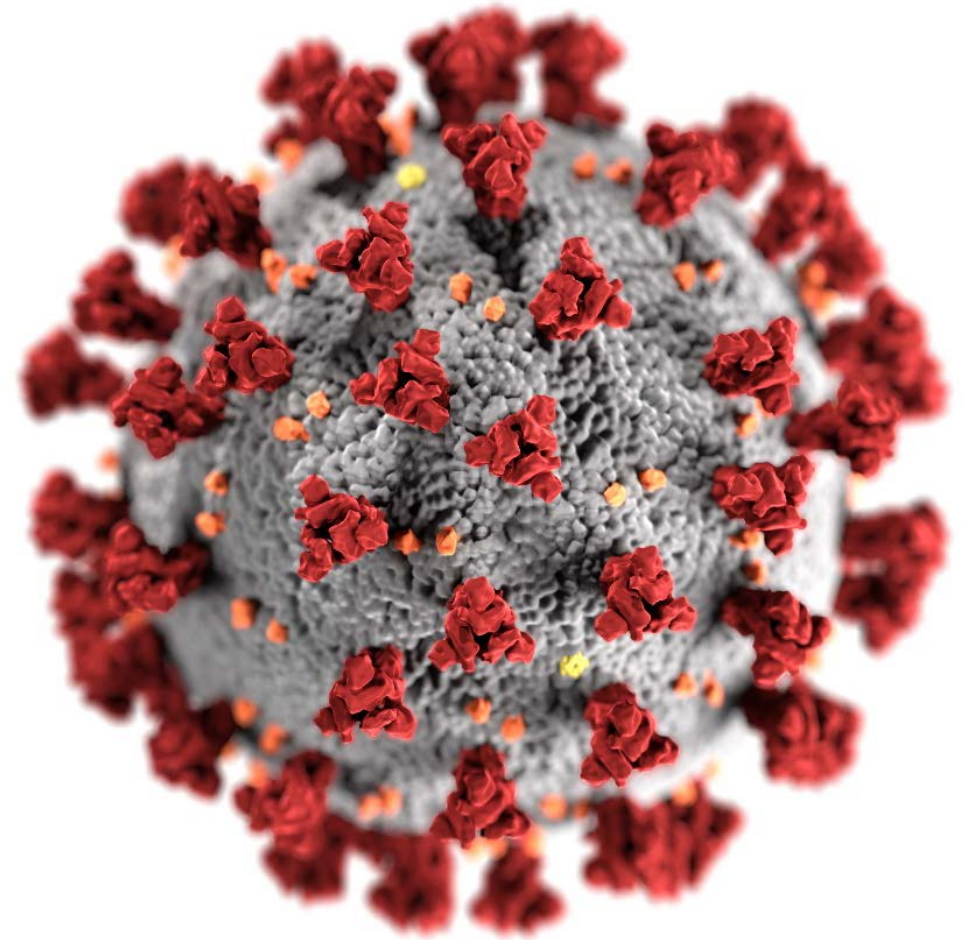


COVID-19 Vaccine Effectiveness in the United States

Ruth Link-Gelles, PhD, MPH
Co-Lead, Vaccine Effectiveness Team
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

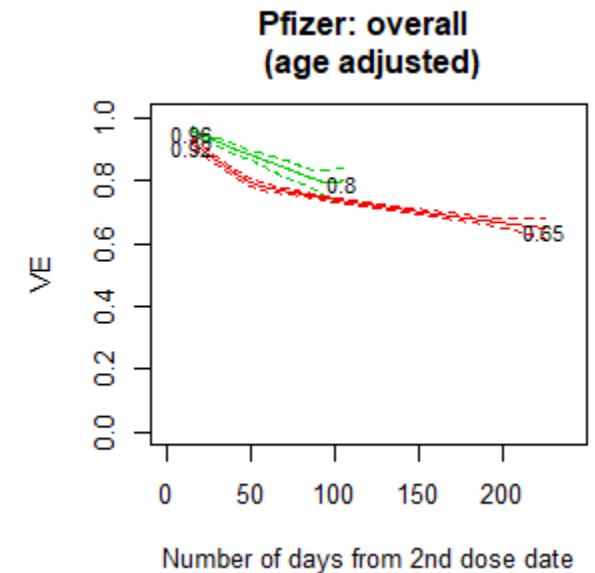
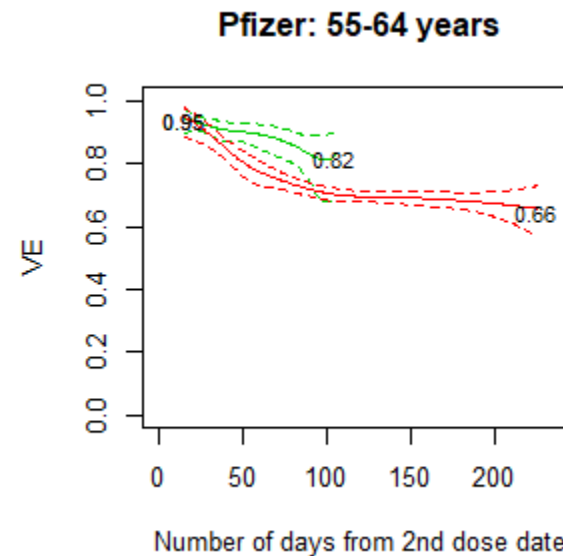
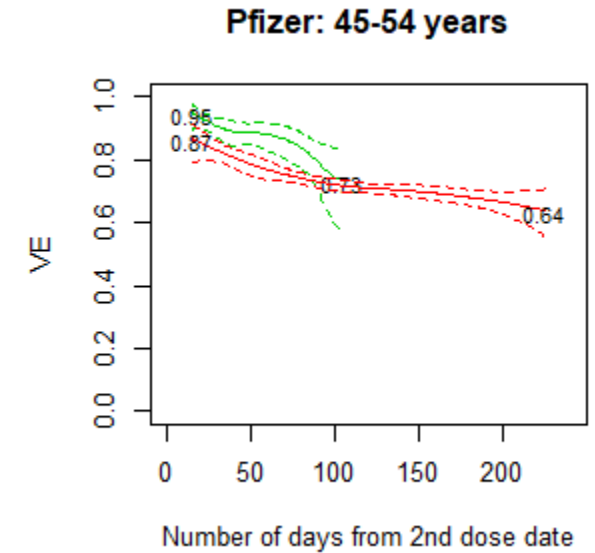
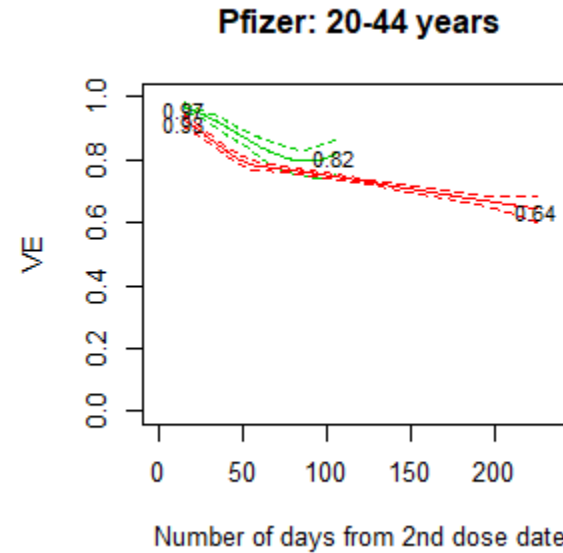
- Nationwide community-based COVID-19 testing via pharmacies and partners
- Self-reported vaccine history at time of registration for COVID-19 testing; excluded those who did not report vaccination status (18%)
- **Design:** Test-negative, case-control assessment
- **Period:** Pre-Delta: March 13–May 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

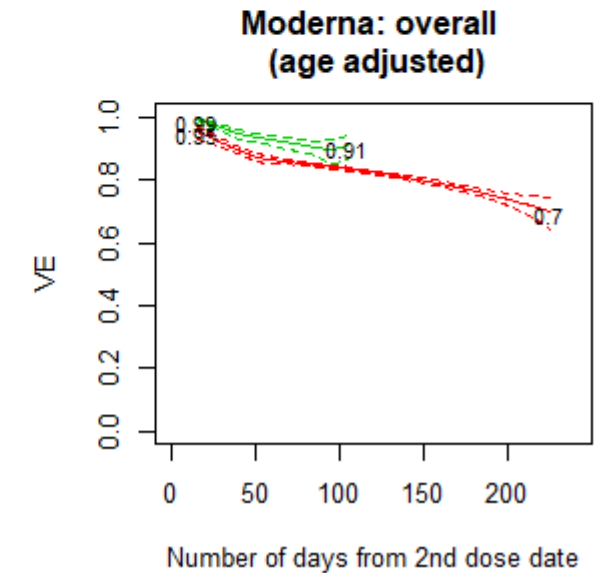
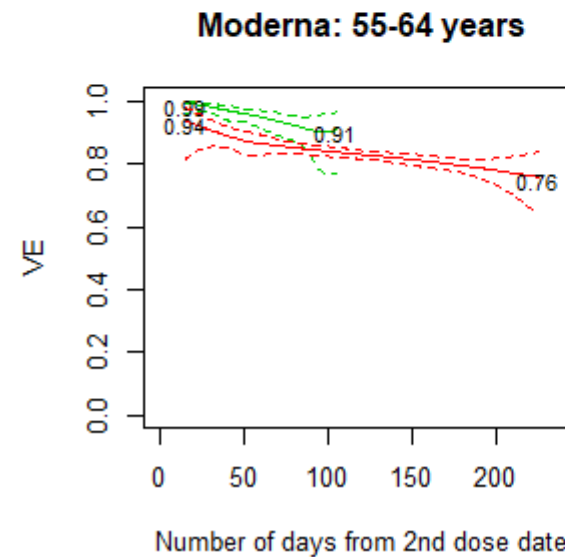
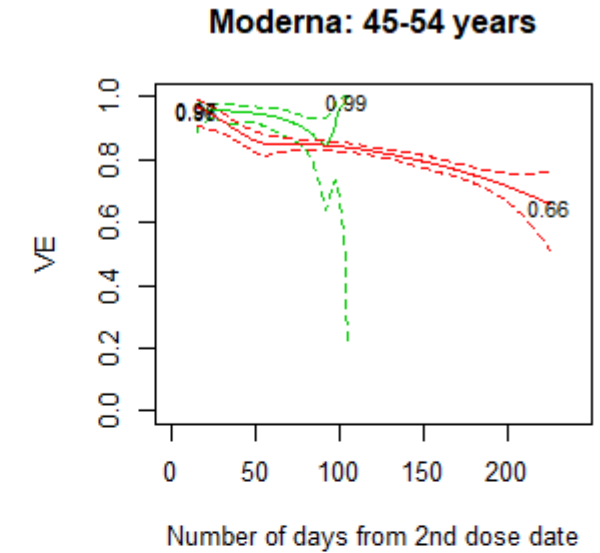
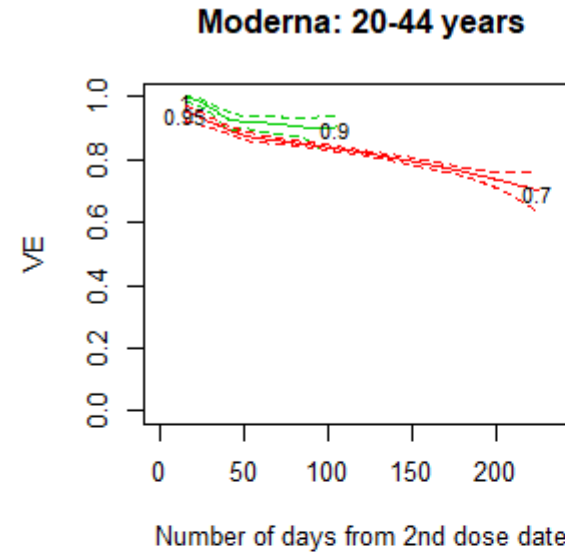


