Results of COVID-19 Vaccine Effectiveness Studies: An Ongoing Systematic Review

Forest Plots: Vaccine Effectiveness against Omicron Variant of Concern

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METHODS FOR INCLUSION IN FOREST PLOTS

Vaccine Effectiveness (VE) estimates included in these plots are from an ongoing systematic review of COVID-19 vaccine effectiveness studies. Due to the predominance of the Omicron variant across the globe, the plots in this document are restricted to studies conducted during a period when the Omicron variant was the dominant circulating variant. The previous version of the plots (posted regularly between November 18, 2021 and June 2, 2022) also showed results for the Delta variant, and an earlier version (prior to November 18, 2021) showed results from all studies, regardless of dominant variant at the time. These earlier versions are available on the VIEW-hub resources page (https://view-hub.org/resources). Complete details on the method of the systematic review as well as a summary table of results can also be found on the VIEW-hub Resources Page:

- “COVID-19 Vaccine Effectiveness and Impact Studies Review Methods”
- “COVID-19 Vaccine Effectiveness Results Summary Table”

The VE estimates included in the plots are a subset of the estimates abstracted from the systematic literature review. A single study can include many VE estimates. In an effort to not overrepresent the amount of evidence that exists for each vaccine, the following criteria are used to determine which VE estimates are displayed in the forest plots located on the VIEW-hub resources page (https://view-hub.org/resources). There are some instances when more than one estimate from a study will be displayed in the same plot (e.g. a study includes VE estimates from two distinct populations). Reference numbers are included for each VE estimate displayed so users can identify when a study is represented more than once within a plot. More information on each reference can be found in the weekly literature review summary table located on VIEW-HUB (https://view-hub.org/resources).

- Complete vaccination is defined as ≥7 days post final dose
- If a study reports results for the same outcome for both combined and individual vaccines, only individual vaccine VE estimates are displayed. This criterion only applies to studies evaluating VE of BNT162b2 (Pfizer) and mRNA-1273 (Moderna) vaccines.
- If a study reports results from 2 different evaluation designs (e.g. test-negative design and cohort design) on the same population, VE estimates from the primary analysis only are displayed.
- If a study reports VE estimates for the same disease outcome for different populations, the general population VE estimate is displayed when available. If a general population estimate is not available, the VE from each population is displayed (exception is when there are estimates for similar age groups in which case the more stable VE estimate will be displayed).
- If a study reports VE estimates on more than one ‘severe’ disease outcome (e.g. ‘severe disease’, ‘hospitalization’, and ‘ICU admission’), the more inclusive disease outcome including a larger population is displayed. These different types of severe outcomes are labeled as ‘severe disease’ in the plots, however it is important to keep in mind that the definition of severe disease varies and may explain some differences in VE estimates for severe disease outcomes.
- If a study reports VE estimates for different time intervals from the final dose, those from the earlier time intervals are plotted in an effort to remove the effect of possible waning of immunity. Studies that report only VE estimates that include a follow-up time that extends beyond 4 months post final dose are indicated with a ‘+’ following the reference number located in the label on the y-axis; these estimates appear at the bottom of each disease outcome panel for all plots.
ABBREVIATIONS

asymptomatic
HCW = healthcare workers
HHC = household contacts
LTCF = long-term care facility
pop = population
SNF = skilled nursing facility
PRIMARY SERIES AND FIRST BOOSTER DOSE EFFECTIVENESS AGAINST OMICRON

BY VACCINE
Indicates estimates that include a follow-up time extending beyond 4 months post final dose.
+ Indicates estimates that include a follow-up time extending beyond 4 months post final dose.
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BY STUDY POPULATION OF SPECIAL INTEREST

Vaccine Effectiveness Among Older Adults/Skilled Nursing Facility Residents, Omicron Variant
(ref no) country, population, subvariant (if known)

