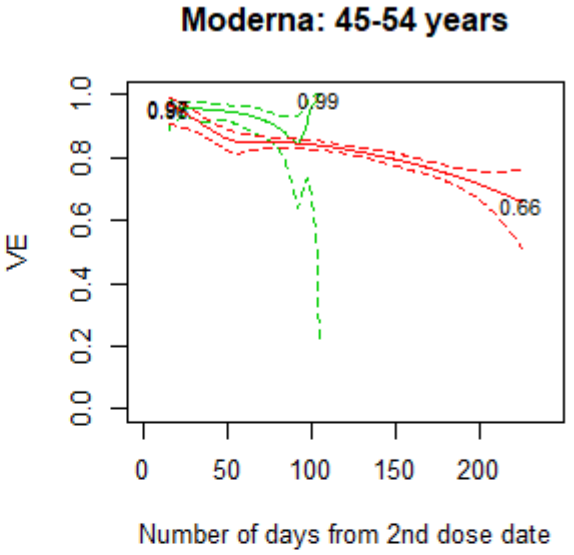
Pre-Delta (March 13–May 29) with 95% CIs in dotted lines

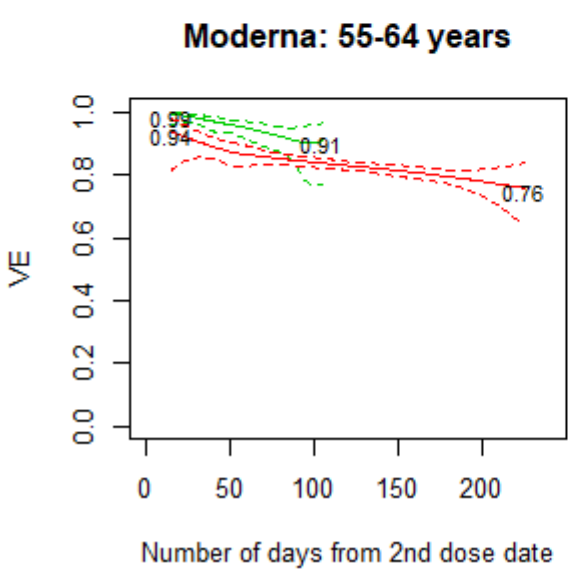
Delta (July 18–August 31) with 95% CIs in dotted lines

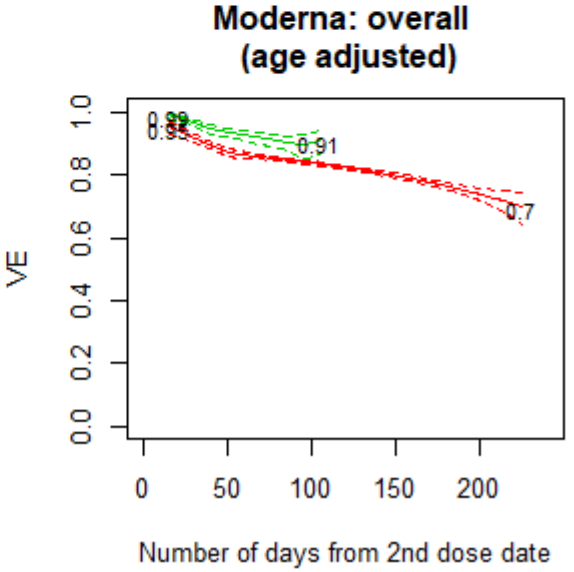


Moderna VE against symptomatic infection by age group and time since vaccination in pre-Delta and Delta periods









- Moderna VE is higher than Pfizer-BioNTech
- VE wanes during Delta
- Curves look similar across age groups

Pre-Delta (March 13–May 29) with 95% CIs in dotted lines

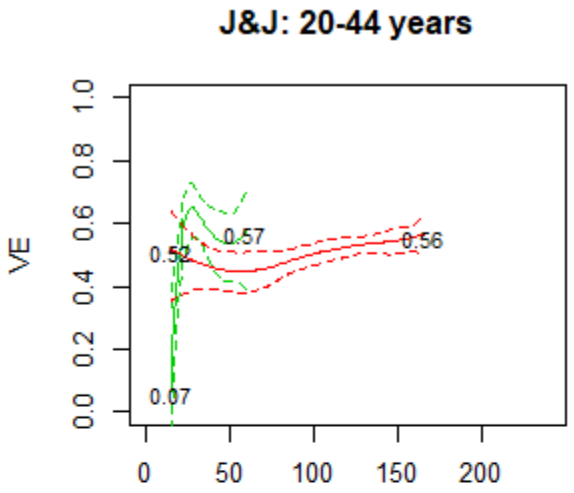
Delta (July 18–August 31) with 95% CIs in dotted lines

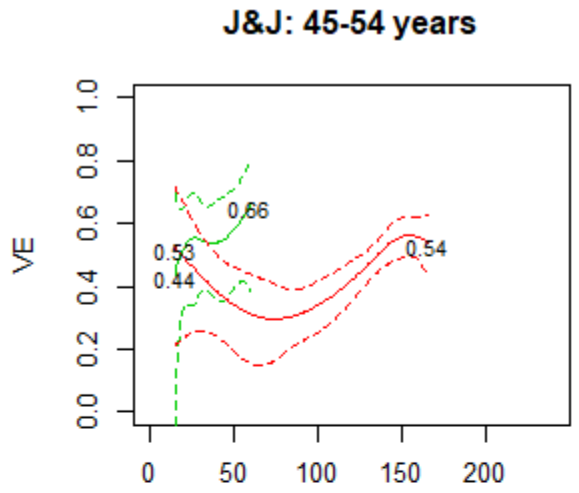
Johnson & Johnson (J&J, Janssen) VE against symptomatic infection by age group and time since vaccination in pre-Delta and Delta periods

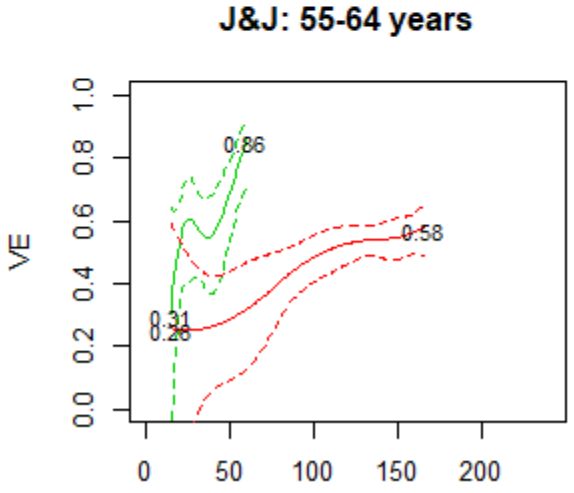
- VE increases with time in both periods
- No clear Delta effect on VE
- Curves look similar across age groups

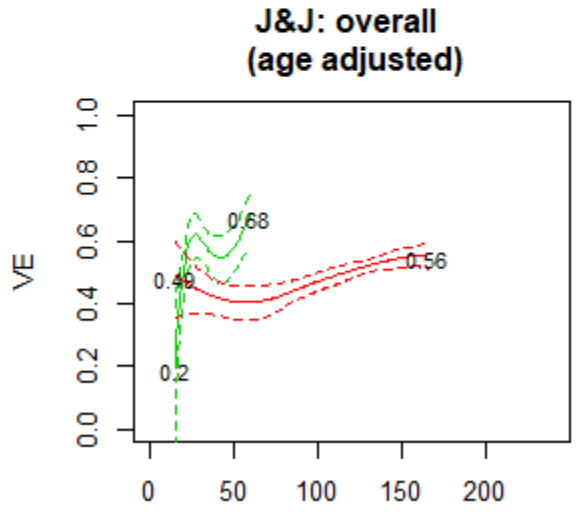
Pre-Delta (March 13–May 29) with 95% CIs in dotted lines

Delta (July 18–August 31) with 95% CIs in dotted lines









ICATT limitations for VE against symptomatic infection

- Self-reported vaccination data, no clinical assessment
  - By limiting to persons with known vaccination status, a substantial proportion of records were lost, possibly introducing bias
- No information on co-morbidities, prior infection, risk behaviors
- Analysis based on tests, no unique identifiers to track individuals in data
- No genetic sequencing results
  - Pre-Delta: March 13–May 29
  - Delta: July 18–August 31

Vaccine effectiveness in individuals ≥65 years of age, including residents of long-term care facilities

COVID-19-Associated Hospitalization Surveillance Network (COVID-NET)

- **Population-based** surveillance **for laboratory-confirmed** COVID-19-associated **hospitalizations**
- Defined catchment area: >250 acute care hospitals in 99 counties in 14 states, representing 10% of U.S. population
- **Case definition**: Resident of the surveillance area and positive SARS-CoV-2 test within 14 days prior to or during hospitalization
- **VE estimates:** variation of **screening method**
  - Immunization information systems (ISS)
  - Representative sample of hospitalized cases (>37,000 to date)
  - Underlying population in catchment area by week

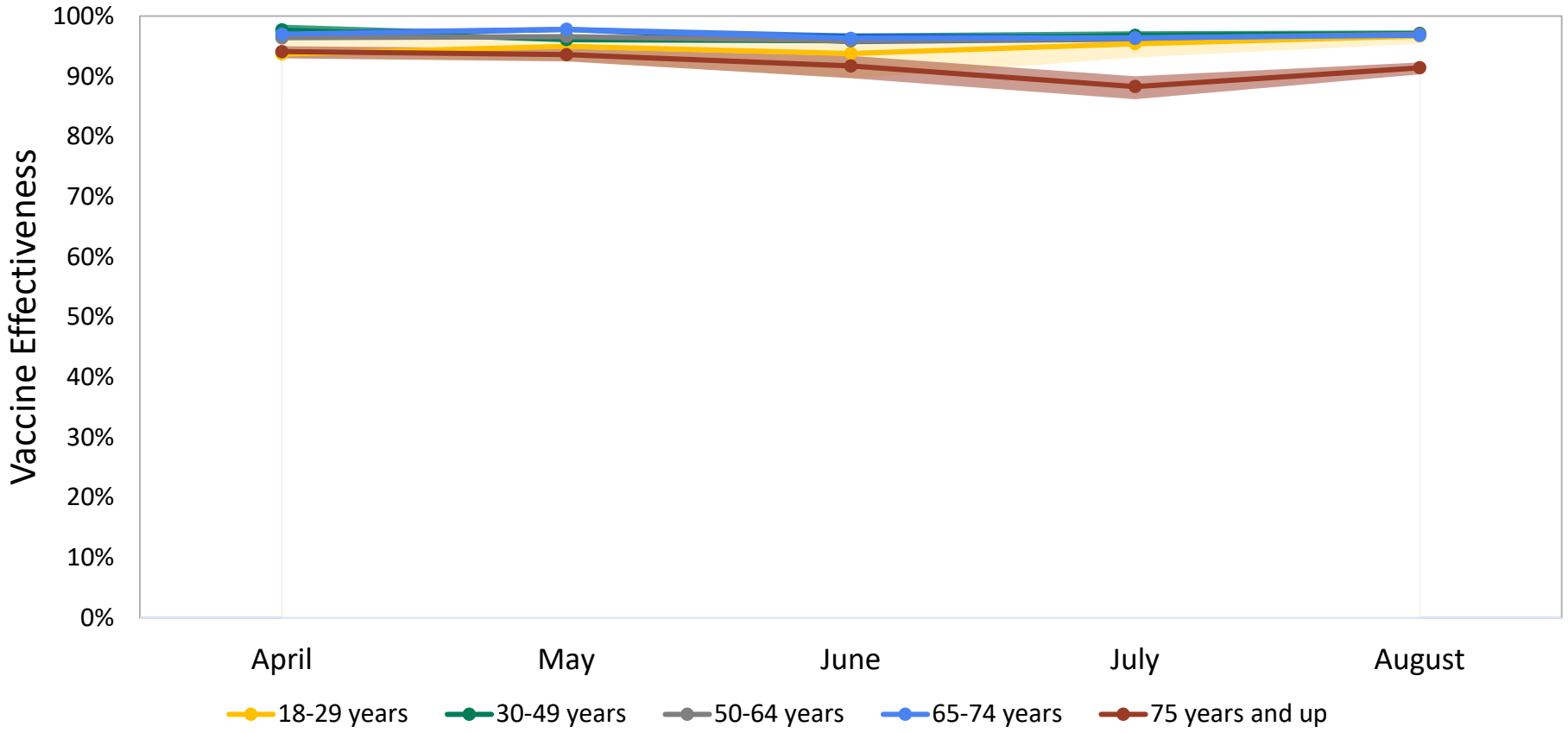
Represents ~10% of U.S. population (32 million people)