Moderna VE against symptomatic infection by age group and time since vaccination in **pre-Delta** and **Delta** periods

- 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

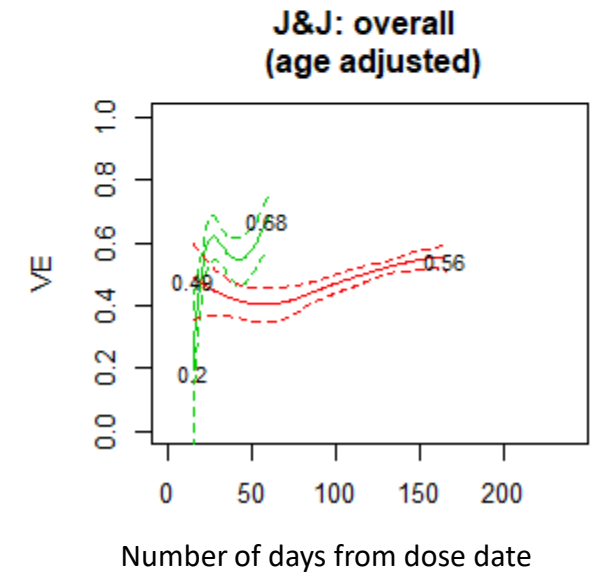
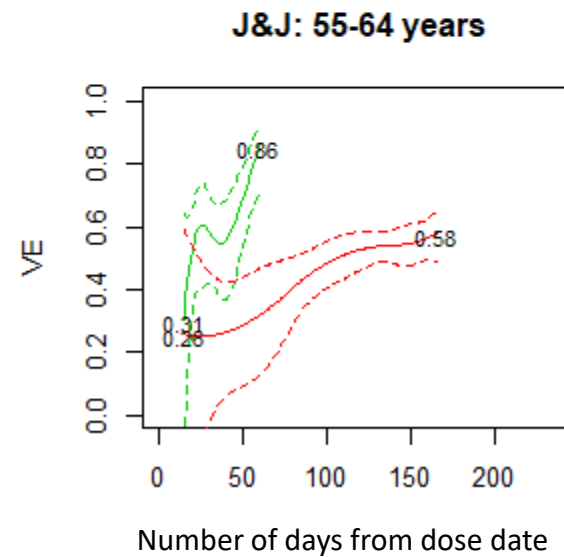
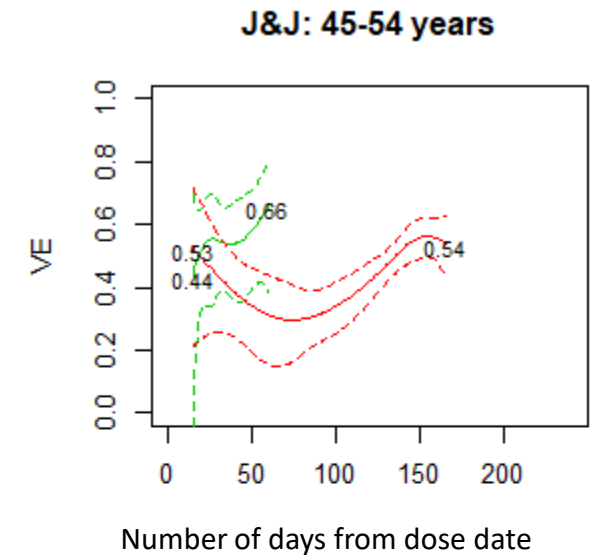
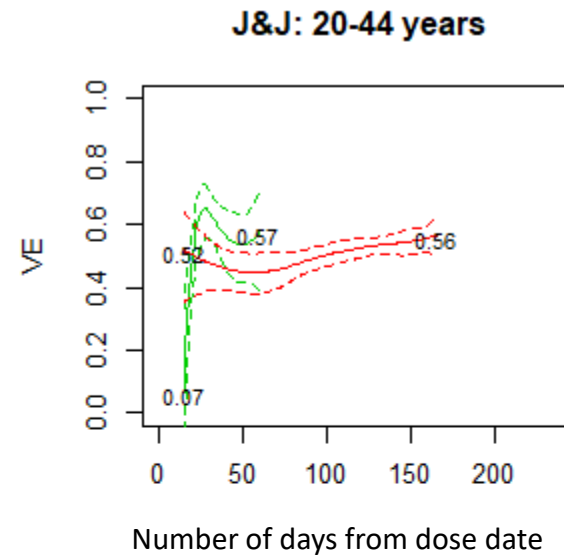


Johnson & Johnson (J&J, Janssen) VE against symptomatic infection by age group and time since vaccination in **pre-Delta** and **Delta** periods

- 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



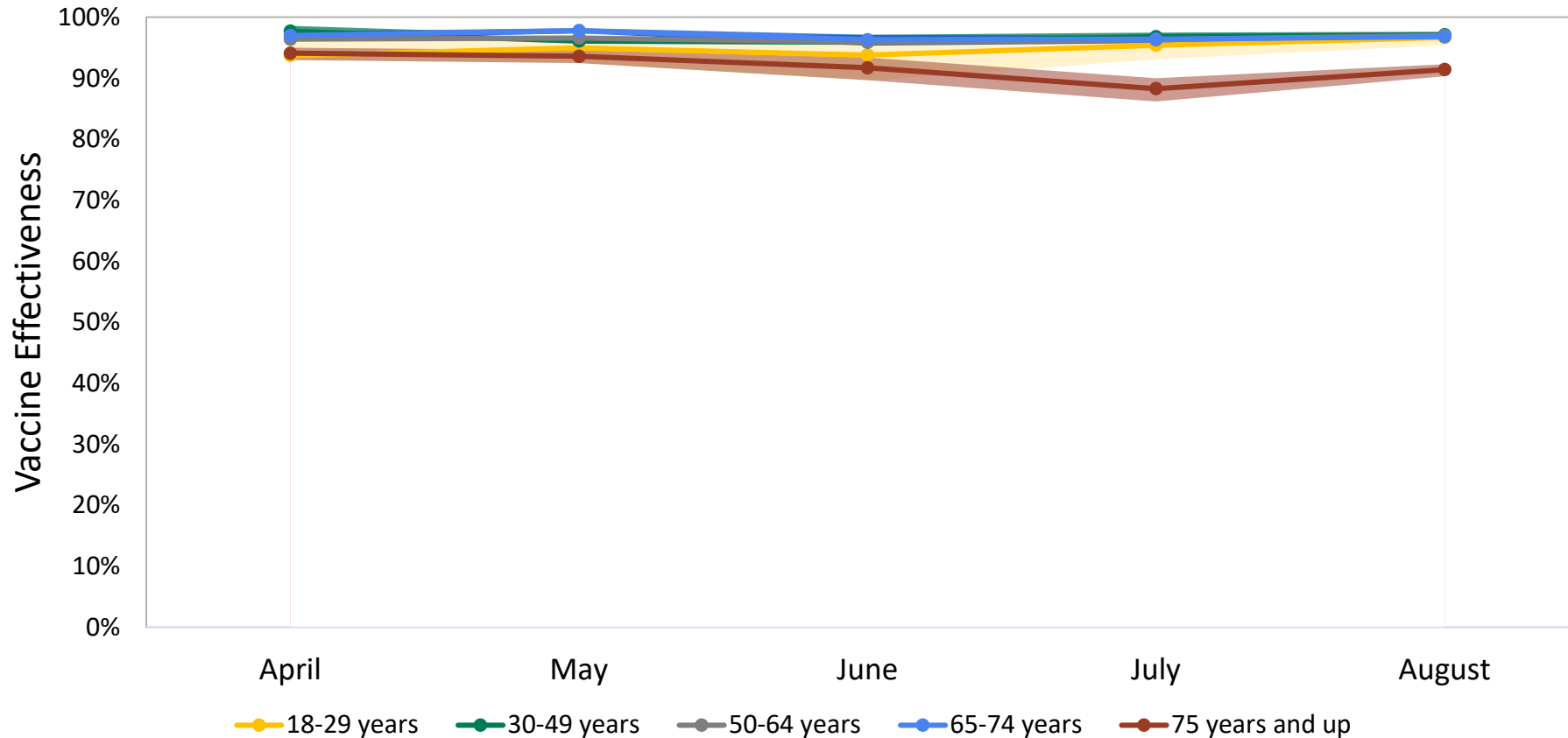
Represents ~10% of U.S. population (32 million people)

- **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

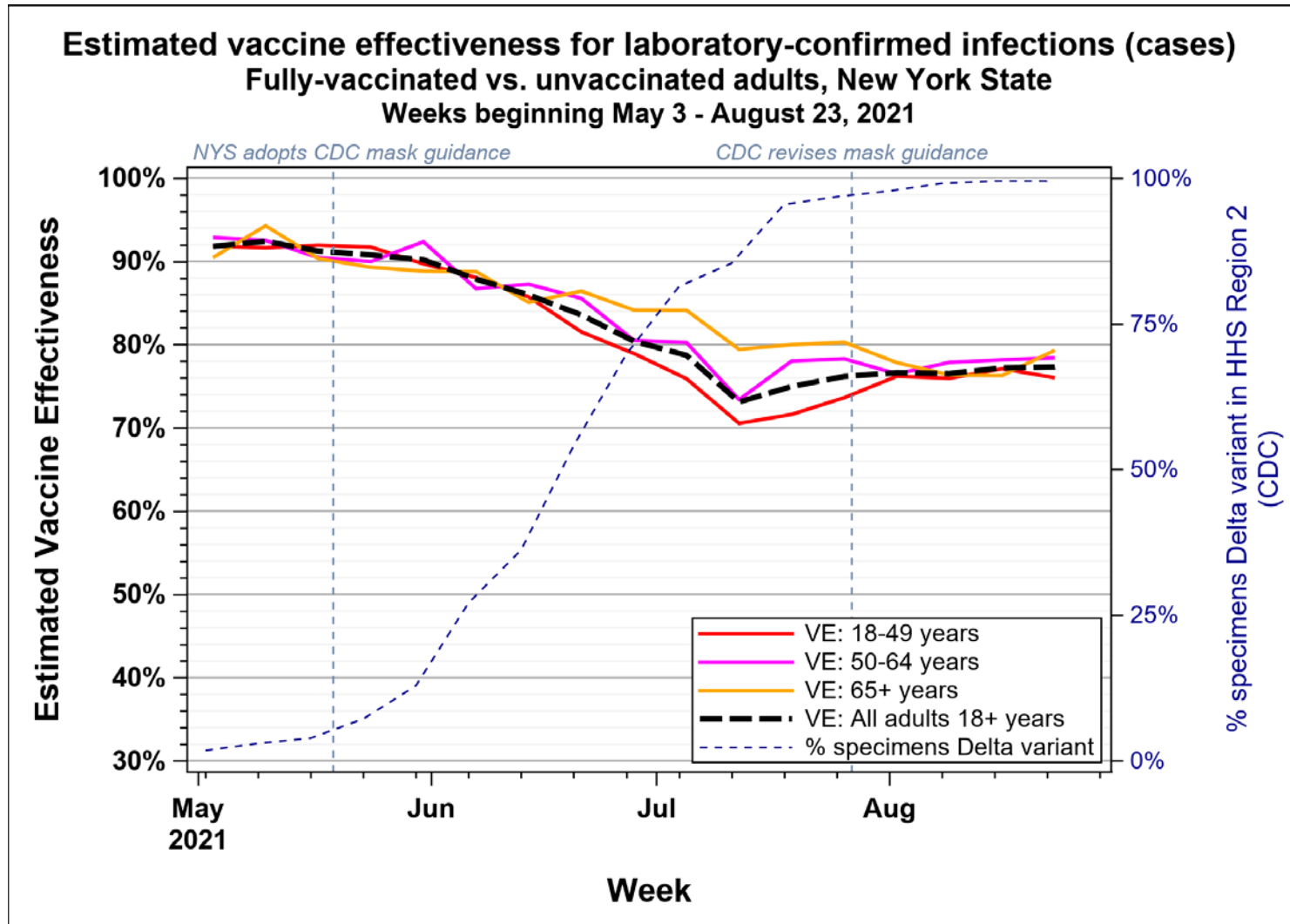
Category	Unvaccinated weighted % N=5,513	Fully vaccinated weighted % N=465
Age group (median, IQR)	59 (47–71)	72 (62–80)
18–49 years	28	11
50–64 years	33	16
≥ 65 years	40	72
LTCF residence	5	13
DNR/DNI/CMO	6	16
Underlying medical conditions		
Cardiovascular disease	34	50
Neurologic disease	17	28
Renal 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