Primary series vaccination

<table>
<thead>
<tr>
<th>Study</th>
<th>Country</th>
<th>Age Group</th>
<th>Subvariant</th>
</tr>
</thead>
<tbody>
<tr>
<td>301+</td>
<td>Hong Kong, SAR, 65+ years, BA.2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>332+</td>
<td>Hong Kong, SAR, 60+ years, BA.2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>365+</td>
<td>China, 60+ years, BA.1/BA.2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>366+</td>
<td>South Korea, 60+ years, BA.1/BA.2/BA.4/BA.5</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Study</th>
<th>Country</th>
<th>Age Group</th>
<th>Subvariant</th>
</tr>
</thead>
<tbody>
<tr>
<td>200+</td>
<td>Finland, 70+ years, omicron</td>
<td></td>
<td></td>
</tr>
<tr>
<td>210+</td>
<td>UK, 65+ years, omicron</td>
<td></td>
<td></td>
</tr>
<tr>
<td>221+</td>
<td>Brazil, 60-74 years, omicron</td>
<td></td>
<td></td>
</tr>
<tr>
<td>222+</td>
<td>Brazil, 75+ years, omicron</td>
<td></td>
<td></td>
</tr>
<tr>
<td>236+</td>
<td>Denmark, 60+ years, omicron</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(325) Canada, LTCF residents, BA.1/BA.2/BA.4/BA.5

<table>
<thead>
<tr>
<th>Study</th>
<th>Country</th>
<th>Age Group</th>
<th>Subvariant</th>
</tr>
</thead>
<tbody>
<tr>
<td>333+</td>
<td>Canada, 70-79 years, BA.1/BA.2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>334+</td>
<td>Canada, 60+ years, BA.1/BA.2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>335+</td>
<td>Canada, 70-79 years, BA.4/BA.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>336+</td>
<td>Canada, 80+ years, BA.4/BA.5</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(354) Canada, 60+ years, BA.1

(355) Canada, 60+ years, BA.2

(304) Canada, 60+ years, BA.4/BA.5

(210+ UK, 65+ years, omicron

(301+ Hong Kong, SAR, 65+ years, BA.2

(332+ Hong Kong, SAR, 60+ years, BA.2

(366+ China, 60+ years, BA.1/BA.2

(366+ South Korea, 60+ years, BA.1/BA.2/BA.4/BA.5

(402+ Chile, Costa Rica, Ecuador, Guatemala, Paraguay, Uruguay, 65+ years, BA.1/BA.2/BA.5

Booster vaccination

<table>
<thead>
<tr>
<th>Study</th>
<th>Country</th>
<th>Age Group</th>
<th>Subvariant</th>
</tr>
</thead>
</table>

(221) Brazil, 60-74 years, omicron

(222) Brazil, 75+ years, omicron

(247) UK, 65+ years, omicron

(325) Canada, LTCF residents, BA.1/BA.2/BA.4/BA.5

<table>
<thead>
<tr>
<th>Study</th>
<th>Country</th>
<th>Age Group</th>
<th>Subvariant</th>
</tr>
</thead>
<tbody>
<tr>
<td>159+</td>
<td>USA, 65+ years, omicron</td>
<td></td>
<td></td>
</tr>
<tr>
<td>236+</td>
<td>Denmark, 60+ years, omicron</td>
<td></td>
<td></td>
</tr>
<tr>
<td>325 +</td>
<td>Canada, LTCF residents, BA.1/BA.2/BA.4/BA.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>159+</td>
<td>USA, 65+ years, omicron</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Effectiveness

Primary Series Vaccine

- Vaxzevria (AstraZeneca)
- BBaB-CorV (Beijing CNBG)
- Covaxin (Shivad)
- CoronaVac (Sinovac)
- WIBP-CorV (Wuhan CNBG)
- Comirnaty (Pfizer BioNTech)
- Spikevax (Moderna)

Booster Vaccine

- No booster (primary series only)
- BBaB-CorV (Beijing CNBG)
- Comirnaty (Pfizer BioNTech)
- Spikevax (Moderna)

* Indicates estimates that that include a follow-up time extending beyond 4 months post final dose.
## Vaccine Effectiveness Among Children, Omicron Variant

(ref no, country, population, subvariant (if known)

