COVID-19 Vaccine Effectiveness in the United States

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

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

Risk group \times Outcome \times 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
- VE estimates adjusted for time, but cannot adjust for other important potential confounders (e.g., comorbidities, prior infection)
COVID-NET vaccine effectiveness against hospitalization, by month and age group, mRNA vaccines

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

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

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

* 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
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

- 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)

Estimates are from over 74,000 hospitalizations across 187 hospitals
VISION Network: VE against hospitalization by time period and age group, Pfizer-BioNTech and Moderna

Pfizer-BioNTech

<table>
<thead>
<tr>
<th>Age Group</th>
<th>Jan to May</th>
<th>Jun to Aug</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-29 years</td>
<td>91%</td>
<td>82%</td>
</tr>
<tr>
<td>30-49 years</td>
<td>85%</td>
<td>99%</td>
</tr>
<tr>
<td>50-64 years</td>
<td>93%</td>
<td>91%</td>
</tr>
<tr>
<td>65+ years</td>
<td>91%</td>
<td>86%</td>
</tr>
</tbody>
</table>

Modern

<table>
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<th>Age Group</th>
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<th>Jun to Aug</th>
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*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

- ≥50 years: 68%
- ≥18 years: 60%

Pre-Delta

Delta

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)

<table>
<thead>
<tr>
<th></th>
<th>Pre-Delta (Mar 1–May 9)</th>
<th>Intermediate (May 10–Jun 20)</th>
<th>Delta (Jun 20–Aug 1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of weekly reports</td>
<td>17,407</td>
<td>33,160</td>
<td>85,593</td>
</tr>
<tr>
<td>No. of facilities</td>
<td>3,862</td>
<td>11,581</td>
<td>14,917</td>
</tr>
</tbody>
</table>

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

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

![Vaccine Effectiveness Graph]

- **Pfizer-BioNTech**
  - 18-64 years: 92%
  - ≥65: 77%

- **Moderna**
  - 18-64 years: 97%
  - ≥65: 87%

- **Combined mRNA**
  - 18-64 years: 95%
  - ≥65: 80%

Source: [CDC](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

Pre-Delta vs. Delta
- February 1-June 30: 84%
- July 1-August 6: 89%

Time since full vaccination
- <90 days since full vaccination: 86%
- ≥90 days: 87%

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

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

Vaccine Effectiveness

- **Pfizer-BioNTech**
  - 14-120 days after full vaccination: 91%
  - >120 days after full vaccination: 77%

- **Moderna**
  - 14-120 days after full vaccination: 93%
  - >120 days after full vaccination: 92%

- **Janssen**
  - >28 days after full vaccination: 68%

* 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](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

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

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**Adjusted VE against infection**

<table>
<thead>
<tr>
<th>Time since dose 2</th>
<th>Overall VE</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Full cohort to date</td>
<td>80 (69-80)</td>
<td>85 (68-93)</td>
</tr>
<tr>
<td>14-119 days post dose 2</td>
<td>81 (34-95)</td>
<td>73 (49-86)</td>
</tr>
<tr>
<td>Pre-Delta variant predominance, overall VE</td>
<td>91 (81-96)</td>
<td>66 (26-84)</td>
</tr>
</tbody>
</table>

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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

≥ 65 years of age

Underlying medical conditions

Frontline workers
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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  - Heidi Moline
  - Jessica Smith
  - Manish Patel
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1-800-CDC-INFO (232-4636)

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