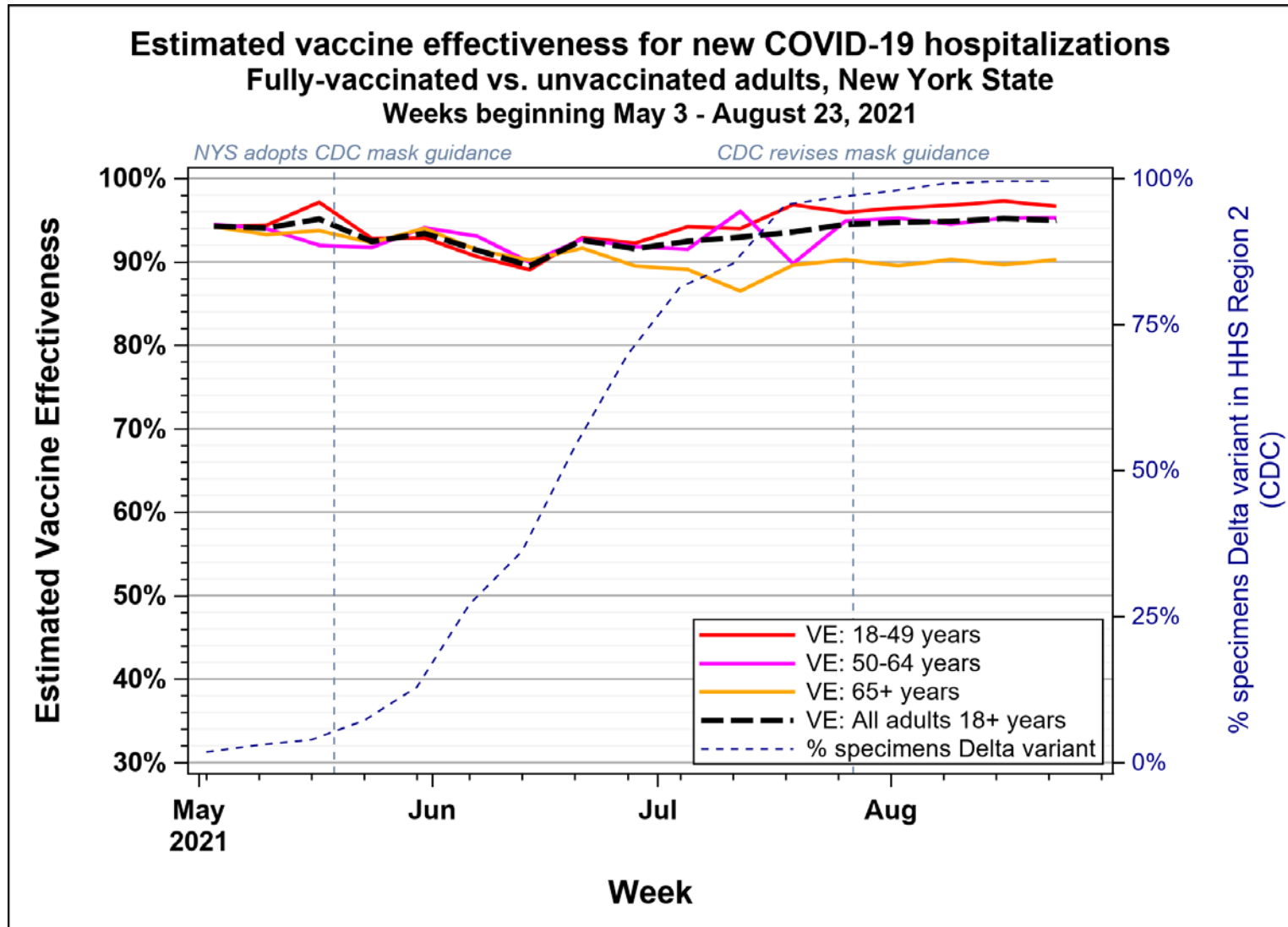
- NY State linked lab, immunization, and hospitalization data to estimate VE from May 3–August 29, 2021
 - 147,937 new diagnoses among fully vaccinated and unvaccinated persons
 - 16,261 new hospitalizations among fully vaccinated and unvaccinated persons
- Breakdown by vaccine:
 - Pfizer-BioNTech: 52%
 - Moderna: 39%
 - Johnson & Johnson/Janssen: 9%
- Delta proportion: <2% (May 2–8) to >99% (August 22–28) (CDC NS3, HHS Reg. 2)

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



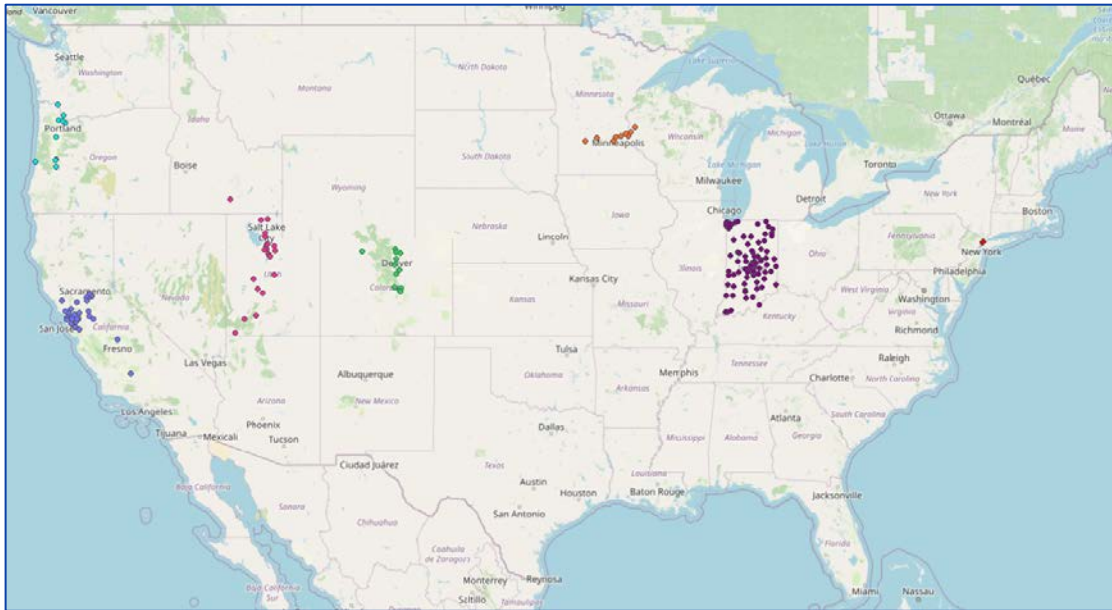
Age-adjusted VE against new COVID-19 infections declined from 92% (May 3–9) to 73% (July 12–18), when Delta reached 85%. Then, decline ceased, with plateau around 77%.

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



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

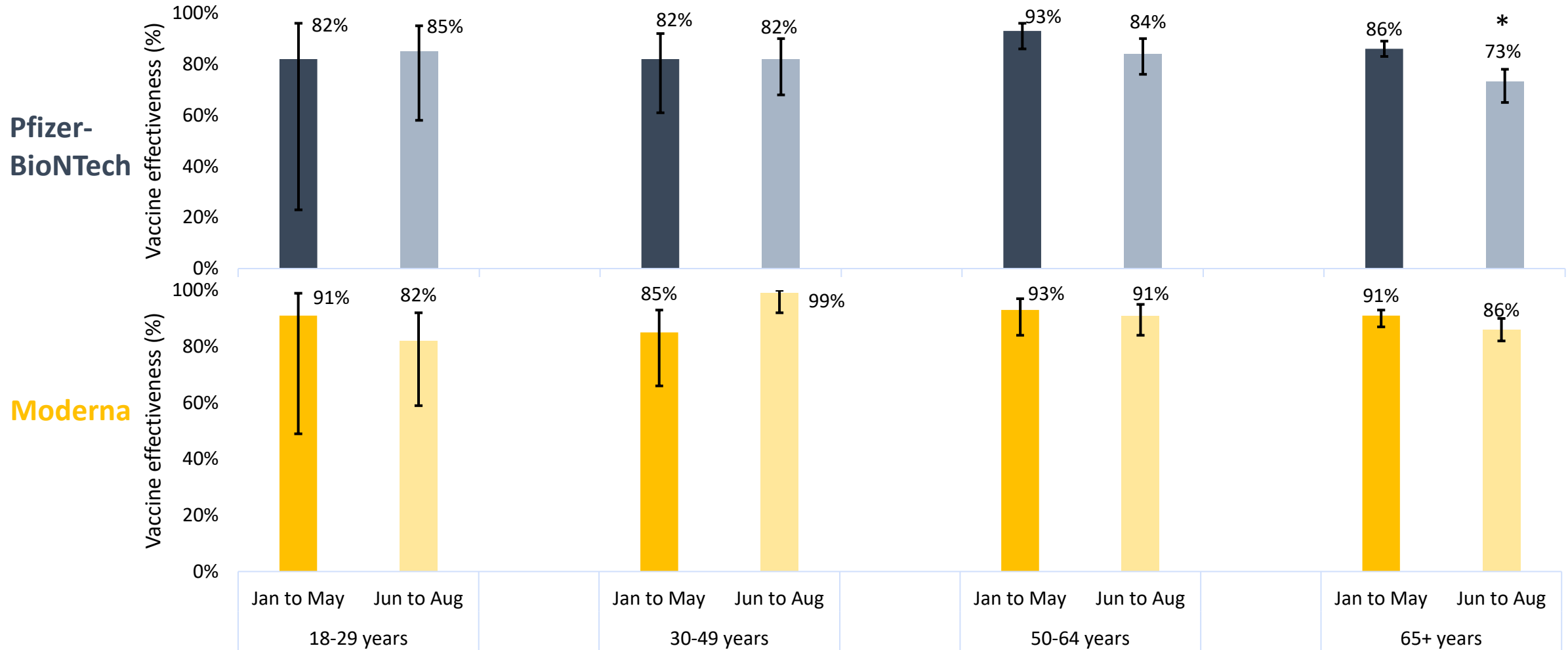
VISION Multi-State Network of Electronic Health Records for VE against hospitalization