### Primary series vaccination

<table>
<thead>
<tr>
<th>Effectiveness</th>
<th>Booster Vaccine</th>
<th>Primary Series Vaccine</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>No booster (primary series only)</td>
<td>CoronaVac (Sinovac)</td>
</tr>
<tr>
<td>0</td>
<td>CoronaVac (Sinovac)</td>
<td>CoronaVac (Sinovac)</td>
</tr>
</tbody>
</table>

### Booster vaccination

<table>
<thead>
<tr>
<th>Effectiveness</th>
<th>Death</th>
<th>Severe disease</th>
<th>Symptomatic disease</th>
<th>Any Infection</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>100</td>
<td>90</td>
<td>80</td>
<td>70</td>
</tr>
</tbody>
</table>

*+ Indicates estimates that that include a follow-up time extending beyond 4 months post final dose.*
Vaccine Effectiveness Among Healthcare Workers, Omicron Variant
(ref no) country, population, subvariant (if known)

(271) South Africa, HCW, omicron-
(280) USA, HCW, omicron-
(261) USA, HCW, omicron-
(275+) Canada, HCW, BA.2-
(363+) Albania, HCW, BA.1/BA.2-
(334) Italy, HCW, omicron-
(395) Norway, HCW, BA.1-
(829) USA, HCW, BA.1/BA.2/BA.5-
(223+) USA, HCW, omicron-
(275+) Canada, HCW, BA.2-
(351+) Italy, HCW, BA.1/BA.2/BA.4/BA.5-
(393+) Albania, HCW, BA.1/BA.2-
(409+) Italy, HCW w/pre infection, BA.1/BA.2/BA.5/BA.1.1-

Primary Series Vaccine: 
- Comirnaty (Pfizer/BioNTech)
- Comirnaty (Pfizer/BioNTech) OR Spikevax (Moderna)
- Spikevax (Moderna)

Booster Vaccine: 
- No booster (primary series only)
- Comirnaty (Pfizer/BioNTech)
- Comirnaty (Pfizer/BioNTech) OR Spikevax (Moderna)
- Spikevax (Moderna)

Vaccine Effectiveness Among Immunocompromised Persons, Omicron Variant
(ref no) country, population, subvariant (if known)

(268+) Hong Kong, SAR, patients with chronic kidney disease, omicron-
(323) USA, immunocompromised adults, omicron-
(323) USA, immunocompromised, 18+ years, omicron-
(333) USA, immunocompromised, BA.1/BA.2/BA.4/BA.5-
(298+) Hong Kong, SAR, patients with chronic kidney disease, omicron-
(299+) USA, immunocompromised adults, omicron-
(299+) USA, immunocompromised, omicron-
(337+) USA, immunocompromised adults, BA.1/BA.2/BA.4/BA.5-
(156) USA, immunocompromised, omicron-
(850) USA, dialysis patients, omicron-
(170+) UK, end stage kidney disease patients, omicron-
(298+) Hong Kong, SAR, patients with chronic kidney disease, omicron-
(299+) USA, immunocompromised, omicron-

Primary Series Vaccine: 
- Vaccinia (Altracaneca)
- CoronaVac (Sinovac)
- Comirnaty (Pfizer/BioNTech)
- Comirnaty (Pfizer/BioNTech) OR Spikevax (Moderna)
- Spikevax (Moderna)

Booster Vaccine: 
- No booster (primary series only)
- Comirnaty (Pfizer/BioNTech)
- Comirnaty (Pfizer/BioNTech) OR Spikevax (Moderna)
- Spikevax (Moderna)

+ Indicates estimates that that include a follow-up time extending beyond 4 months post final dose.
SECOND BOOSTER DOSE ABSOLUTE VACCINE EFFECTIVENESS AGAINST OMICRON

Absolute Vaccine Effectiveness of a Second Booster Dose, Omicron Variant
(booster table ref no) country, population, subvariant (if known)

- Indicates estimates that that include a follow-up time extending beyond 4 months post final dose.
SECOND BOOSTER DOSE RELATIVE VACCINE EFFECTIVENESS AGAINSTOMICRON

(Note: For more information on interpreting relative VE, see the special focus on relative vaccine effectiveness from the WHO June 29th Weekly Epidemiologic Update.)

