COVID-19 vaccine effectiveness updates

19 April 2023

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Organization of presentation

- Updates on vaccine effectiveness (VE) of monovalent vaccines against *symptomatic infection* in children aged 6 months–4 years (Pfizer-BioNTech) and 6 months–5 years (Moderna)
- Update on VE of monovalent and bivalent vaccines against *severe disease* in adults with and without immunocompromising conditions

Estimates of Effectiveness of Monovalent mRNA Vaccines in Preventing Symptomatic SARS-CoV-2 Infection Among Children Aged 3–5 Years, Increasing Community Access to Testing Program

Updated analyses based on: Fleming Dutra KE, Ciesla AA, Roper, LE et al. Preliminary Estimates of Effectiveness of Monovalent mRNA Vaccines in Preventing Symptomatic SARS CoV 2 Infection Among Children Aged 3 5 Years Increasing Community Access to Testing Program, United States, July 2022 February 2023. MMWR Morb Mortal Wkly Rep 2023;72:177 182. DOI: http://dx.doi.org/10.15585/mmwr.mm7207a3

Percent of people receiving COVID-19 vaccine by age and date administered – United States, December 14, 2020 – April 12, 2023

	<2 yrs	2-4 yrs	5-11 yrs	12-17 yrs	18-24 yrs	25-49 yrs	50-64 yrs	+65 yrs
At Least One Dose	8.7%	10.8%	40.0%	72.2%	82.2%	85.5%	95.0%	95.0%
Completed Primary Series	4.5%	6.0%	32.8%	61.8%	66.7%	72.2%	83.8%	94.3%
Updated (Bivalent) Booster Dose	0.5%	0.5%	4.6%	7.6%	7.2%	11.9%	21.5%	42.6%

https://covid.cdc.gov/covid-data-tracker/#vaccination-demographics-trends

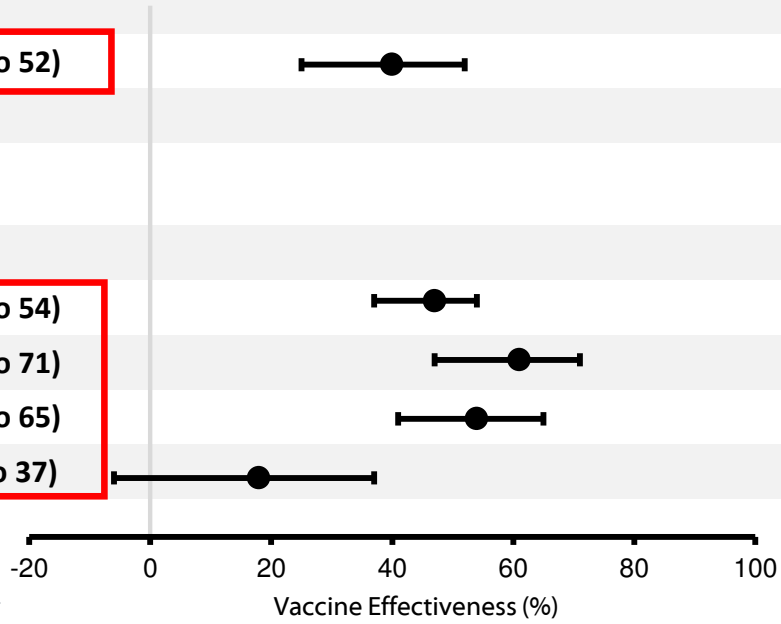
Increasing Community Access to Testing (ICATT) Program: VE of monovalent COVID-19 vaccines against *symptomatic infection* in children aged 3-5 years

- Nationwide community-based drive-through SARS-CoV-2 testing via pharmacies
- Self-reported vaccine history at time of registration for SARS-CoV-2 testing
- **Design**: Test-negative, case-control analysis*
- **Population**: Immunocompetent children aged 3 – 4/5** years with ≥1 COVID-like symptom and nucleic acid amplification testing (NAAT)
- **Period for analysis:**
  - Tested: July 4, 2022*** – April 8, 2023, BA.4/BA.5 and XBB predominant period

*Models adjusted for: age, gender, race, ethnicity, social vulnerability index and HHS region of the testing location, underlying conditions (presence versus absence), pharmacy chain conducting the test, local incidence (cases per 100,000 by individual county and state in the 7 days before test date), and date of testing.
** ICATT testing is generally limited to children ages 3 and up.
***Analysis start date depended on vaccine/dose number being analyzed: Pfizer and Moderna 1st doses started 7/4/2022; Pfizer 2nd dose started 7/25/2022; Moderna 2nd dose started 8/1/2022; Pfizer 3rd dose started 9/19/2022.