Estimates are from over 74,000 hospitalizations across 187 hospitals

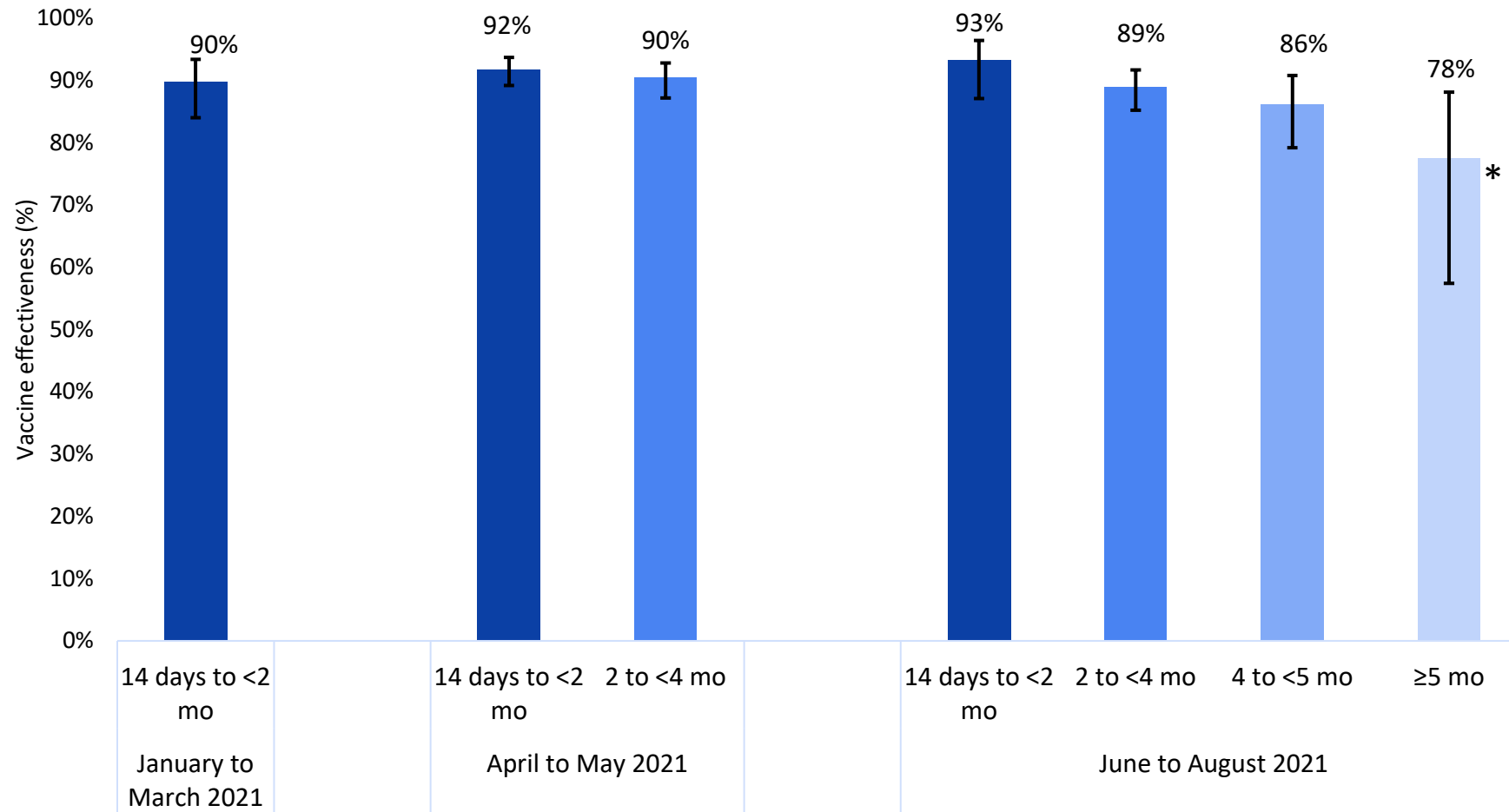
- VE for adults aged ≥ 18 years
- **Cases:** COVID-like illness (CLI) with positive PCR for SARS-CoV-2
- **Controls:** CLI with negative PCR for SARS-CoV-2
- VE adjusted for propensity to be vaccinated, calendar time, site-region, local virus circulation, and age
 - Waning VE models are matched on calendar 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



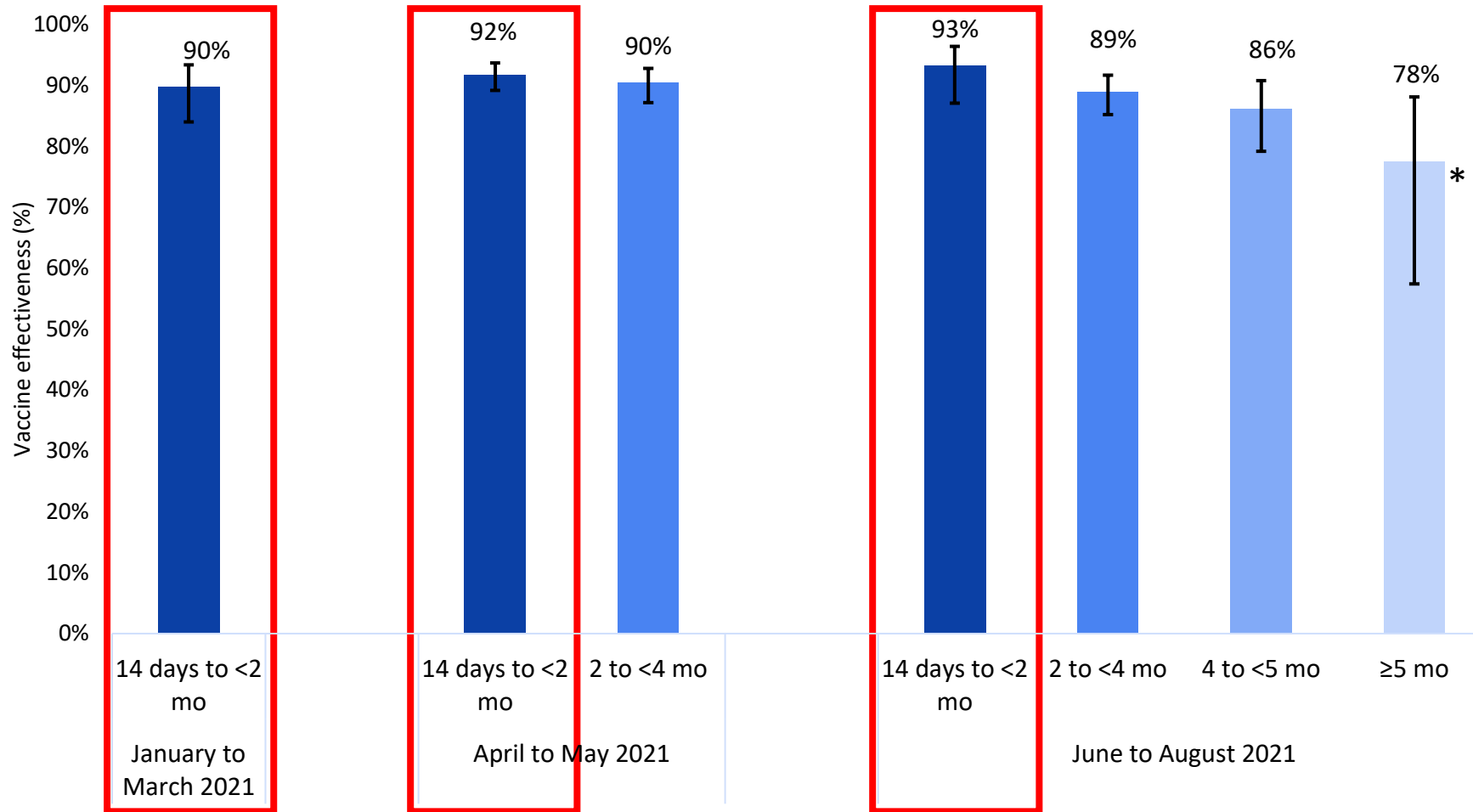
* p<0.05 17

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



* $p < 0.05$ for trend

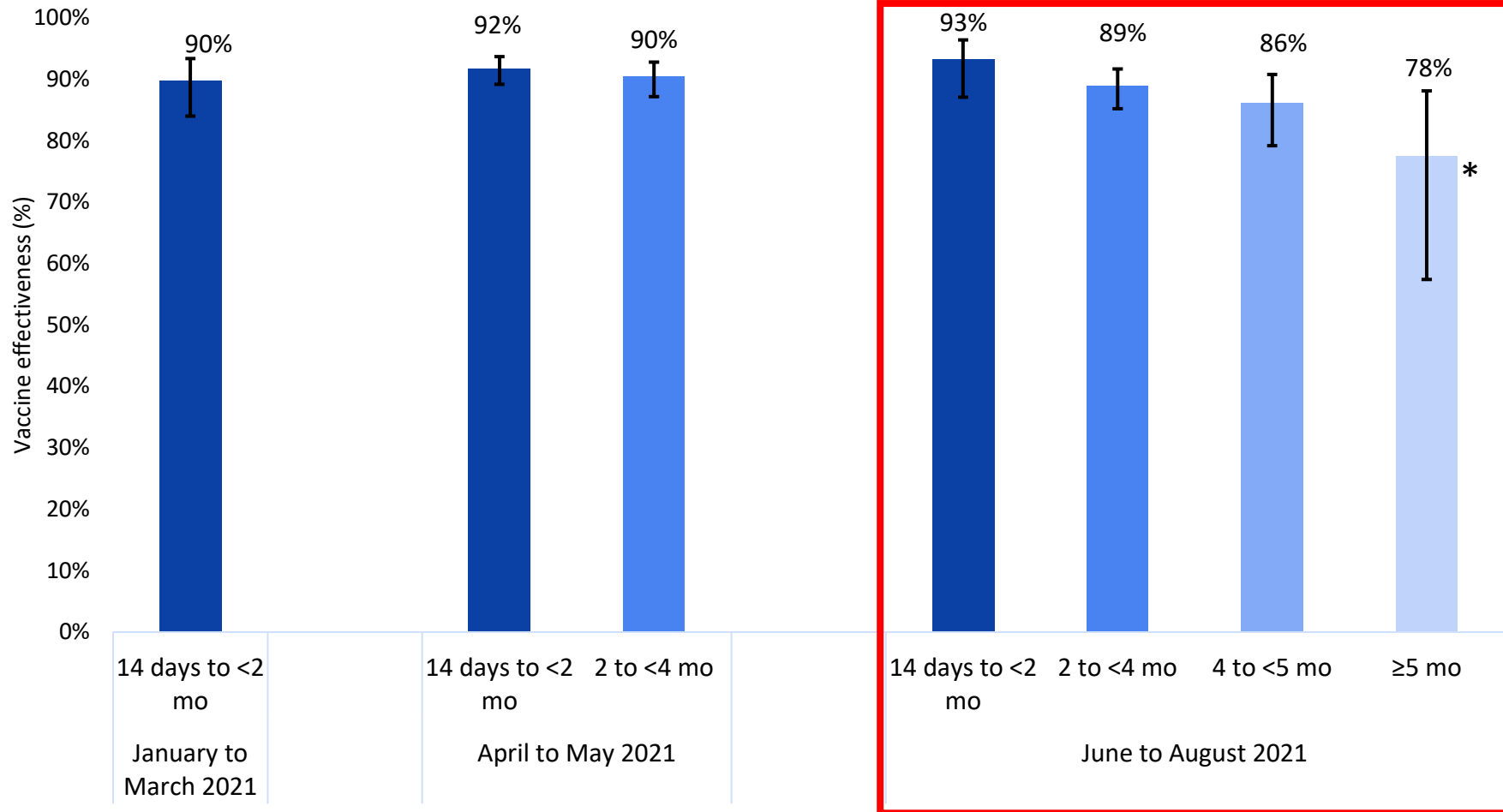
VISION Network: Preliminary VE against hospitalization by time since vaccination in each calendar period, adults ≥ 18 years, mRNA products