- VE estimates adjusted for time, but cannot adjust for other important potential confounders (e.g., comorbidities, prior infection)

*Vaccine effectiveness calculated using previously described methods: Moline et al. Effectiveness of COVID-19 Vaccines in Preventing Hospitalization Among Adults Aged ≥65 Years — COVID-NET, 13 States, February–April 2021. MMWR, August 13, 2021

‡California, Colorado, Connecticut, Georgia, Maryland, Michigan, Minnesota, New Mexico, New York, Ohio, Oregon, Tennessee, and Utah are included in these analyses

COVID-NET vaccine effectiveness against hospitalization, by month and age group, mRNA vaccines



No significant differences in VE by age group or calendar month of hospitalization

Among **fully vaccinated** patients, defined as receipt of both doses of Moderna or Pfizer-BioNTech vaccine, with second dose received ≥14 days before hospitalization

Source: Unpublished COVID-NET data, 2021

COVID-19-associated hospitalizations among vaccinated adults ≥18 years with COVID-19 as primary reason for admission — COVID-NET, January 1–July 31, 2021

- Fully vaccinated cases more likely to be:
  - Older
  - Long-term care facility resident
  - DNR/DNI code
- More underlying medical conditions

Category	Unvaccinated weighted % N=5,513	Fully vaccinated weighted % N=465
Age group (median, IQR)	59 (47–71)	72 (62–80)
18–49 years	28	11
50–64 years	33	16
≥65 years	40	72
LTCF residence	5	13
DNR/DNI/CMO	6	16
Underlying medical conditions		
Cardiovascular disease	34	50
Neurologic disease	17	28
Renal disease	16	29
Immunosuppressive condition	12	29
Rheumatologic or autoimmune	3	7
Blood disorder	3	4
≥3 Underlying medical conditions	55	66

* All characteristics were significantly different on univariate analysis

VE against infection and hospitalization: Data from NY State, May–July 2021

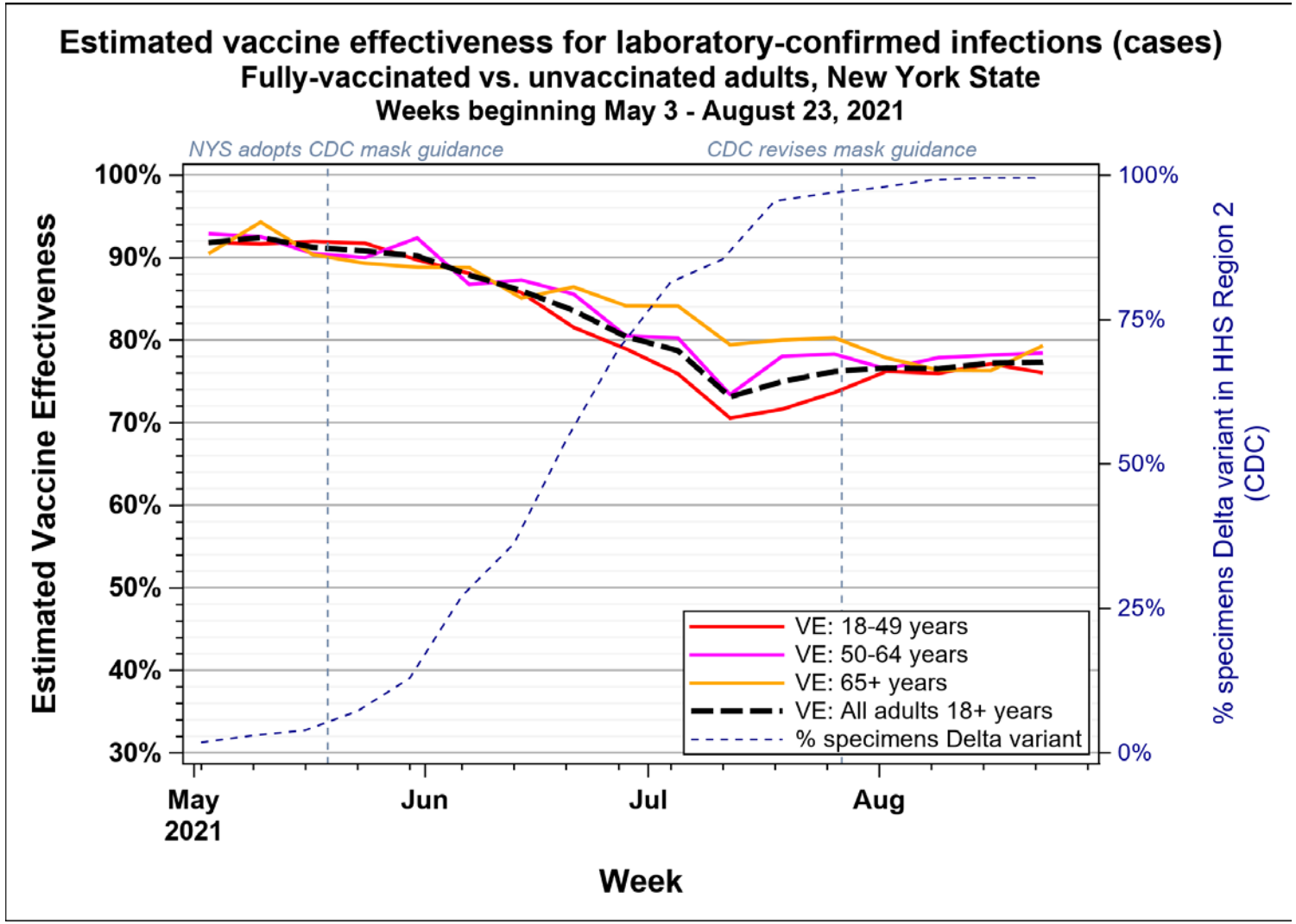
- NY State linked lab, immunization, and hospitalization data to estimate VE from May 3–August 29, 2021
  - 147,937 new diagnoses among fully vaccinated and unvaccinated persons
  - 16,261 new hospitalizations among fully vaccinated and unvaccinated persons

- Breakdown by vaccine:
  - Pfizer-BioNTech: 52%
  - Moderna: 39%
  - Johnson & Johnson/Janssen: 9%

- Delta proportion: <2% (May 2–8) to >99% (August 22–28) (CDC NS3, HHS Reg. 2)

Update of published study: https://www.cdc.gov/mmwr/volumes/70/wr/mm7034e1.htm

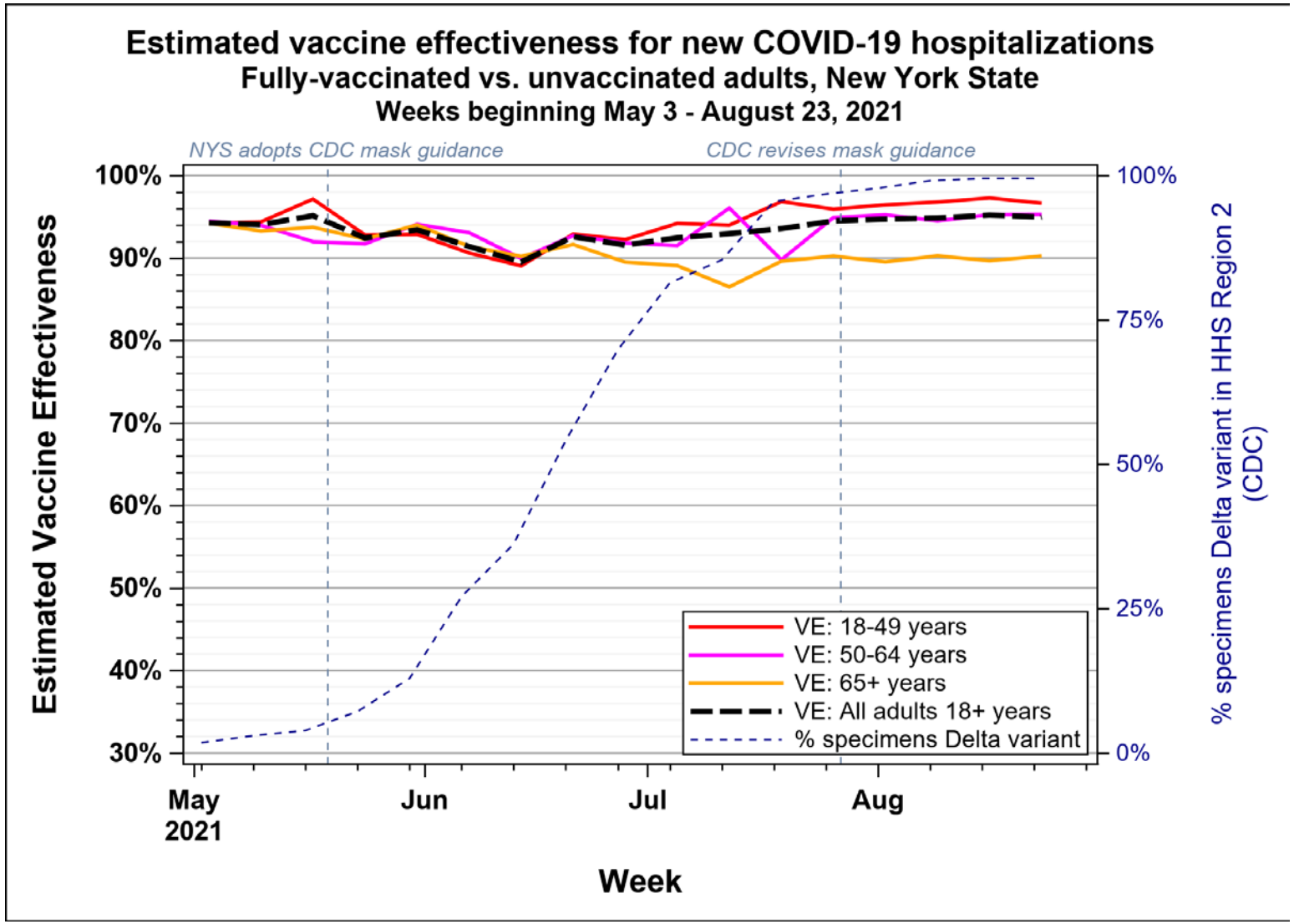
VE against infection: Data from NY State, May–August 2021



Age-adjusted VE against new COVID-19 infections declined from 92% (May 3–9) to 73% (July 12–18), when Delta reached 85%. Then, decline ceased, with plateau around 77%.