Relative Vaccine Effectiveness of a Second Booster Dose, Omicron
(booster table ref no country, population, subvariant (if known)

<table>
<thead>
<tr>
<th>Country</th>
<th>Population</th>
<th>Relative VE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Israel</td>
<td>60+ years</td>
<td>80% increase</td>
</tr>
<tr>
<td>Norway</td>
<td>50+ years</td>
<td>75% increase</td>
</tr>
<tr>
<td>Portugal</td>
<td>55-69 years</td>
<td>80% increase</td>
</tr>
</tbody>
</table>

Primary series and first booster vaccine
- Comirnaty (Pfizer-BioNTech) primary + any mRNA booster
- Ad26.COV2.S (Janssen) or Comirnaty (Pfizer-BioNTech) or Spikevax (Moderna) primary + any mRNA booster
- Any primary vaccine + any mRNA booster
- Vaccinem (AstraZeneca) or any mRNA primary + any mRNA booster
- Vaccinem (AstraZeneca) primary + any mRNA booster
- Any primary series + any booster

Symptomatic disease

Second Booster Dose Vaccine
- CoronaVac (Sinovac)
- Ad26.COV2.S (Janssen)
- Vaccinem (AstraZeneca)
- Comirnaty (Pfizer-BioNTech) primary + any mRNA booster
- Spikevax (Moderna) primary + any mRNA booster
- any mRNA
- any mRNA Omicron BA.4/BA.5 variants
- CoronaVac (AstraZeneca) Omicron BA.4/BA.5 variants
- any mRNA Omicron BA 1 variants
- any mRNA Omicron BA 1 or BA.4/BA.5 variants

Any Infection

Relative Vaccine Effectiveness (Second Booster Compared to First Booster)

*All values shown estimate VE of a 2nd booster dose relative to a 1st booster dose.

+ Indicates estimates that that include a follow-up time extending beyond 4 months post final dose.
DURATION OF VACCINE EFFECTIVENESS AGAINST OMICRON: PRIMARY SERIES, FIRST BOOSTER DOSE, AND SECOND BOOSTER DOSE (WHERE DATA AVAILABLE)

Dots represent point estimates of VE from each study; dark black horizontal lines represent median VE across all studies in stratum. Vertical panels represent VE for full primary series (grey dots) and VE for homologous or heterologous booster vaccination (other colored dots) following completion of primary series vaccination with vaccine of primary series noted in panel header. Not shown in plot: VE against severe disease at 0.5–3 month post primary series of Beijing CNBG-BBIBP-CorV (59%). Additional details on the methods for inclusion of the estimates in the plots provided below.
Methods for Duration of Vaccine Effectiveness Figure

- VE studies included in the plot were identified from an ongoing systematic review of COVID-19 vaccine effectiveness studies. All studies were cohort or test-negative designs conducted when Omicron was the predominant circulating variant. Methods for the systematic review and inclusion/exclusion criteria are available on view-hub.org.
- Only studies providing VE estimates of individual vaccines are included in the plot; studies assessing combined VE of more than one vaccine are excluded except for studies of heterologous primary and booster schedules where all participants included in a VE estimate received the same brands of vaccines in the same order.
- Only studies providing VE estimates for discrete time intervals since vaccination or estimates with limited follow-up time (such that the median time point falls clearly in one of the intervals for the plot) are included. Studies that only provide VE estimates over a cumulative period of time covering more than one time interval are excluded because they are difficult to interpret due to the marked waning of VE over time with Omicron.
- Only estimates of absolute vaccine effectiveness (i.e., the comparison group is unvaccinated persons) are included in the plot; estimates of relative vaccine effectiveness (e.g., the comparison group for booster doses is persons having completed the primary series) are excluded as the interpretation of relative vaccine effectiveness is not comparable to absolute vaccine effectiveness.
**Bivalent Vaccine Absolute Vaccine Effectiveness Against Omicron**