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

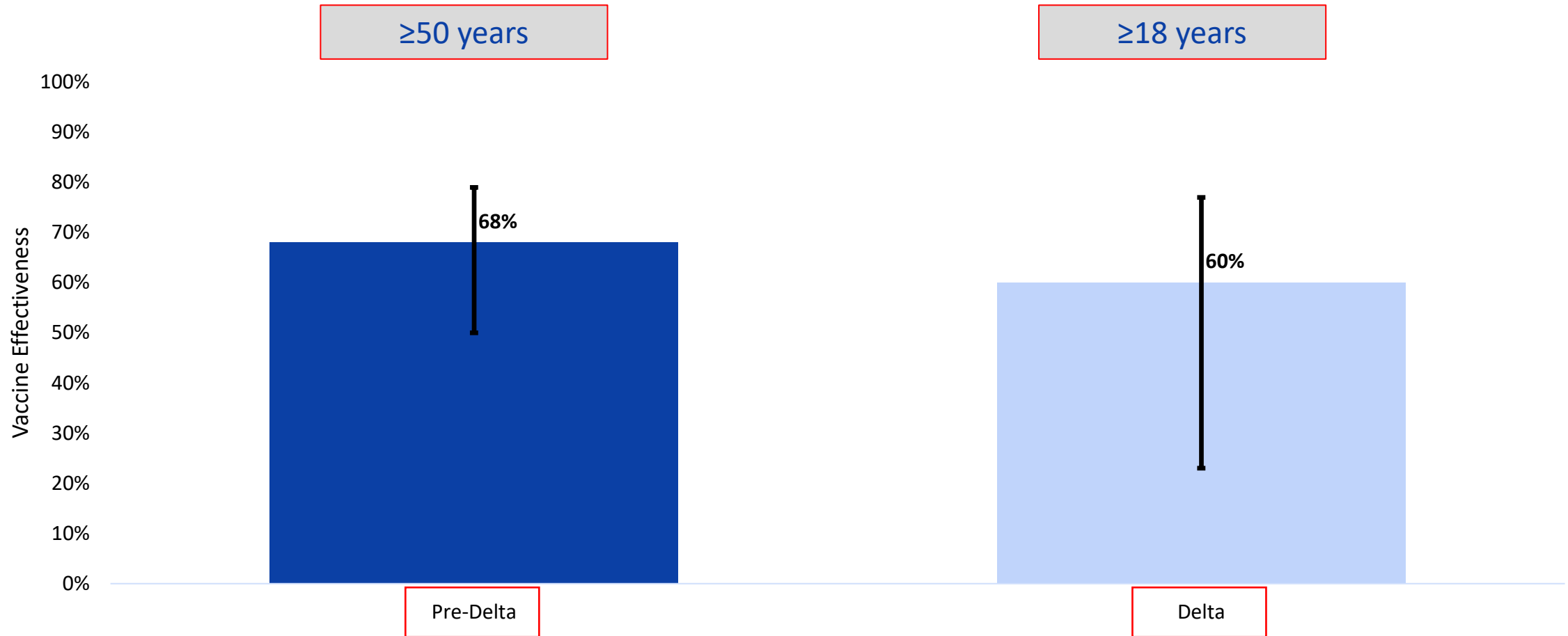
VISION Network: Preliminary VE against hospitalization by time since vaccination in each calendar period, adults ≥ 18 years, mRNA products



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*

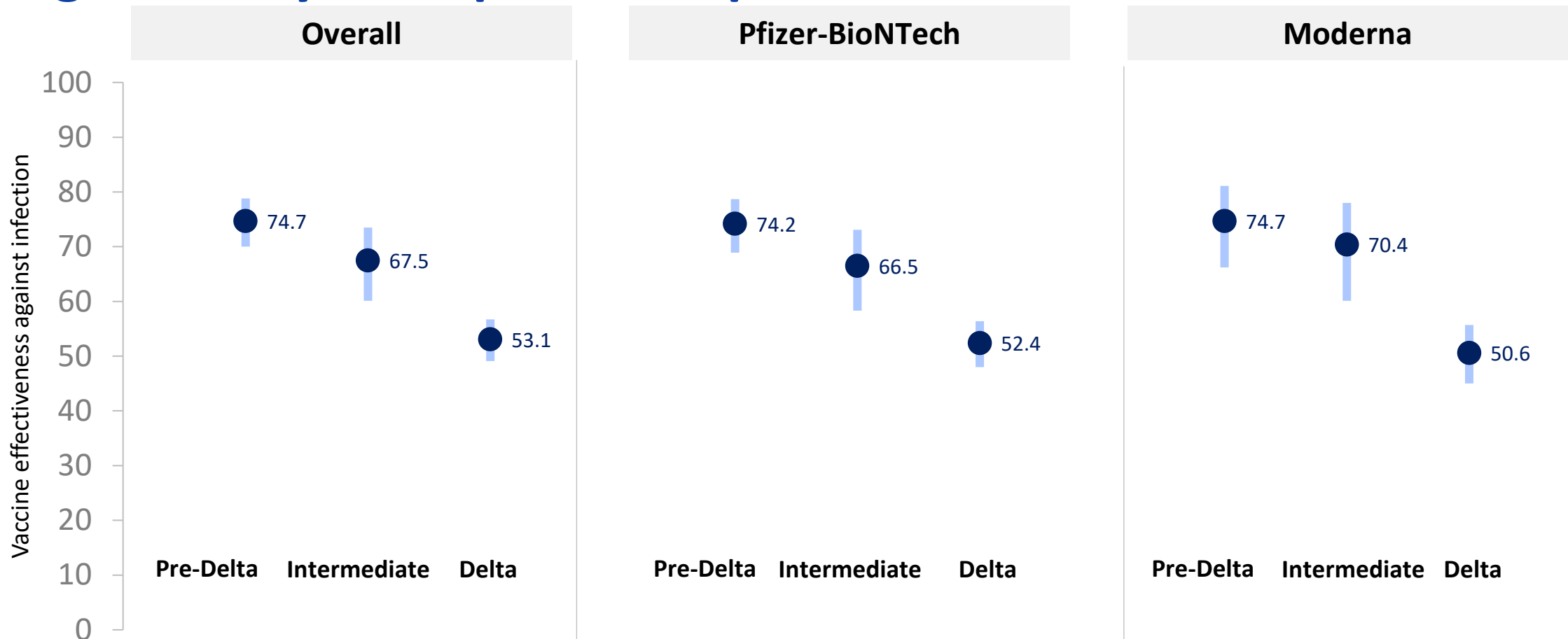


VE of mRNA vaccines against infection among nursing home residents before and during widespread Delta circulation

- 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)

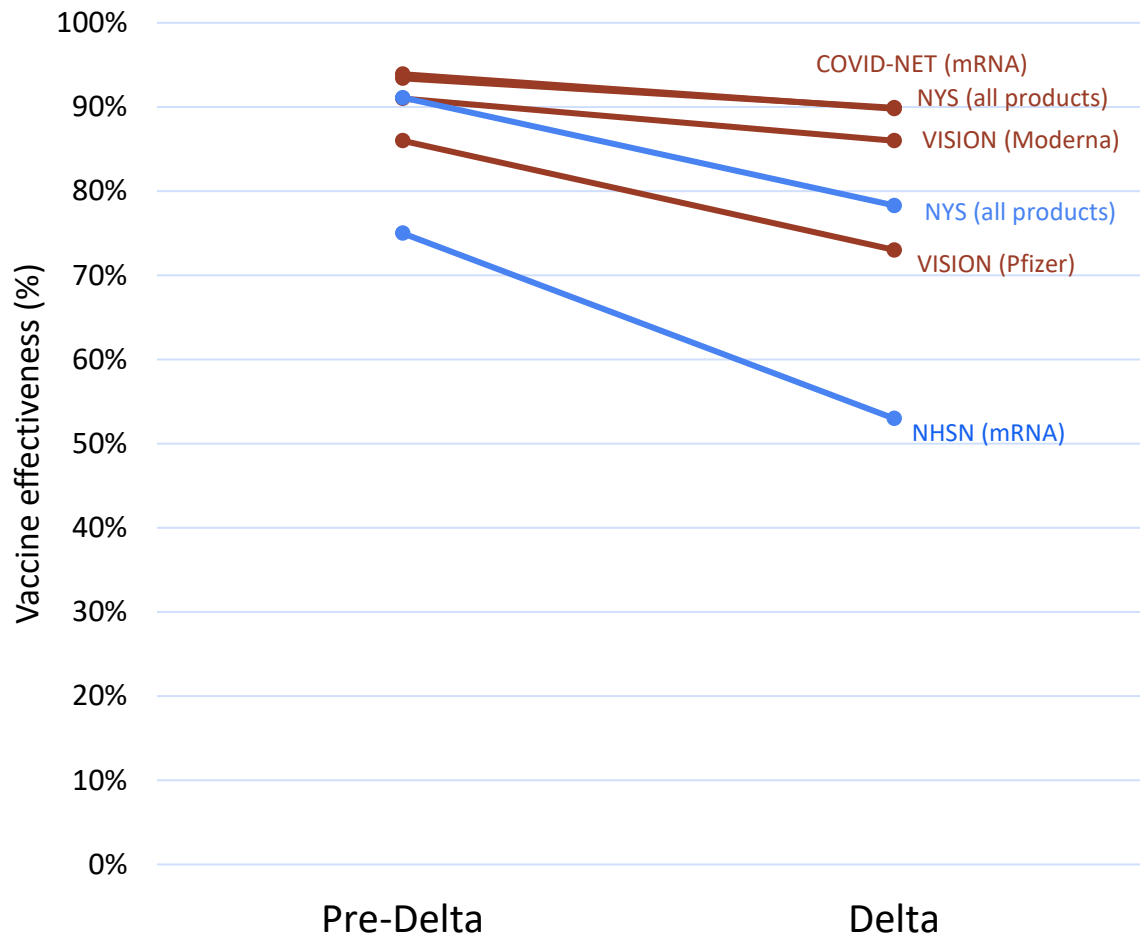
	Pre-Delta (Mar 1–May 9)	Intermediate (May 10–Jun 20)	Delta (Jun 20–Aug 1)
No. of weekly reports	17,407	33,160	85,593
No. of facilities	3,862	11,581	14,917