Update of published study: https://www.cdc.gov/mmwr/volumes/70/wr/mm7034e1.htm

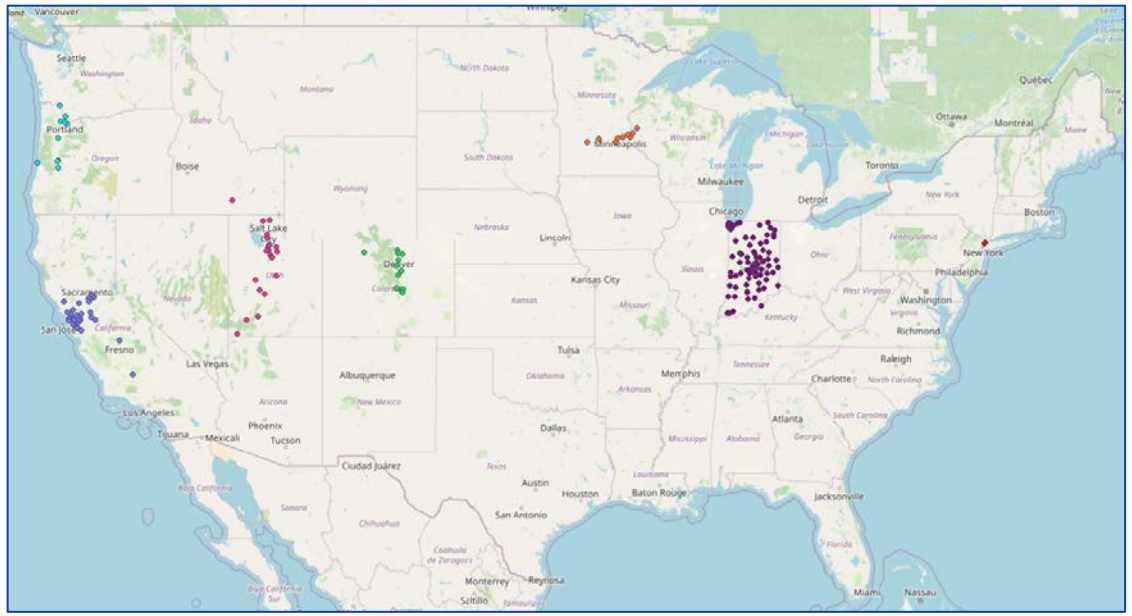
VE against hospitalization: Data from NY State, May-August 2021



Age-adjusted VE against new COVID-19 hospitalizations remained stable at 90%–95%.

Update of published study: https://www.cdc.gov/mmwr/volumes/70/wr/mm7034e1.htm

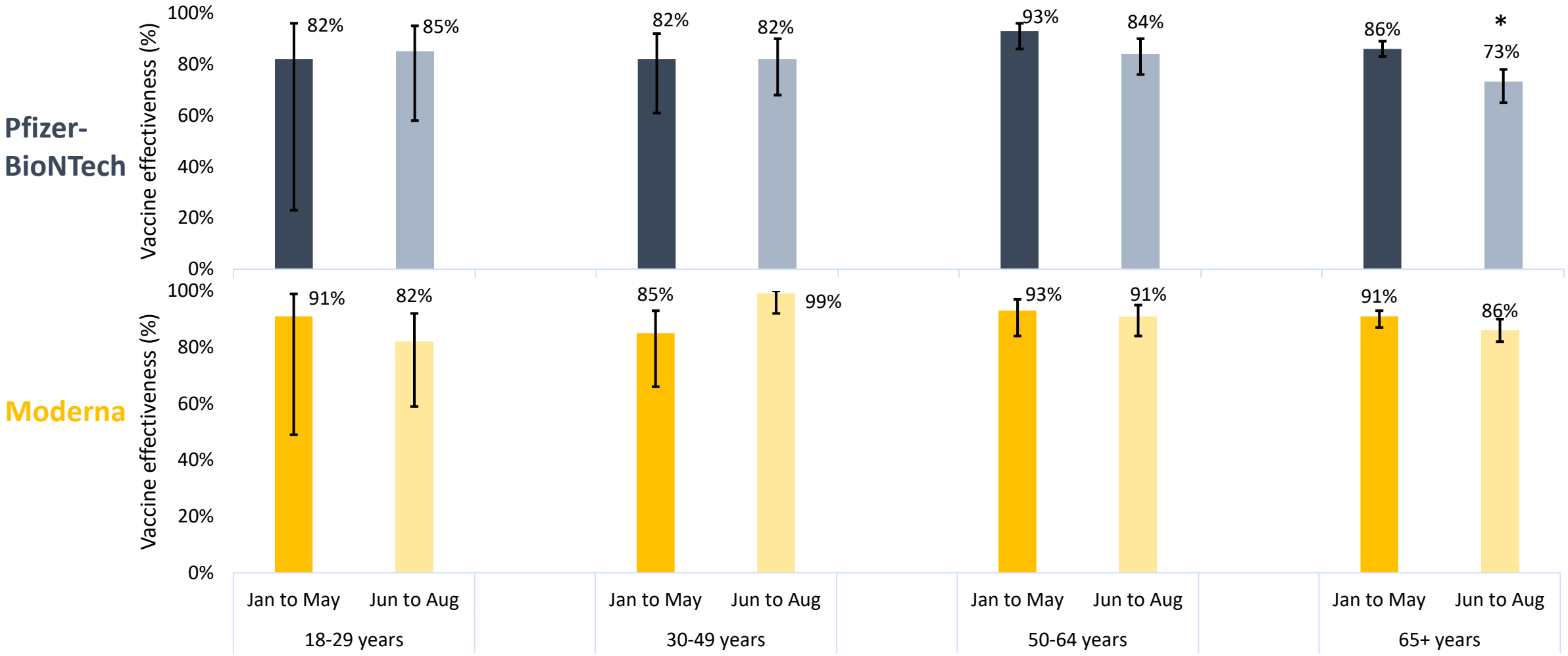
VISION Multi-State Network of Electronic Health Records for VE against hospitalization



Estimates are from over 74,000 hospitalizations across 187 hospitals

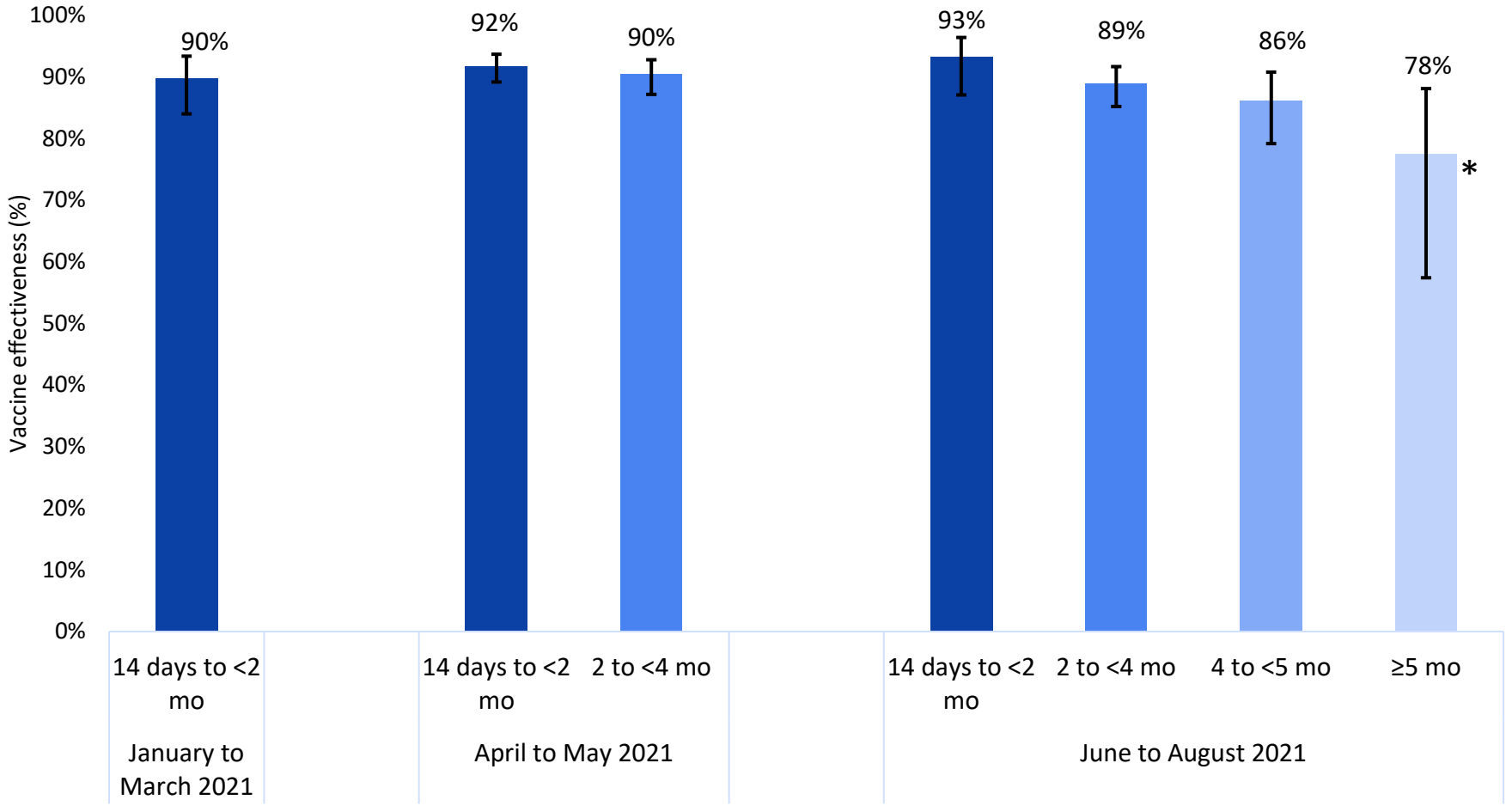
- VE for adults aged ≥18 years
- **Cases**: COVID-like illness (CLI) with positive PCR for SARS-CoV-2
- **Controls**: CLI with negative PCR for SARS-CoV-2
- VE adjusted for propensity to be vaccinated, calendar time, site-region, local virus circulation, and age
  - Waning VE models are matched on calendar week and site and restricted to six of seven VISION sites
- Vaccination documented by electronic health records and state and city registries
- Median age of cases: 65 years (IQR 48-77)

VISION Network: VE against hospitalization by time period and age group, Pfizer-BioNTech and Moderna



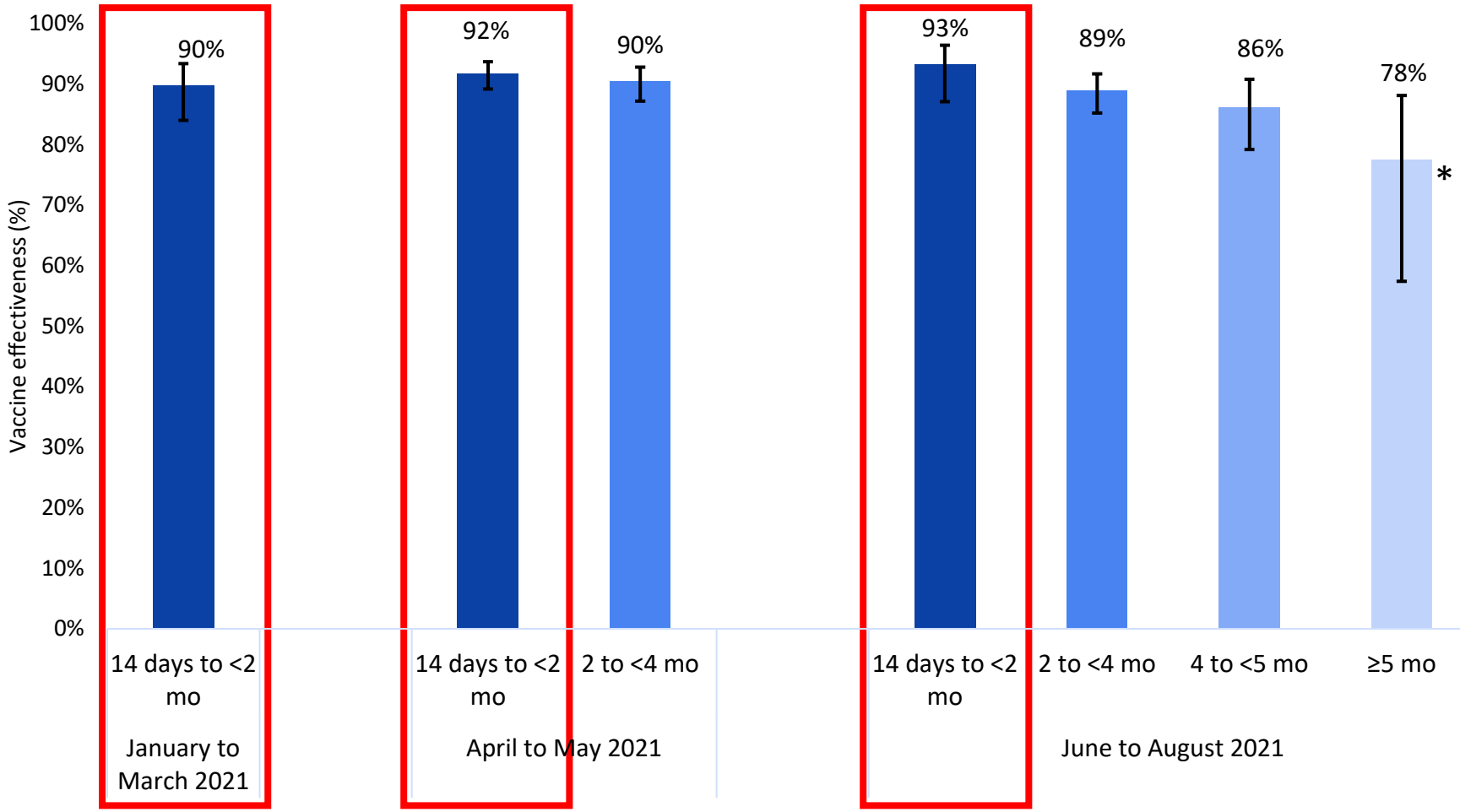
* p<0.05

VISION Network: Preliminary VE against hospitalization by time since vaccination in each calendar period, adults ≥18 years, mRNA products