Absolute Vaccine Effectiveness of Bivalent mRNA Vaccines received as any dose

- Booster Dose Vaccine
  - Any mRNA BA.4/BA.5 bivalent (as any dose)
  - Any mRNA BA.4/BA.5 Bivalent (1st booster)
  - Any mRNA BA.4/BA.5 Bivalent (2nd booster)
  - Any mRNA BA.4/BA.5 Bivalent (1st, 2nd, or 3rd booster)
  - Any mRNA BA.4/BA.5 Bivalent (3rd booster)
  - Pfizer BA.4/BA.5 Bivalent (1st-4th booster)
  - Pfizer BA.4/BA.5 Bivalent (2nd or 3rd booster)
  - Moderna BA.4/BA.5 Bivalent (1st, 2nd, or 3rd booster)
  - Moderna BA.4/BA.5 Bivalent (1st-5th booster)
  - Moderna BA.1 Bivalent (2nd or 3rd booster)
  - Any mRNA BA.1 or BA.4/BA.5 Bivalent (2nd booster)
  - Any mRNA BA.1 or BA.4/BA.5 Bivalent (3rd booster)

- Primary and Previous Booster Vaccines
  - Any monovalent mRNA
  - Any COVID-19 vaccine
  - Any primary series + any monovalent or bivalent mRNA booster

+ Indicates estimates that that include a follow-up time extending beyond 4 months post final dose.
**Vaccine Effectiveness against Omicron XBB Subvariant**

Absolute Vaccine Effectiveness against Omicron XBB

(booster table ref no) country, population, time since last dose

- **First booster**
  - any mRNA BA.4/BA.5 bivalent (as any dose)
  - Pfizer BioNTech BA.4/BA.5 bivalent (1st-4th booster)
  - Moderna BA.4/BA.5 bivalent (1st-5th booster)
  - Pfizer BioNTech XBB.1.5 (any booster dose)

- **Vaccination history**
  - any mRNA
  - any COVID-19 vaccine
  - any monovalent or bivalent BA.4/5 mRNA

+ Indicates estimates that include a follow-up time extending beyond 4 months post final dose.
Relative Vaccine Effectiveness against Omicron XBB

(Note: For more information on interpreting relative VE, see the special focus on relative vaccine effectiveness from the WHO June 29th Weekly Epidemiologic Update.)

(booster table ref no) country, population, time since last dose

Last booster vaccine
- any mRNA monovalent (2nd booster)
- any mRNA BA.4/BA.5 bivalent (as any dose)
- any mRNA BA.4/BA.5 bivalent (2nd or 3rd booster)
- any mRNA BA.4/BA.5 bivalent (1st or 2nd booster)
- any mRNA BA.4/BA.5 bivalent (1st-3rd booster)
- Moderna BA.4/BA.5 bivalent (1st-5th booster)
- Moderna BA.1 bivalent (1st-3rd booster)
- any mRNA BA.1 bivalent (1st-4th booster)
- any mRNA BA.1 bivalent (1st-5th booster)
- Moderna BA.1 bivalent or Pfizer BioNTech BA.4/BA.5 bivalent (2nd booster)
- any mRNA BA.1 or BA.4/BA.5 bivalent (3rd booster)
- Pfizer BioNTech XBB.1.5 (any booster dose)
- SanoBi/GSK monovalent beta variant booster (1st-5th booster)

Vaccination history
- AstraZeneca or any mRNA
- any mRNA
- any COVID-19 vaccine
- any COVID-19 vaccine primary + any mRNA first booster
- any COVID-19 vaccine primary + any monovalent or bivalent BA.1 mRNA first booster + any bivalent BA.1 mRNA second booster
- any COVID-19 vaccine, with last dose as any Omicron BA.1 bivalent mRNA
- any COVID-19 vaccine + any mRNA first booster + any monovalent or bivalent (BA.1 or BA.4/BA.5) second booster
- any monovalent or bivalent BA.4/BA.5 mRNA

+ Indicates estimates that include a follow-up time extending beyond 4 months post final dose.