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;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

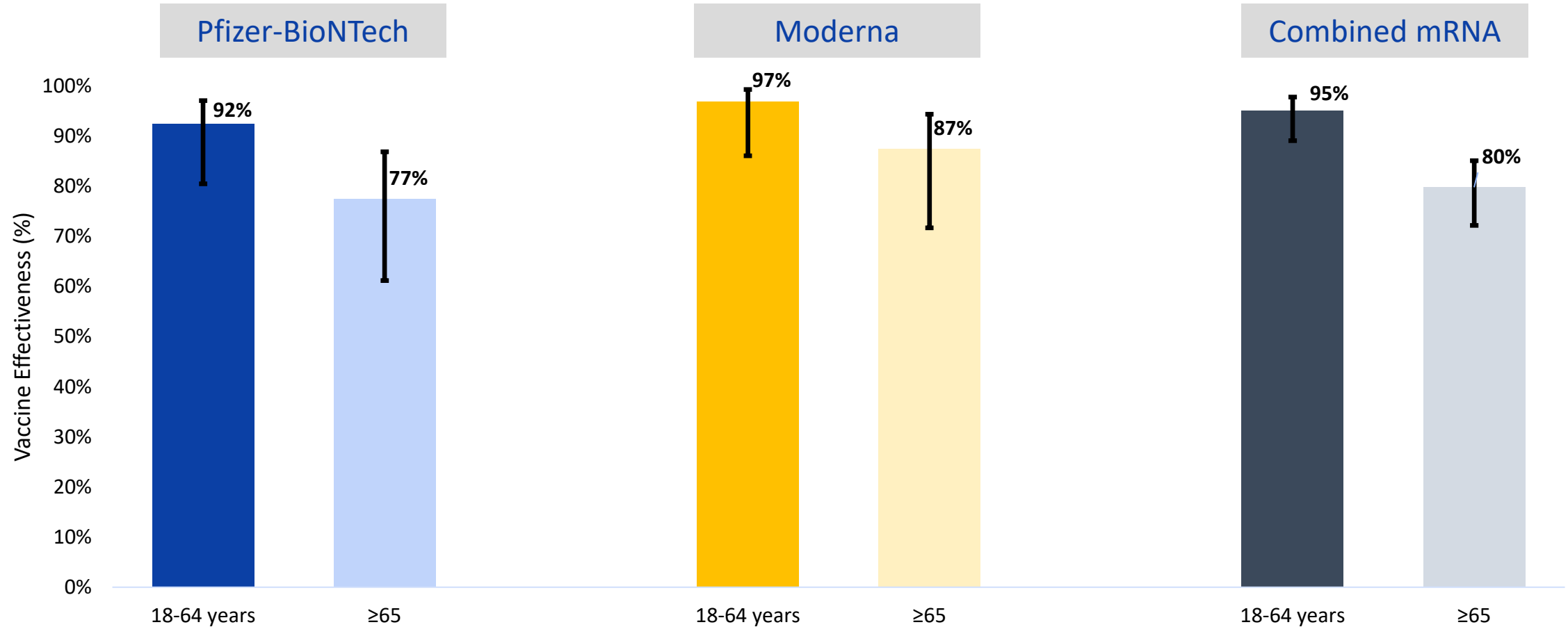
Vaccine effectiveness of mRNA vaccines against COVID-19-associated hospitalization: SUPERNOVA Network

- **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

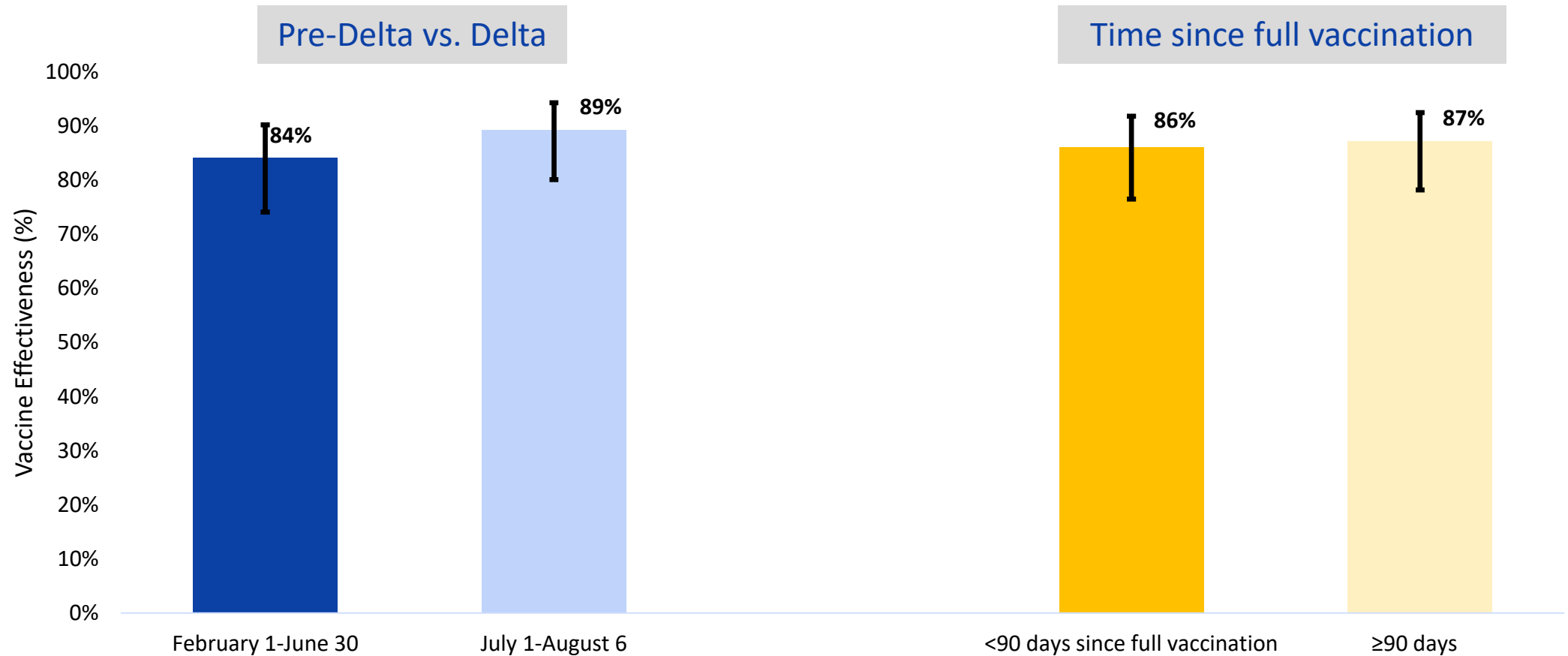
SURveillance Platform for Enteric and Respiratory iNfectious Organisms at the VA



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

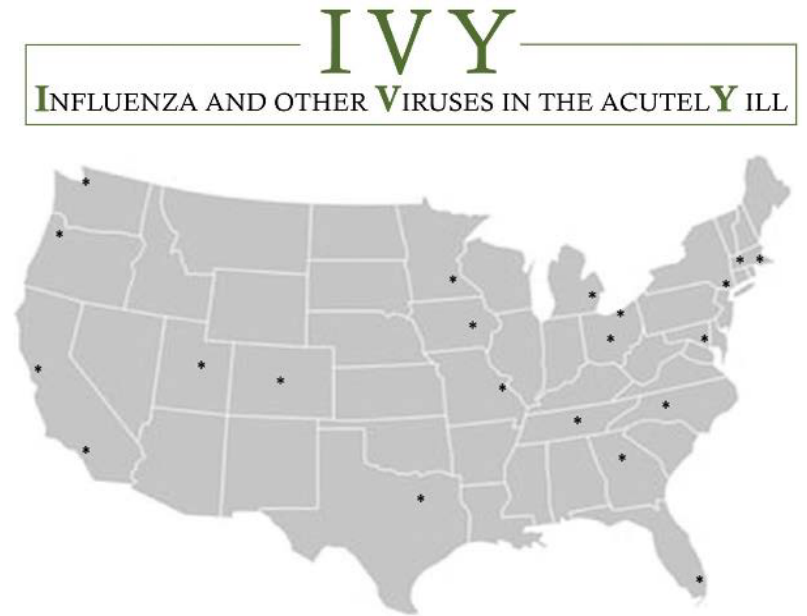


SUPERNOVA: mRNA VE against COVID-19-associated hospitalization, by Delta variant predominance and time since vaccination

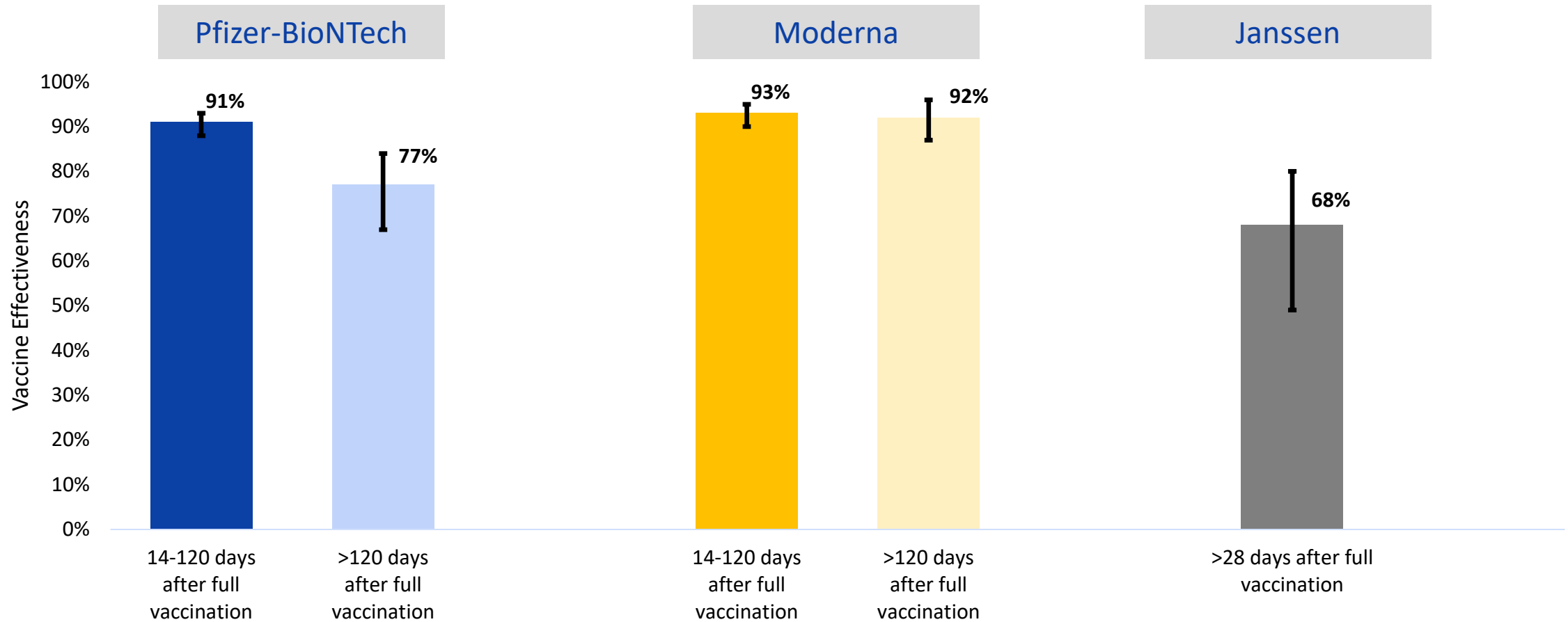


Effectiveness of mRNA vaccines for preventing COVID-19 hospitalization, IVY Network