* p<0.05 for trend

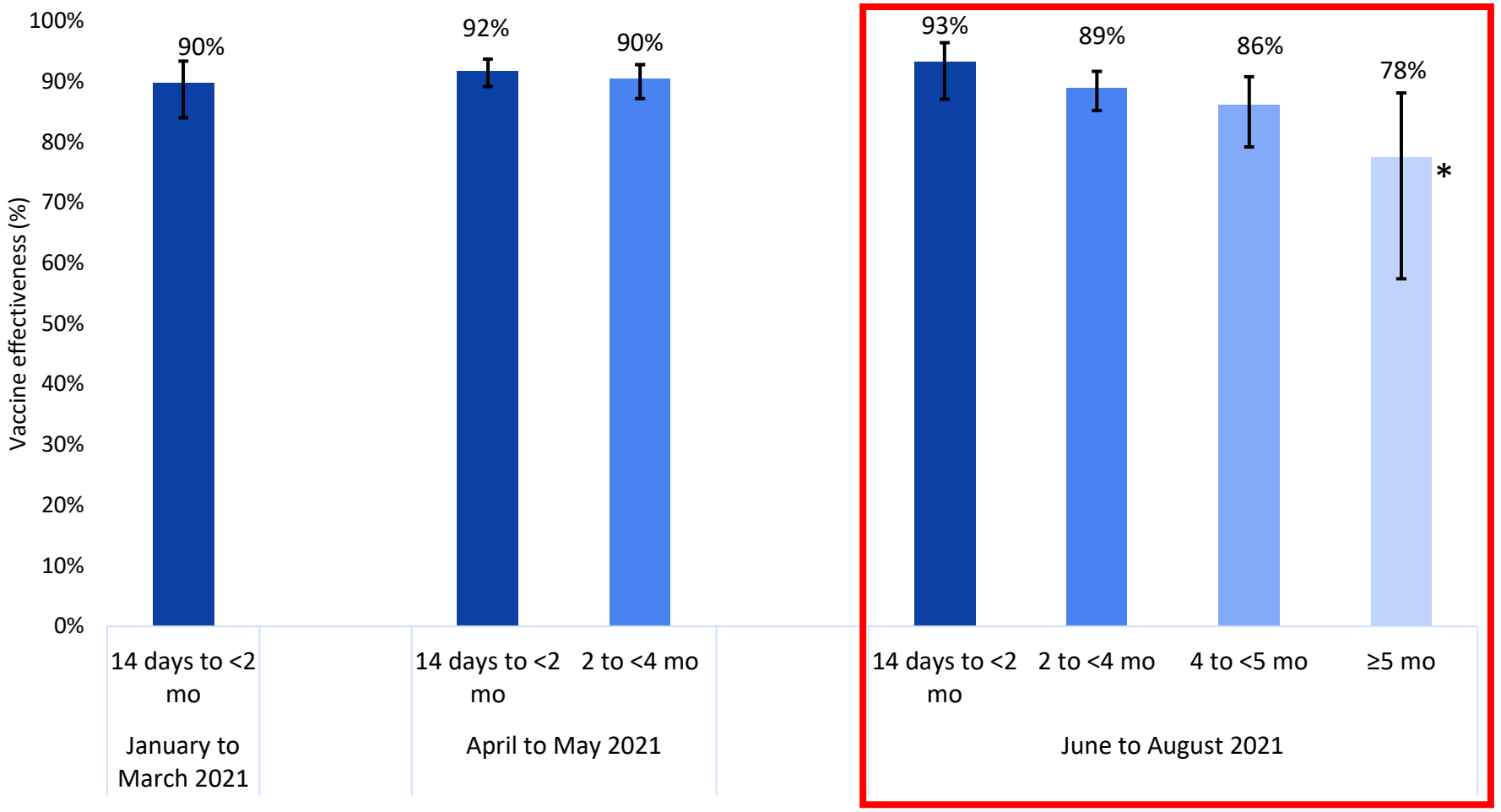
VISION Network: Preliminary VE against hospitalization by time since vaccination in each calendar period, adults ≥18 years, mRNA products



Among people recently vaccinated (<2 months), VE against hospitalization has remained high. VE has declined among those who have been vaccinated for longer periods of time.

* p<0.05 for trend

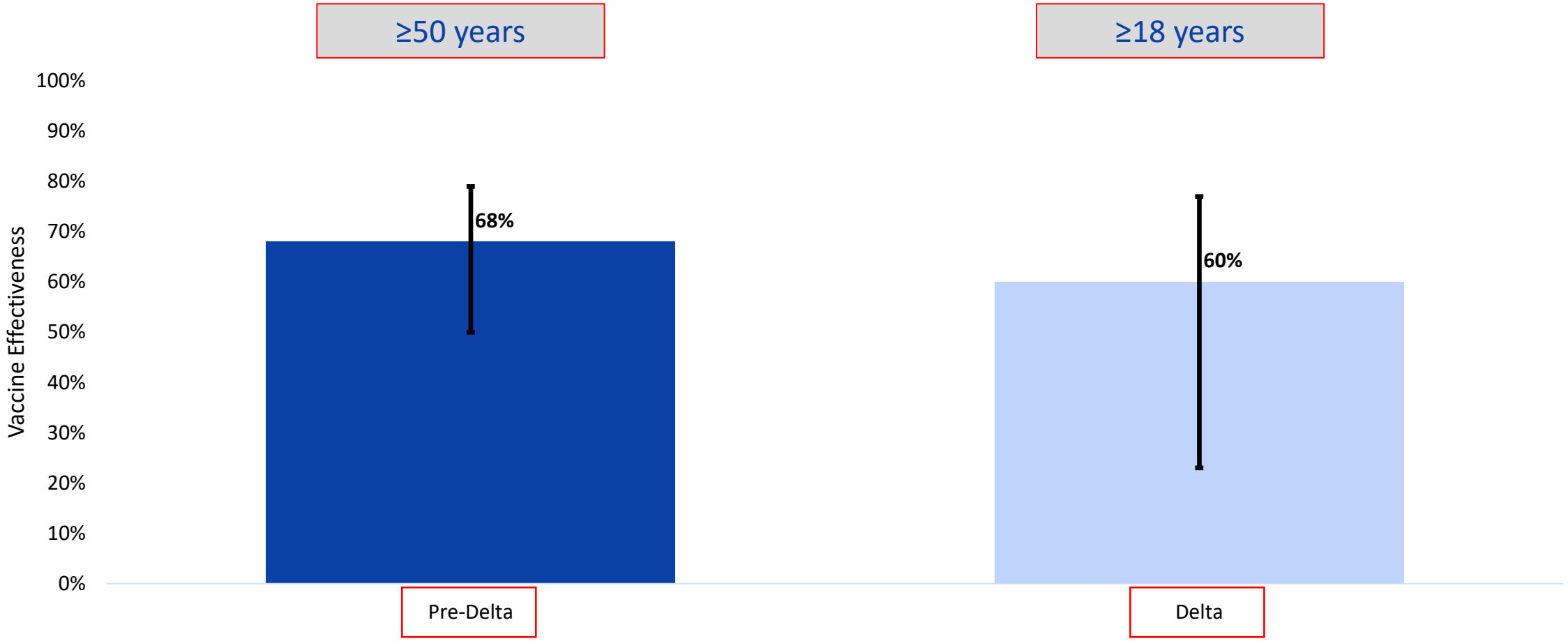
VISION Network: Preliminary VE against hospitalization by time since vaccination in each calendar period, adults ≥18 years, mRNA products



Among people recently vaccinated (<2 months), VE against hospitalization has remained high. VE has declined among those who have been vaccinated for longer periods of time.

* p<0.05 for trend

VISION Network: VE against hospitalization by time period and age group, *Johnson & Johnson/Janssen*



https://www.nejm.org/doi/full/10.1056/NEJMoa2110362
https://www.cdc.gov/mmwr/volumes/70/wr/mm7037e2.htm

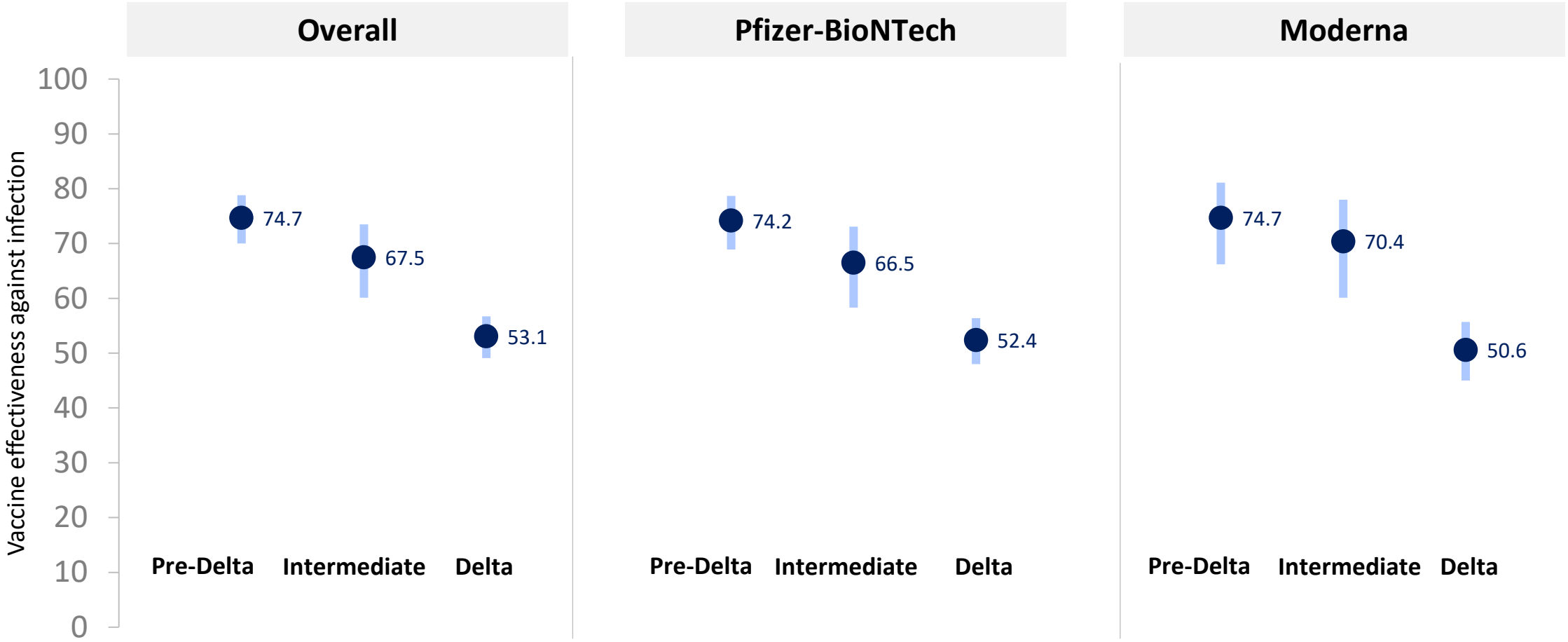
VE of mRNA vaccines against infection among nursing home residents before and during widespread Delta circulation