- **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

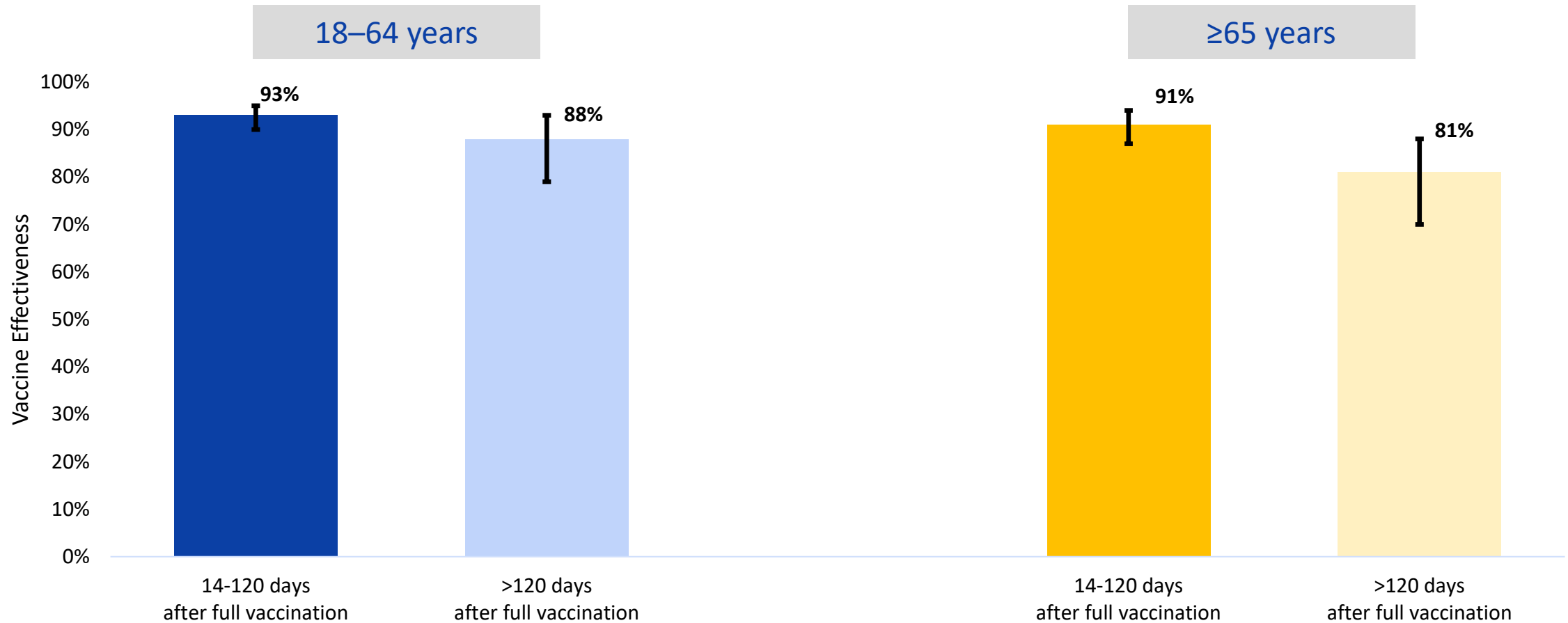


IVY Network: COVID-19 vaccine effectiveness against hospitalization by vaccine product and time since vaccination, adults ≥ 18 years without immunocompromising conditions

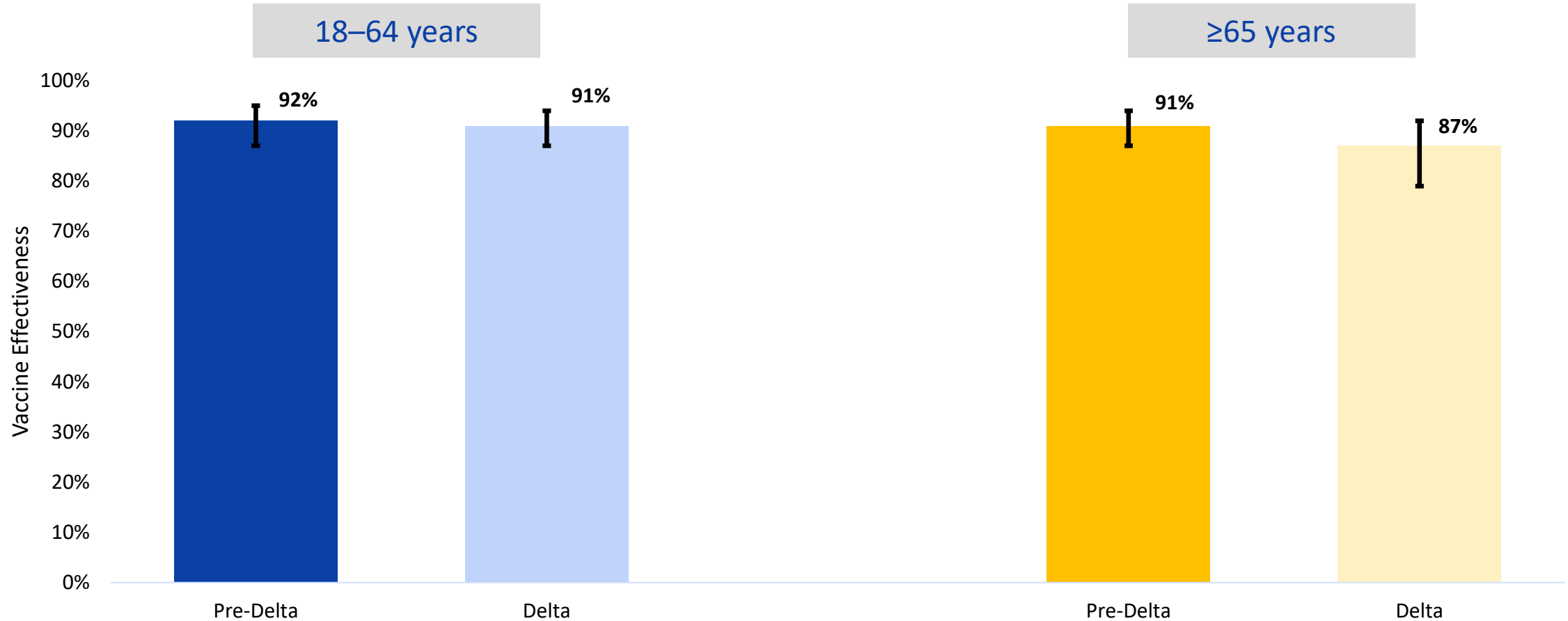


* Adjusted for admission date (biweekly), HHS region, age, sex, race/ethnicity. Not enough recipients of Janssen to assess by time since vaccination.

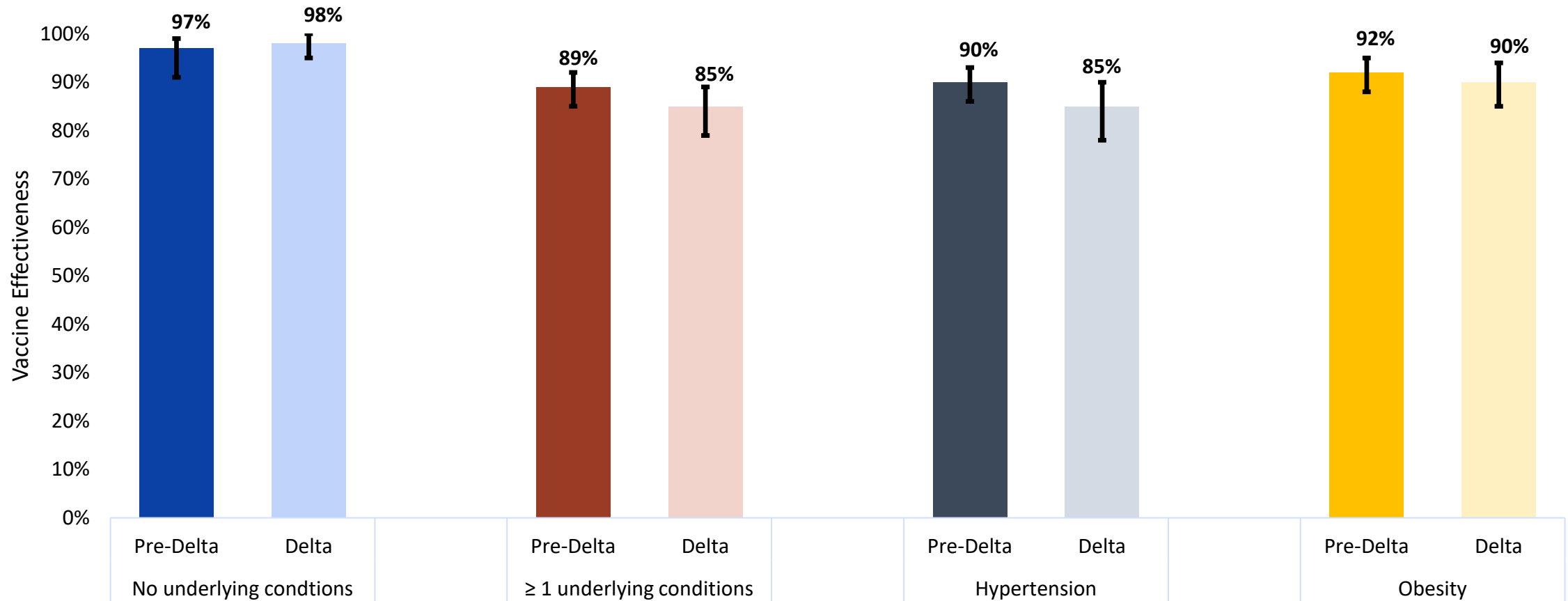
IVY Network: COVID-19 vaccine effectiveness against hospitalization by age group and time since vaccination, adults without immunocompromising conditions, mRNA vaccines



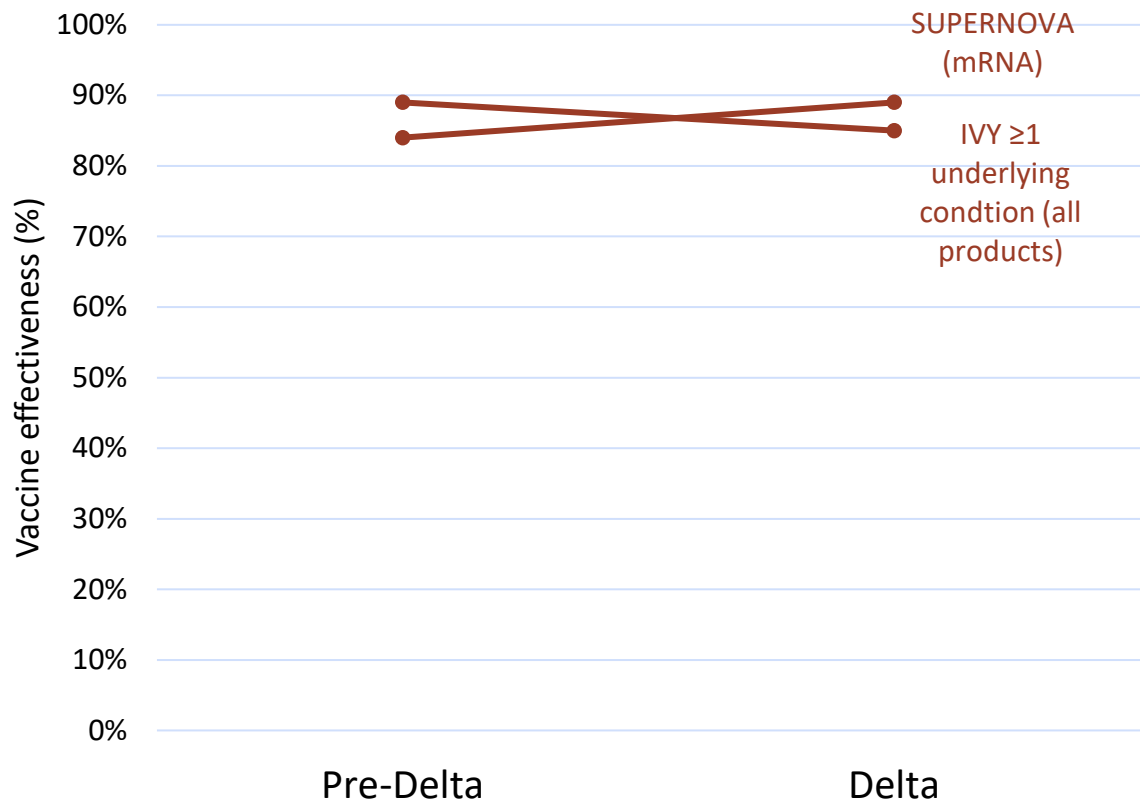
IVY Network: COVID-19 vaccine effectiveness against hospitalization by age group and Delta predominance, adults without immunocompromising conditions, mRNA vaccines



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



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>

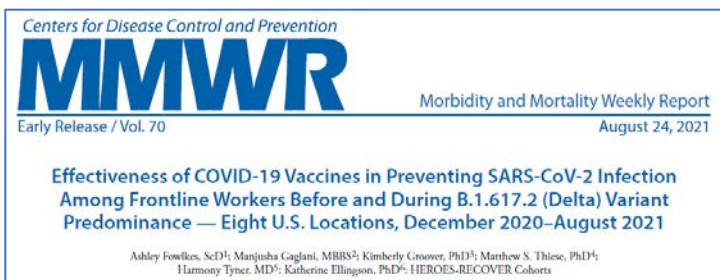
IVY: CDC unpublished data

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

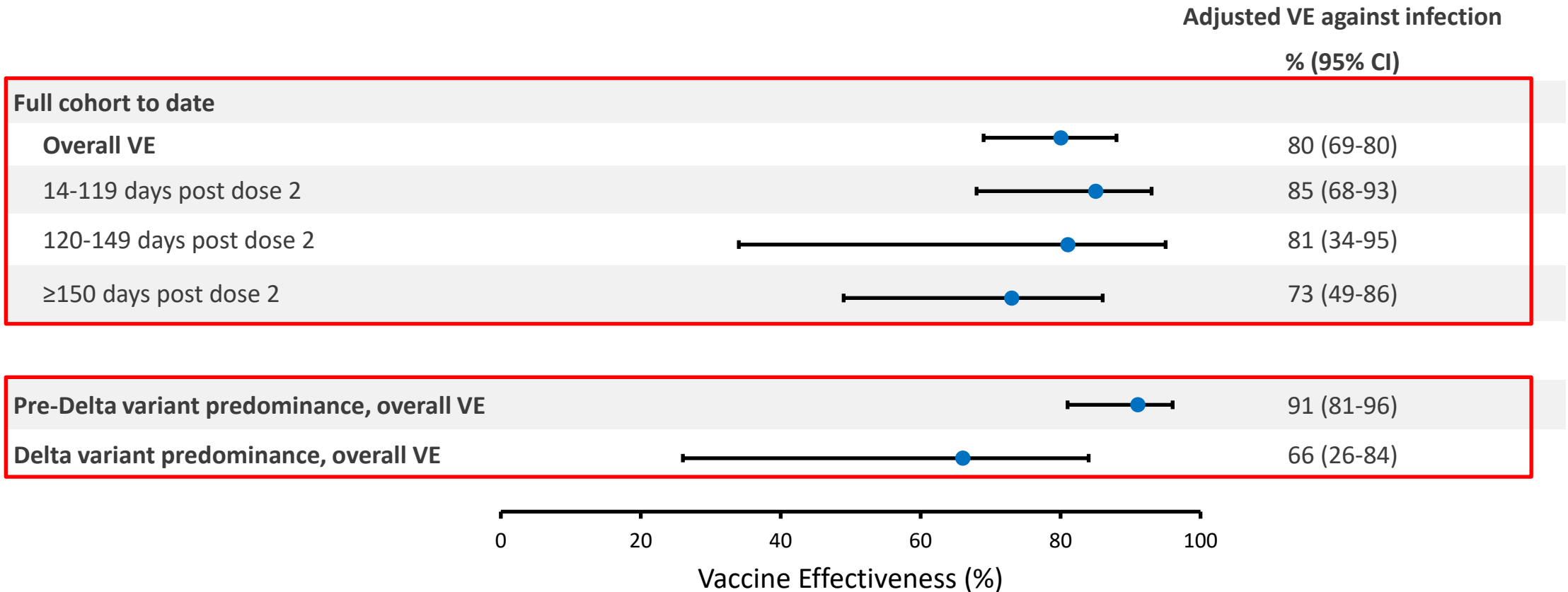
HEROES-RECOVER Cohorts



- 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



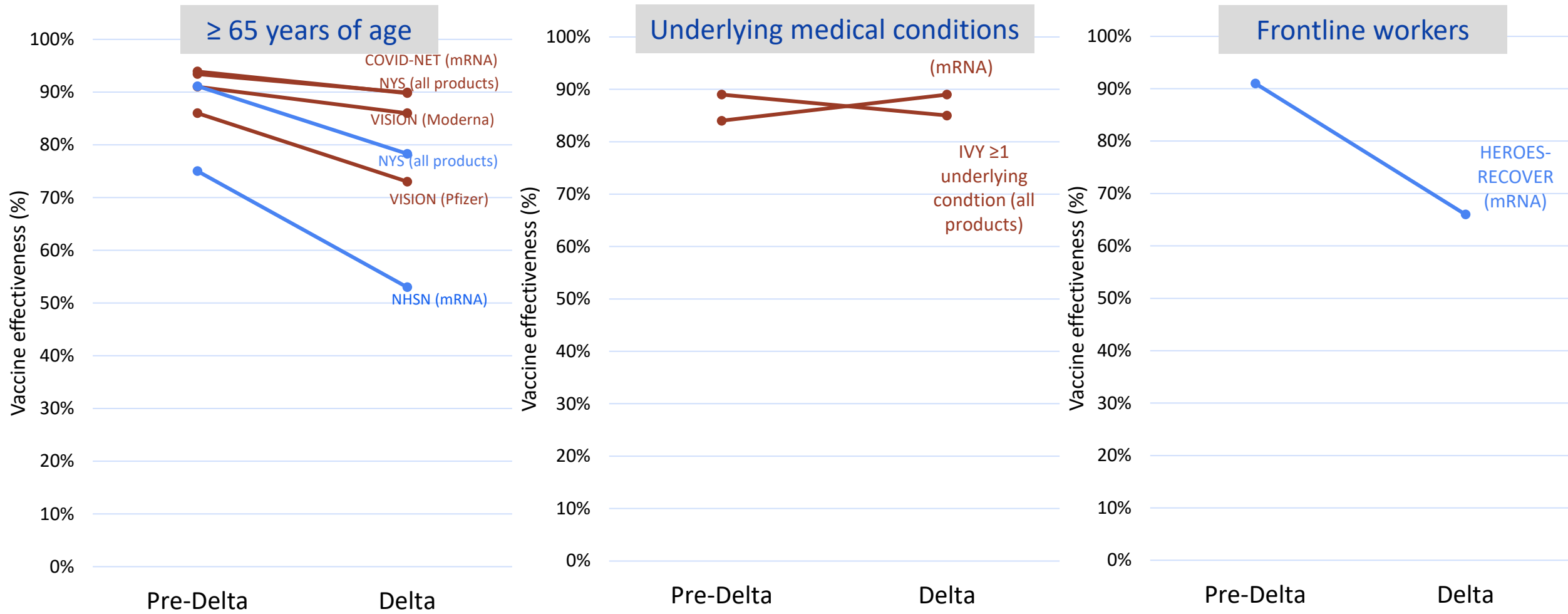
HEROES/RECOVER: VE against SARS-CoV-2 infection by Delta variant predominance and time since full vaccination



- 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

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>

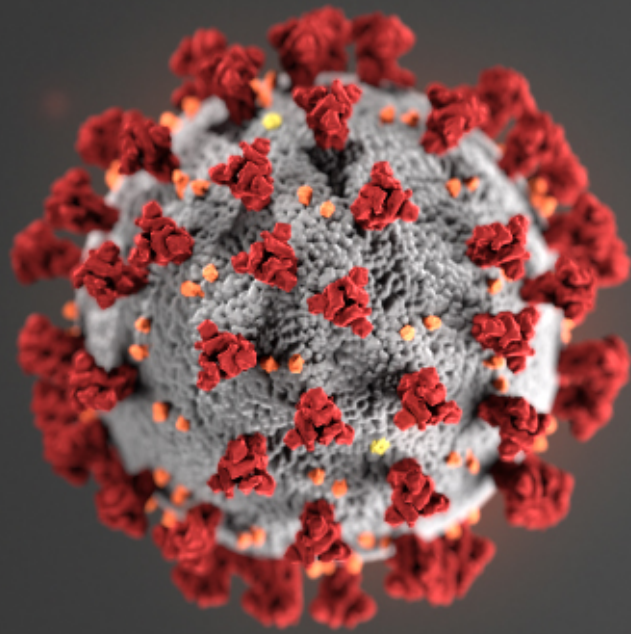
VISION: <https://www.nejm.org/doi/10.1056/NEJMoa2110362> / <https://www.cdc.gov/mmwr/volumes/70/wr/mm7037e2.htm>
 SUPERNOVA: <https://www.cdc.gov/mmwr/volumes/70/wr/mm7037e3.htm>
 HEROES-RECOVER: <https://www.cdc.gov/mmwr/volumes/70/wr/mm7034e4.htm>

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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- New York State Health Department
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 - Fiona Havers
 - Heidi Moline
 - Jessica Smith
 - Manish Patel



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

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