- Data from National Healthcare Safety Network (NHSN)
- Nursing homes report weekly aggregate number of residents and cases by vaccination status (product and number of doses received) to NHSN
- VE estimated for three periods:
  1) Pre-Delta (March 1–May 9)
  2) Intermediate (May 10–June 20)
  3) Delta (June 21–August 1)

	Pre-Delta (Mar 1–May 9)	Intermediate (May 10–Jun 20)	Delta (Jun 20–Aug 1)
No. of weekly reports	17,407	33,160	85,593
No. of facilities	3,862	11,581	14,917

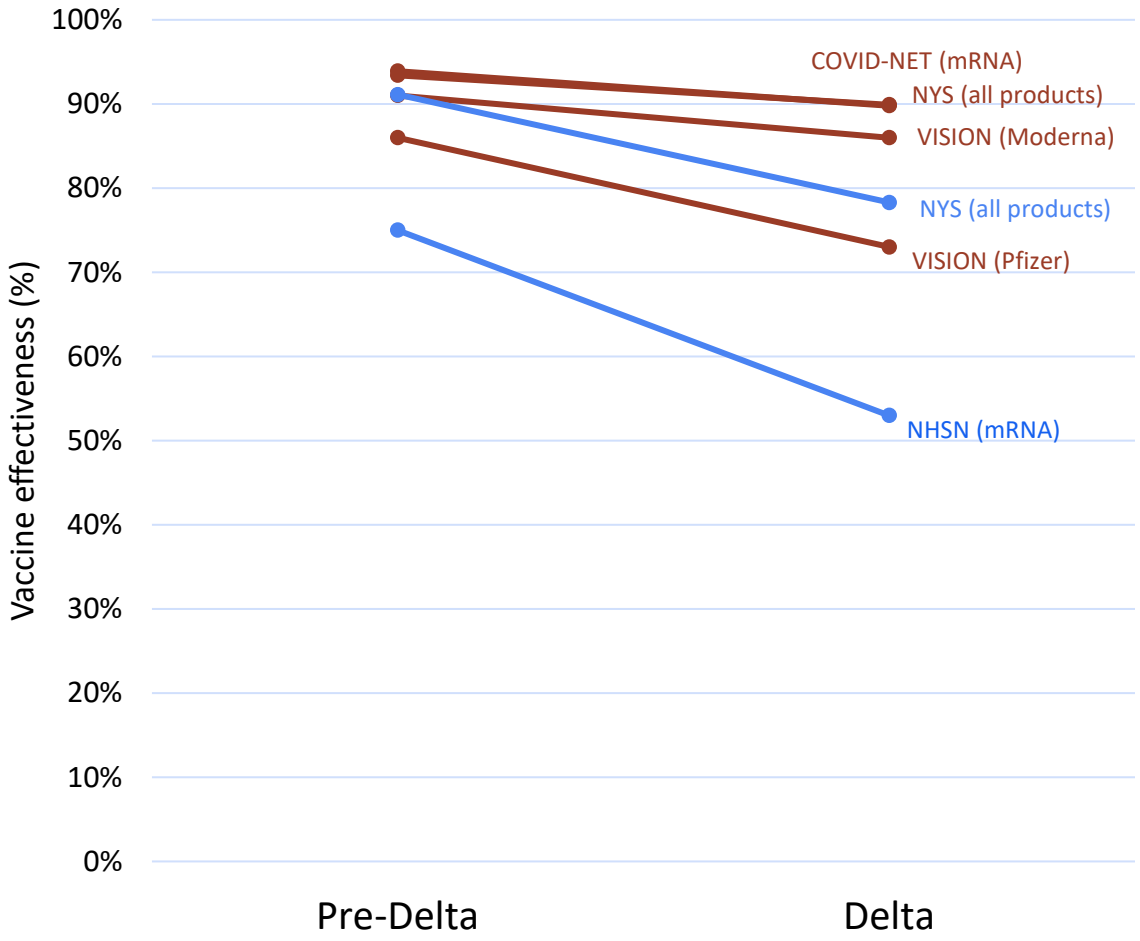
Nanduri et al. *MMWR*: https://www.cdc.gov/mmwr/volumes/70/wr/mm7034e2.htm

NHSN: VE against infection during Delta period differed significantly from pre-Delta period



Adapted from: Nanduri S. Effectiveness of Pfizer-BioNTech and Moderna Vaccines in Preventing SARS-CoV-2 Infection Among Nursing Home Residents Before and During Widespread Circulation of the SARS-CoV-2 B.1.617.2 (Delta) Variant — National Healthcare Safety Network, March 1–August 1, 2021. MMWR Morbidity and Mortality Weekly Report. 2021 2021;70. Slide courtesy of Ian Plumb.

Magnitude of VE against infection or hospitalization by Delta predominance for adults ≥65 years of age, by study



- Decline of 15–25 percentage points for point estimates against infection
- Hospitalization data mixed
  - Larger decline for Pfizer-BioNTech (VISION)
  - Smaller declines for combined mRNA products and Moderna alone

NHSN: https://www.cdc.gov/mmwr/volumes/70/wr/mm7034e3.htm
COVID-NET: CDC unpublished VISION: CDC unpublished

Vaccine effectiveness for adults with underlying medical conditions

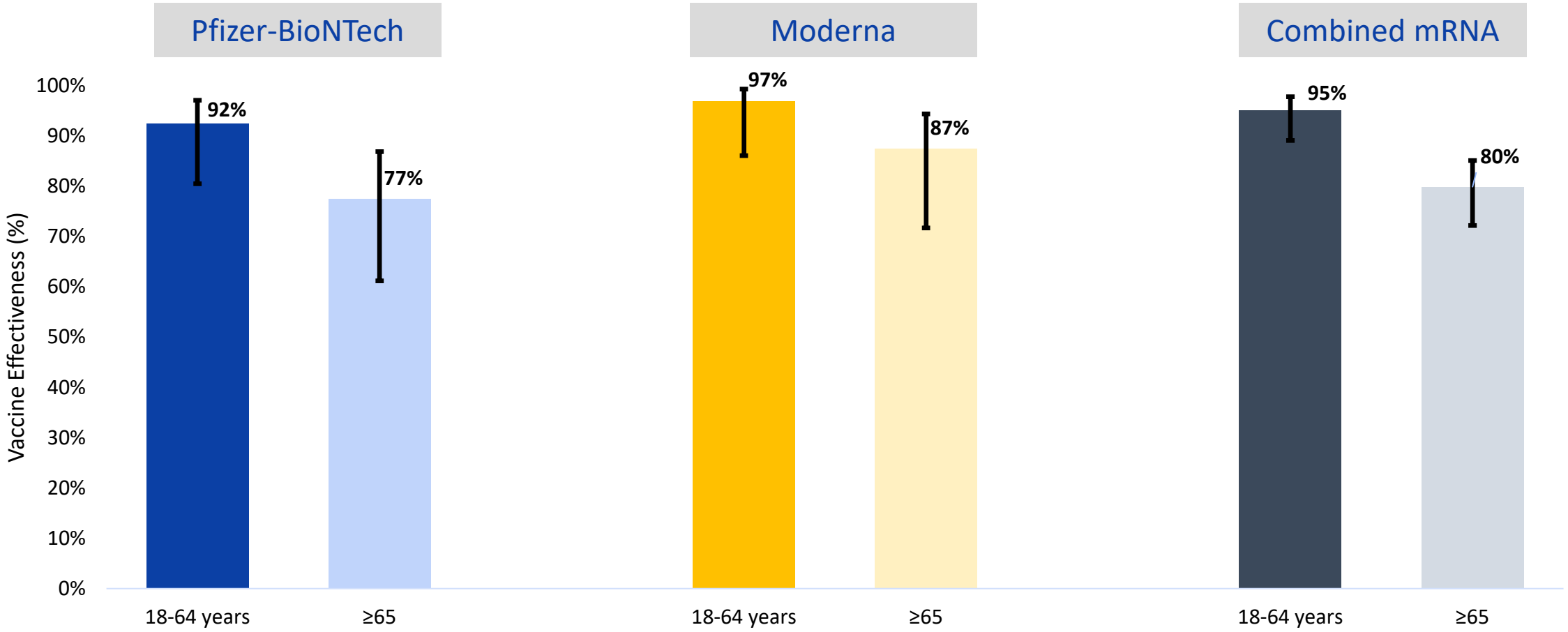
Vaccine effectiveness of mRNA vaccines against COVID-19-associated hospitalization: SUPERNOVA Network

- **Design**: Test-negative, case-control assessment
- **Period**: February 1–August 6, 2021
- **Population**: U.S. Veterans (aged ≥18 years) hospitalized at 5 Veterans Administration Medical Centers
- **Participants**
  - Cases: COVID-like illness (CLI) and SARS-CoV-2-positive test results by RT-PCR
  - Controls: CLI and SARS-CoV-2-negative test results by RT-PCR
- **Demographics:**
  - Median age: 68 years
  - 49% Black, non-Hispanic
  - 44% with Charlson Comorbidity Index score ≥3
    - 70% hypertension; 47% obesity; 43% diabetes

SUrveillance **P**latform for **E**nteric and **R**espiratory i**N**fectious **O**rganisms at the **VA**

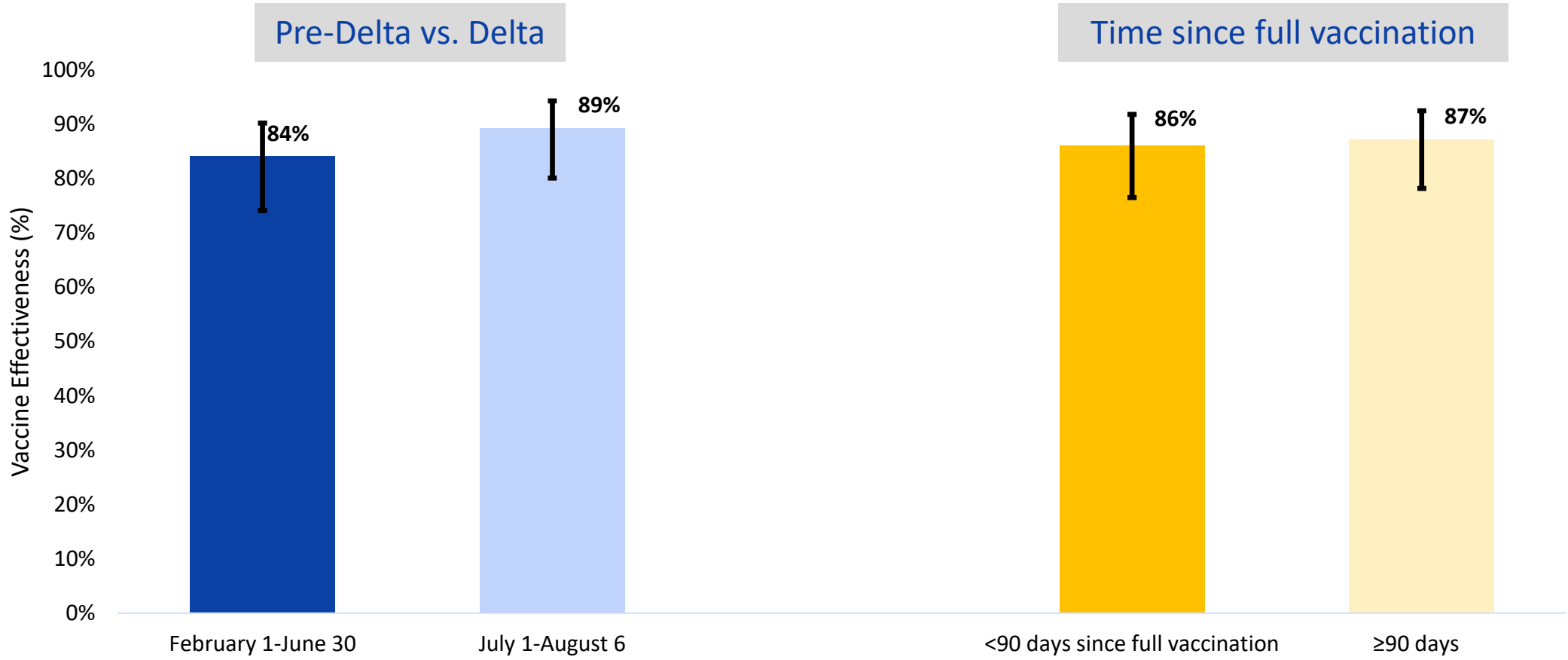
https://www.cdc.gov/mmwr/volumes/70/wr/mm7037e3.htm

SUPERNOVA: VE against COVID-19-associated hospitalization, by mRNA vaccine



https://www.cdc.gov/mmwr/volumes/70/wr/mm7037e3.htm

SUPERNOVA: mRNA VE against COVID-19-associated hospitalization, by Delta variant predominance and time since vaccination



https://www.cdc.gov/mmwr/volumes/70/wr/mm7037e3.htm

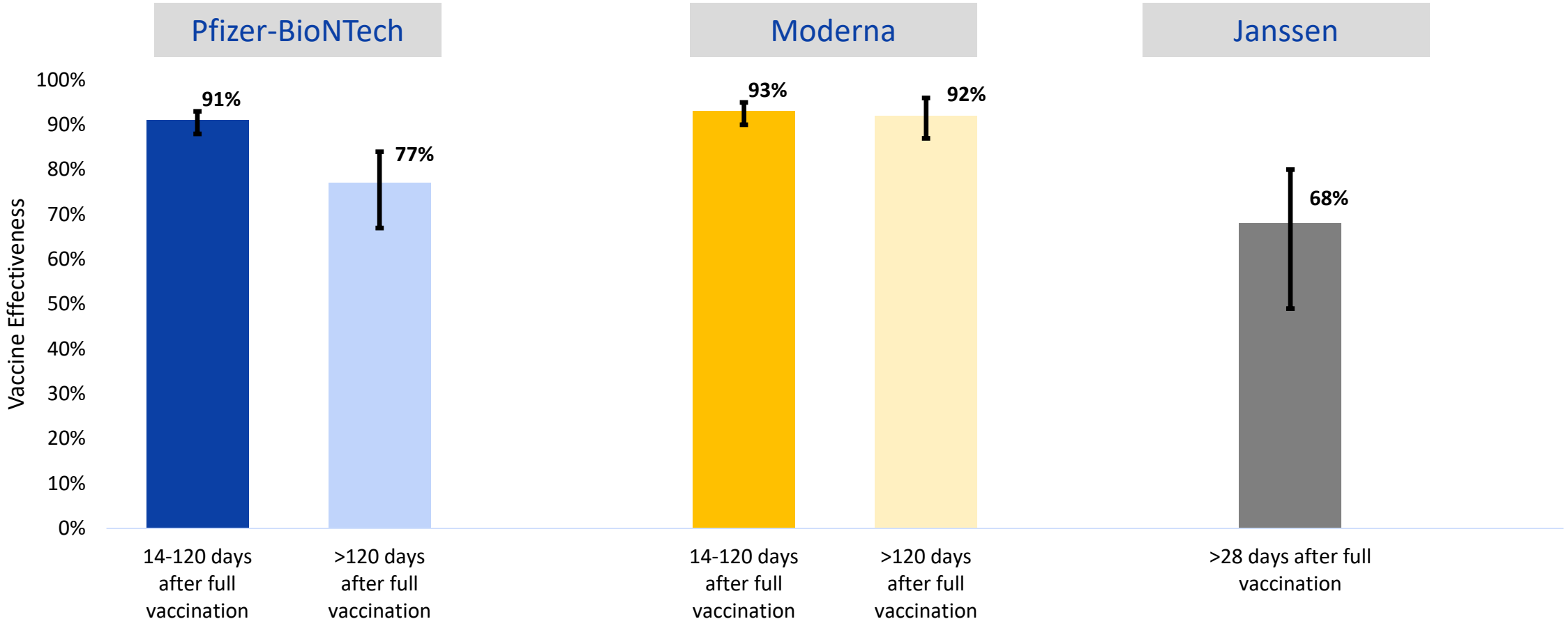
Effectiveness of mRNA vaccines for preventing COVID-19 hospitalization, IVY Network

IVY
INFLUENZA AND OTHER VIRUSES IN THE ACUTELY ILL

- **Population**: Adults (≥18 years) hospitalized at 21 medical centers in 18 states
- **Case status**:
  - Cases with COVID-19-like illness and SARS-CoV-2 antigen / RT-PCR (+)
  - Controls: SARS-CoV-2 RT-PCR (-)
- SARS-CoV-2 testing within 10 days of admission, and admission within 14 days of illness onset
- **Analytic period**: Admitted March 11–August 15, 2021

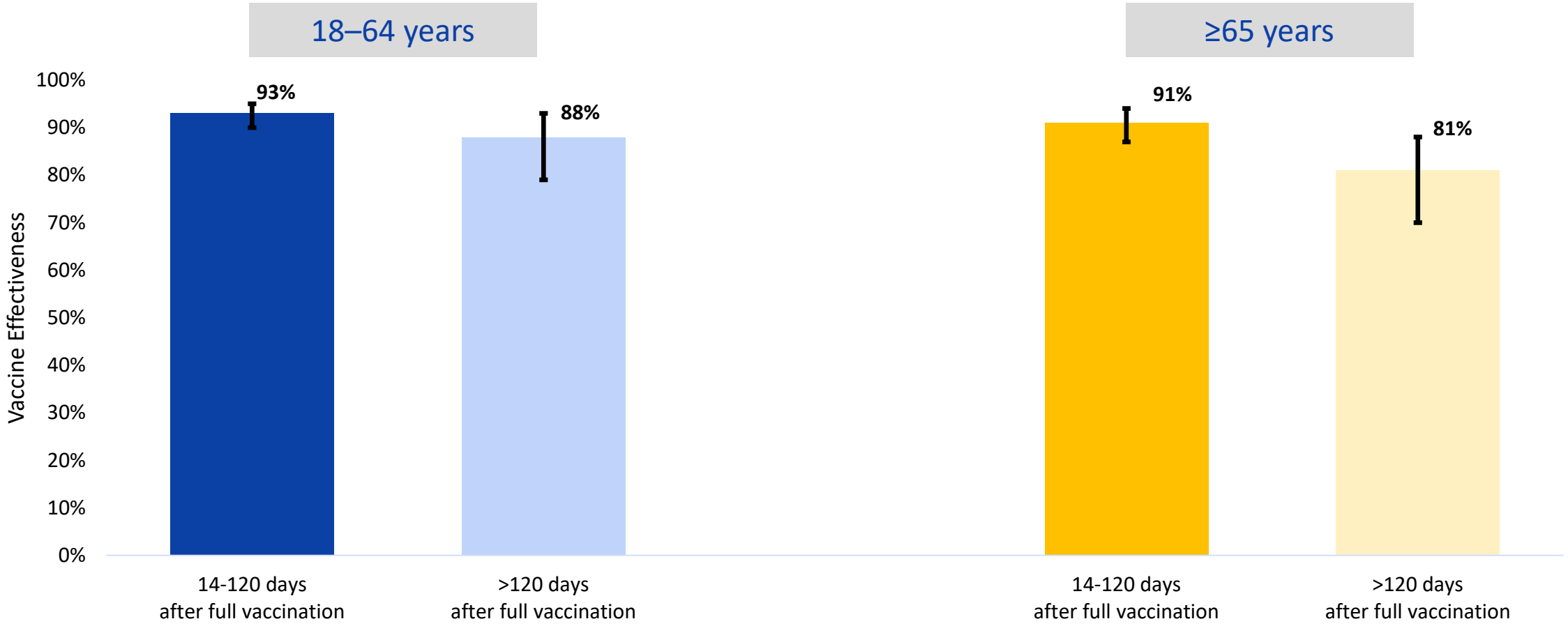
Tenforde et al. *MMWR* https://www.cdc.gov/mmwr/volumes/70/wr/mm7034e2.htm

IVY Network: COVID-19 vaccine effectiveness against hospitalization by vaccine product and time since vaccination, adults ≥18 years without immunocompromising conditions

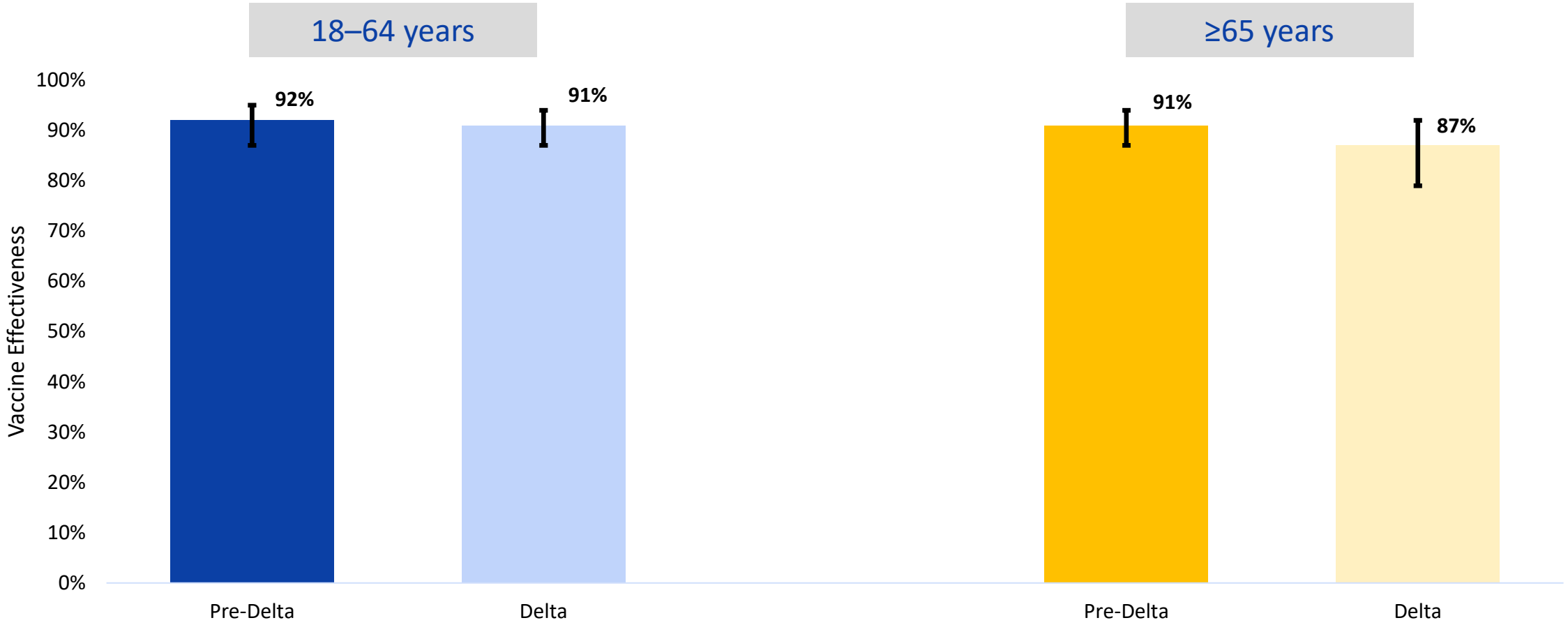


* Adjusted for admission date (biweekly), HHS region, age, sex, race/ethnicity. Not enough recipients of Janssen to assess by time since vaccination.

IVY Network: COVID-19 vaccine effectiveness against hospitalization by age group and time since vaccination, adults without immunocompromising conditions, mRNA vaccines

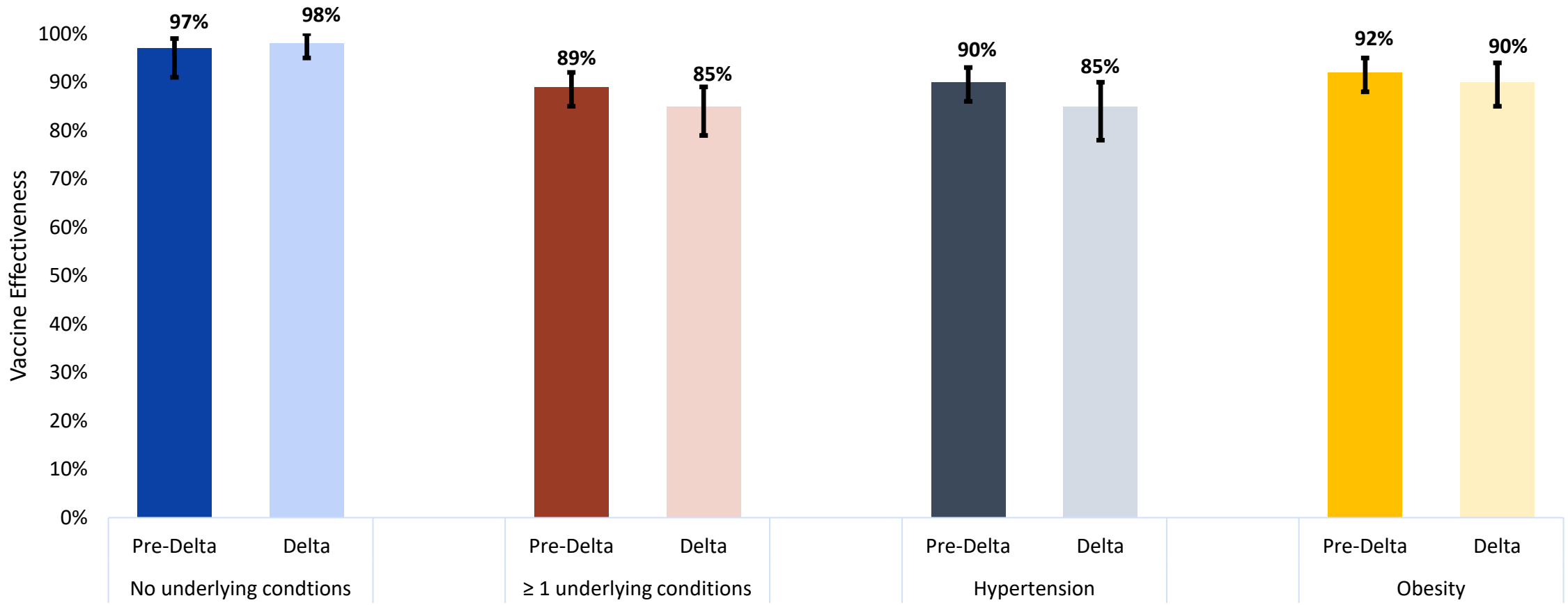


IVY Network: COVID-19 vaccine effectiveness against hospitalization by age group and Delta predominance, adults without immunocompromising conditions, mRNA vaccines



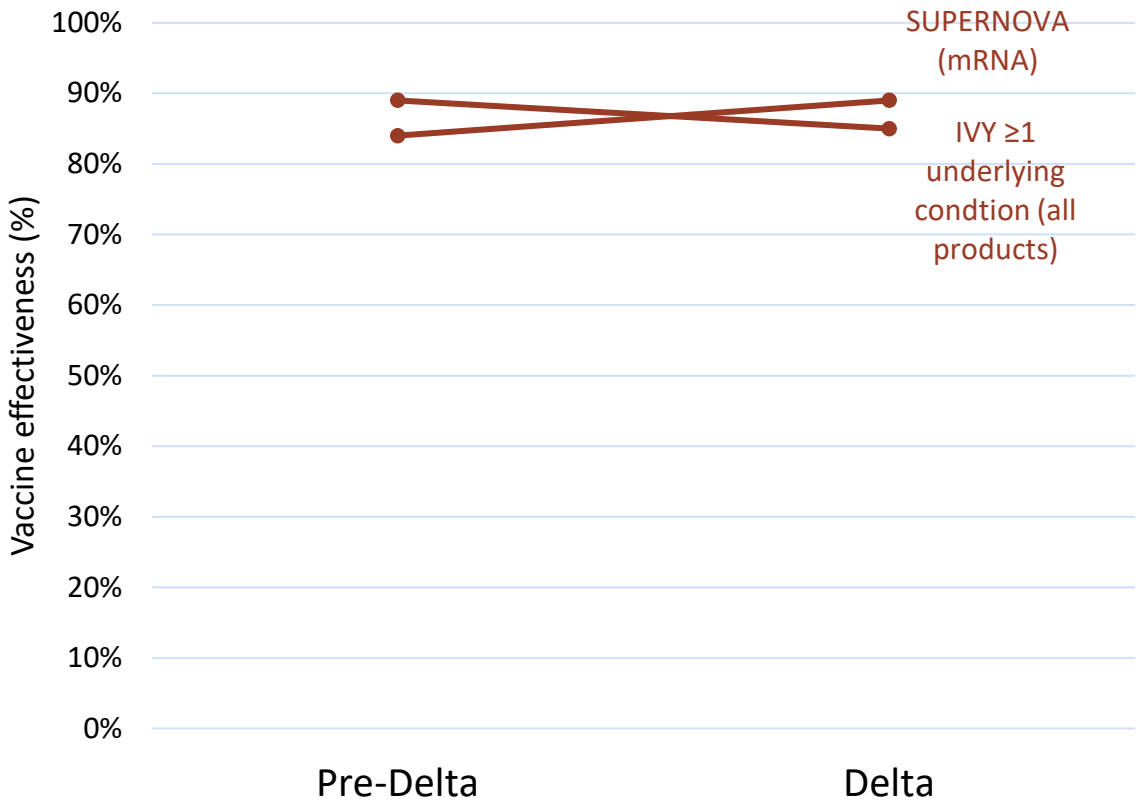
https://www.cdc.gov/mmwr/volumes/70/wr/mm7034e2.htm

IVY Network: COVID-19 mRNA vaccine effectiveness against hospitalization among adults by risk group and Delta predominance, excluding patients with immunocompromising conditions



CDC unpublished; estimates are controlled for age.

Magnitude of VE against infection or hospitalization by Delta predominance for adults with underlying medical conditions, by study

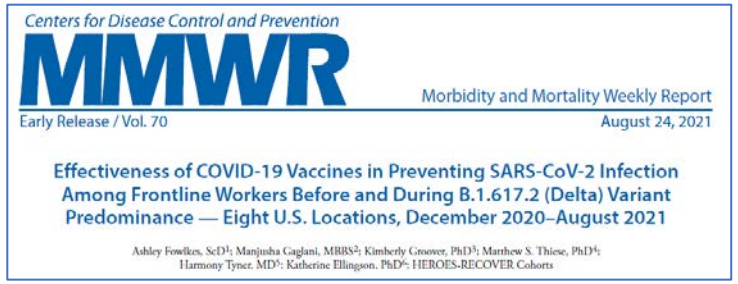


- No VE estimates available for infection
- VE estimates for hospitalization, remain high during Delta

SUPERNOVA: https://www.cdc.gov/mmwr/volumes/70/wr/mm7037e3.htm
IVY: CDC unpublished data

Vaccine effectiveness for workers employed in occupations with high risk of exposure to SARS-CoV-2

HEROES-RECOVER Cohorts


Centers for Disease Control and Prevention
MMWR
Morbidity and Mortality Weekly Report
Early Release / Vol. 70
August 24, 2021

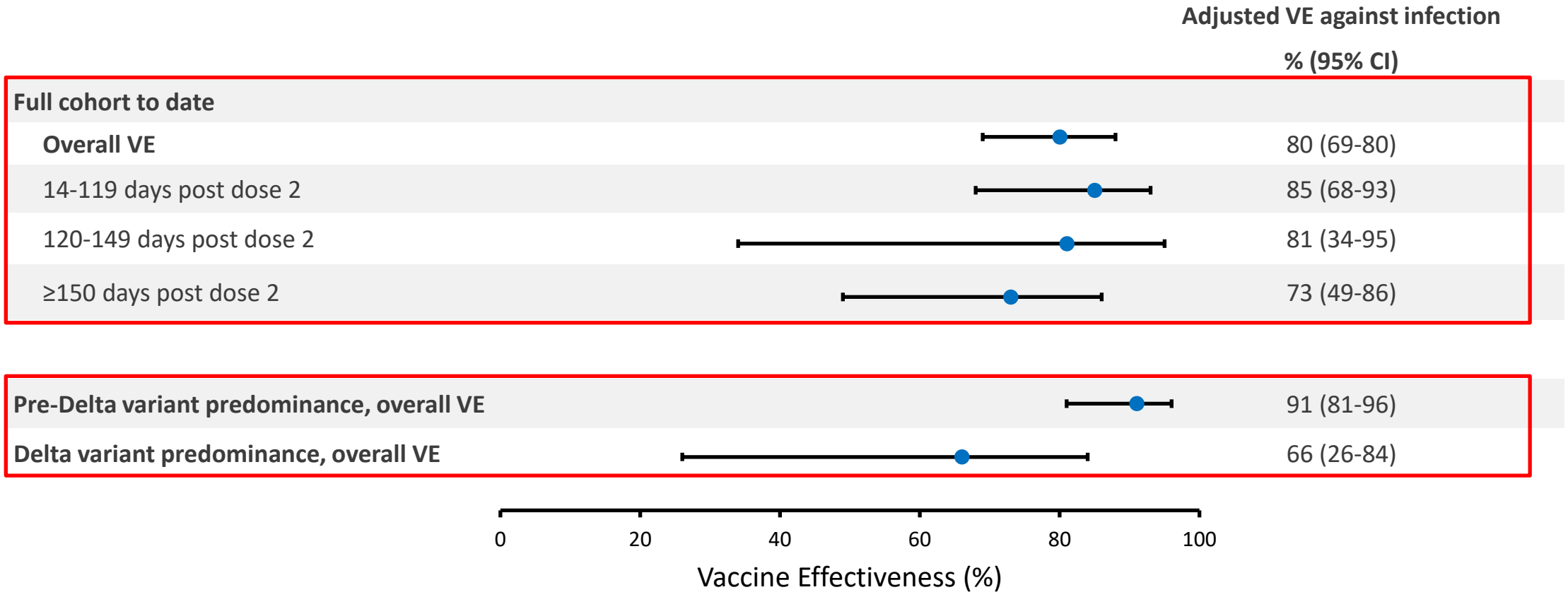
Effectiveness of COVID-19 Vaccines in Preventing SARS-CoV-2 Infection Among Frontline Workers Before and During B.1.617.2 (Delta) Variant Predominance — Eight U.S. Locations, December 2020–August 2021

Ashley Fowlkes, ScD[1]; Manjusha Gaglani, MBBS[2]; Kimberly Groover, PhD[3]; Matthew S. Thiese, PhD[4]; Harmony Tyner, MD[5]; Katherine Ellingson, PhD[6]; HEROES-RECOVER Cohorts

- Prospective cohort of over 4,000 **healthcare personnel, first responders, and other frontline workers in 8 U.S. locations**
- VE of full vaccination in preventing symptomatic and asymptomatic SARS-CoV-2 infection
  - Routine weekly swabbing plus illness specimens
  - Multi-method vaccination documentation; 95% mRNA vaccines
  - Hazard person-time model adjusted for study site, occupation, and local virus circulation and weighted for propensity to be vaccinated (socio-demographics, health, frequency of close contact and mask use)
  - 62% female; 72% aged 18–49 years; 31% with ≥1 underlying medical condition

https://www.cdc.gov/mmwr/volumes/70/wr/mm7034e4.htm

HEROES/RECOVER: VE against SARS-CoV-2 infection by Delta variant predominance and time since full vaccination

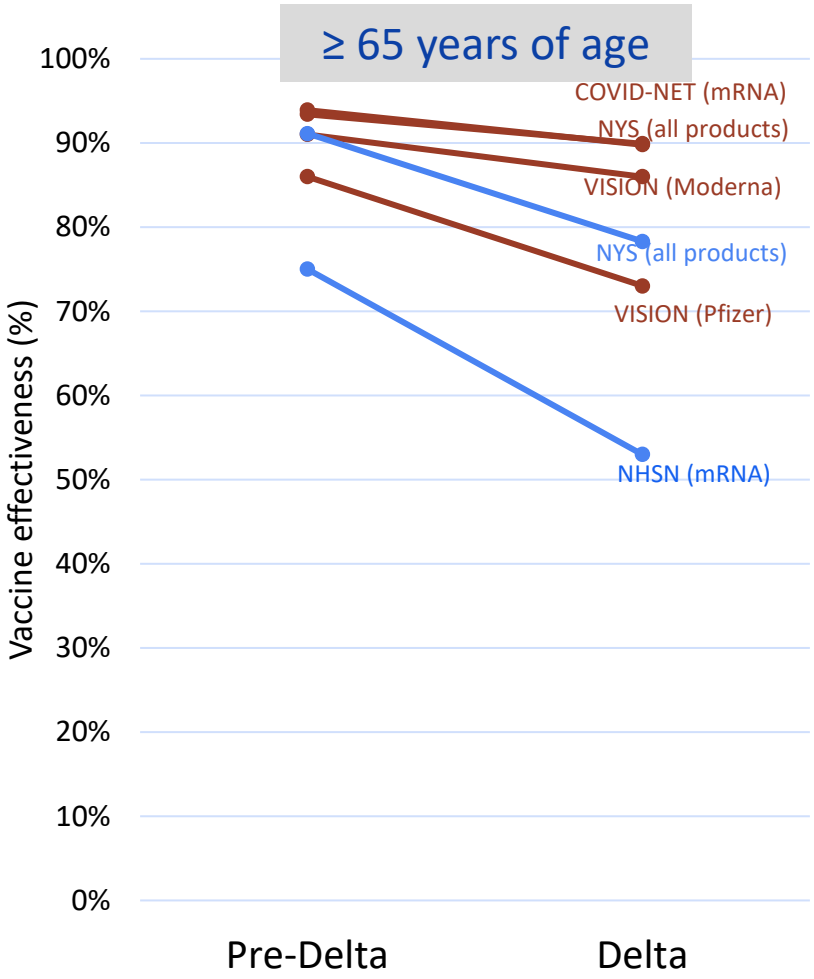


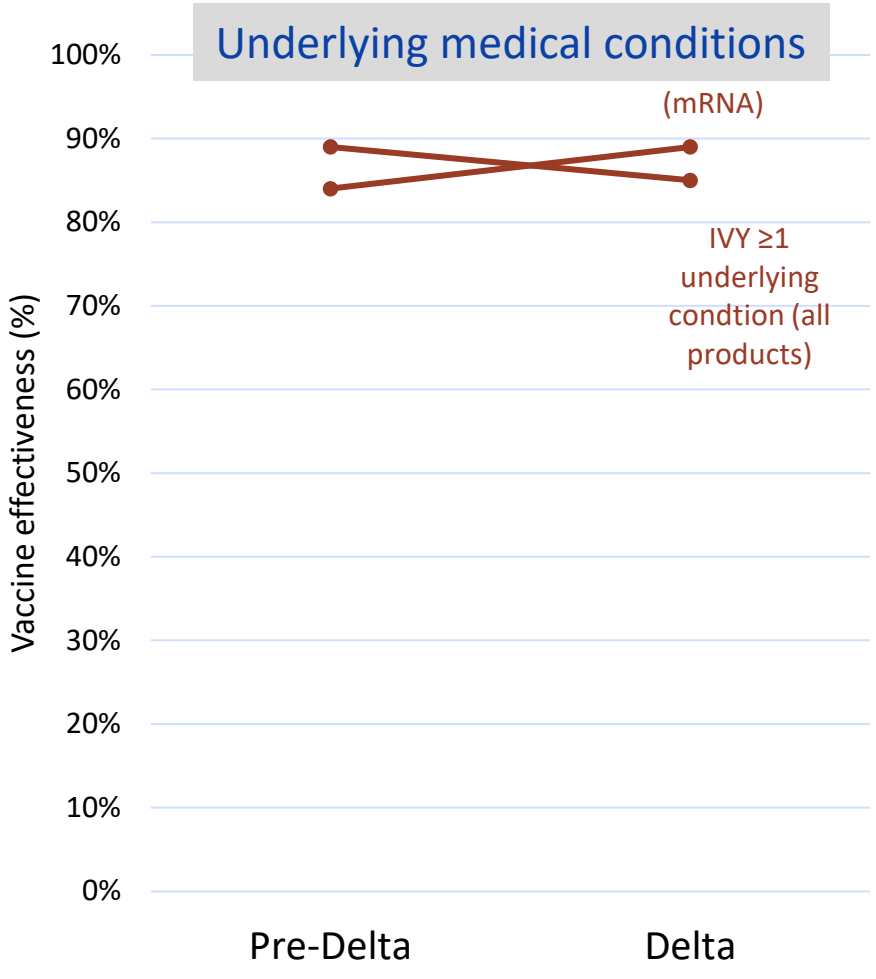
- VE against infection (80% symptomatic) declined from 91% pre-Delta to 66% during Delta
- Did not have enough power to look at time since vaccination pre-Delta and during Delta
- Do not see significant difference between mRNA products

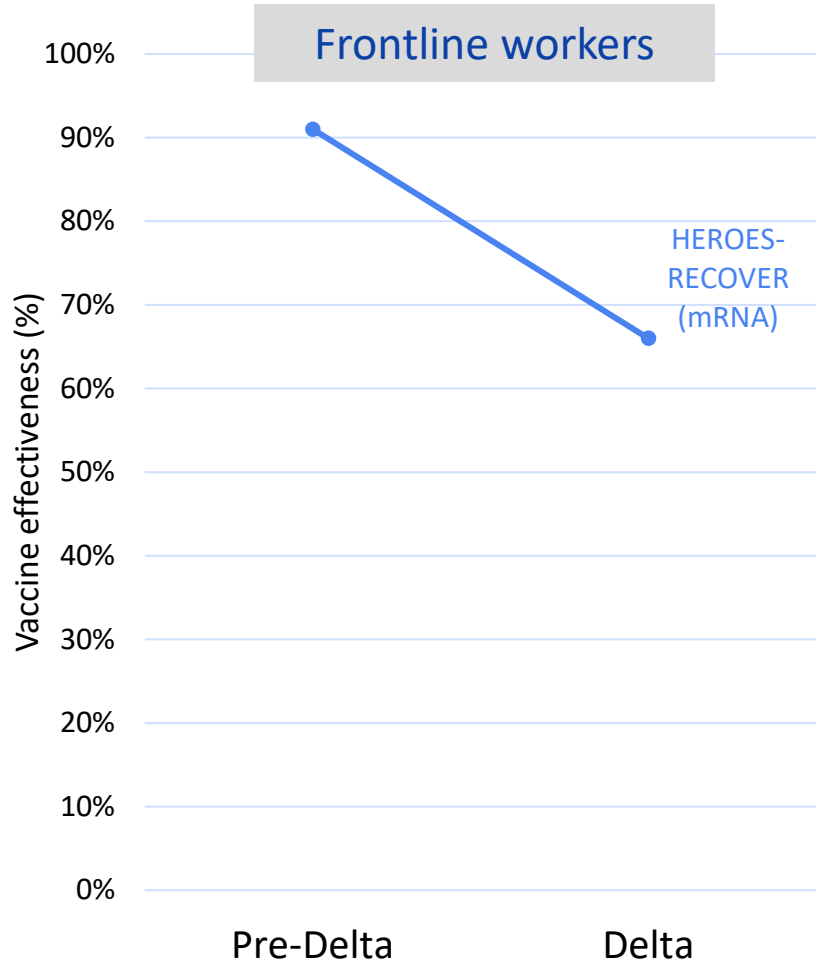
https://www.cdc.gov/mmwr/volumes/70/wr/mm7034e4.htm

Summary and conclusions

Magnitude of VE against infection or hospitalization by Delta predominance and study, by risk group







NHSN: https://www.cdc.gov/mmwr/volumes/70/wr/mm7034e3.htm
COVID-NET: CDC unpublished
IVY: CDC unpublished data
NYS: https://www.cdc.gov/mmwr/volumes/70/wr/mm7034e1.htm

VISION: https://www.nejm.org/doi/10.1056/NEJMoa2110362/ https://www.cdc.gov/mmwr/volumes/70/wr/mm7037e2.htm
SUPERNOVA: https://www.cdc.gov/mmwr/volumes/70/wr/mm7037e3.htm
HEROES-RECOVER: https://www.cdc.gov/mmwr/volumes/70/wr/mm7034e4.htm

Summary & conclusions

- Individuals ≥65 years of age
  - Significant declines in VE against infection for mRNA products in during Delta-variant predominant period
  - Declines for hospitalization (with Pfizer-BioNTech greater than Moderna) in Delta-variant predominant period
  - Evidence of waning in Delta-variant predominant period

- Individuals with underlying conditions
  - No data on VE against infection; likely similar to overall population
  - Similar patterns for VE for hospitalization as in general adult population

- Occupations with high risk of exposure to SARS-CoV-2
  - No data on VE against hospitalization; likely similar to overall population
  - Similar patterns for VE for infection as in general adult population

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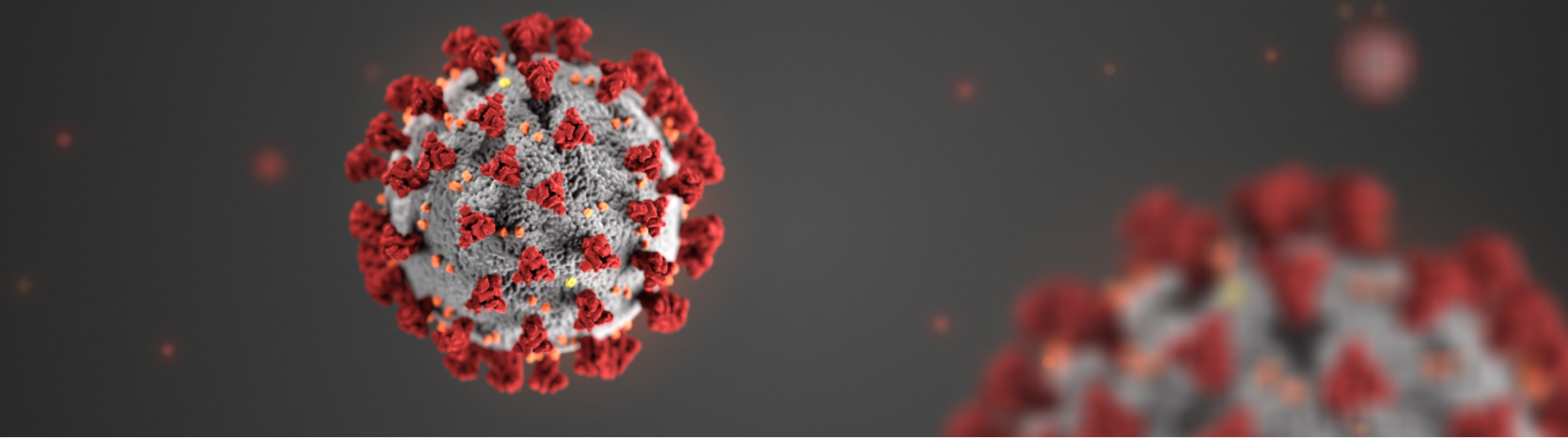

For more information, contact CDC
1-800-CDC-INFO (232-4636)
TTY: 1-888-232-6348 www.cdc.gov

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