ICATT: Estimates of VE for primary series monovalent Moderna vaccine (children aged 3–5 years) against *symptomatic infection*, July 4, 2022 – April 8, 2023

Vaccination status (months since last dose)	Total tests	SARS-CoV-2 positive, N (%)	Adjusted VE (95% CI)
Moderna, 1 dose (partial series; ages 3-5 years) *July 4, 2022 – April 8, 2023*			
Unvaccinated	36,779	9,801 (27)	**Ref**
1 monovalent dose (2 weeks–1 month)*	515	107 (21)	**40 (25 to 52)**
Moderna, 2 doses (complete series; ages 3-5 years) *August 1, 2022 – April 8, 2023*			
Unvaccinated	26,856	5,972 (22)	**Ref**
2 monovalent doses (2 weeks–6 months)*	1,613	183 (11)	**47 (37 to 54)**
2 monovalent doses (2 weeks–1 month)*	461	48 (10)	**61 (47 to 71)**
2 monovalent doses (2–3 months)*	647	63 (10)	**54 (41 to 65)**
2 monovalent doses (4–6 months)*	505	72 (14)	**18 (-6 to 37)**

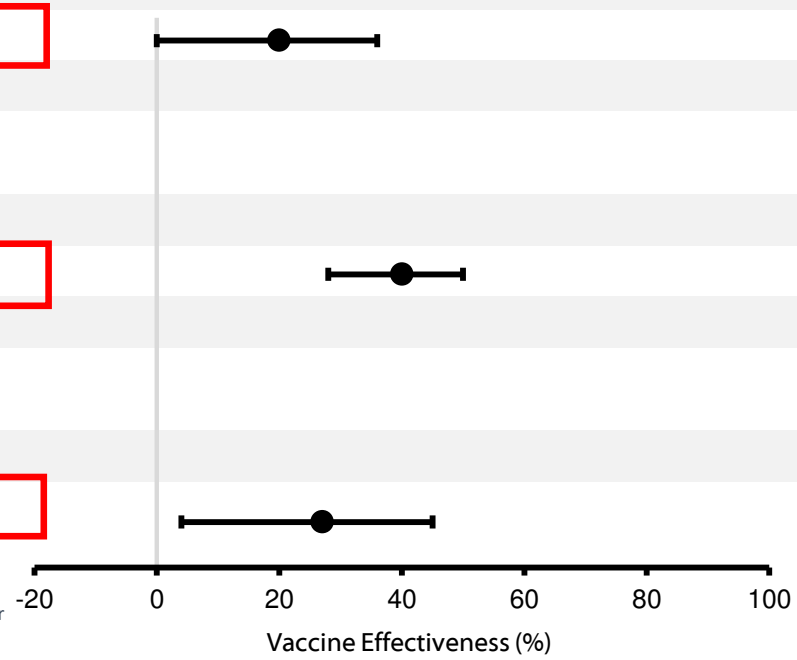


Updated from: Fleming-Dutra, Ciesla, Roper, et al. MMWR February 16, 2023.

*Test registrants who report receiving COVID-19 vaccines are asked to report the total number of doses and manufacturer(s) of vaccines received and for the most recent dose, month and year of receipt; therefore, the number of months between a vaccine dose and testing is a whole number calculated as the difference between the month and year of testing and the month and year of the vaccine dose. For doses received in the same month or the month before SARS-CoV-2 testing, an additional question was asked to specify whether the dose was received ≥2 weeks before testing, and only doses received ≥2 weeks before testing were included. 17% and 21% of children who received 1 and 2 doses of Moderna, respectively, reported a prior infection >90 days before the current test.

ICATT: Estimates of VE for primary series monovalent Pfizer-BioNTech vaccine (children aged 3–4 years) against *symptomatic infection*, July 4, 2022 – April 8, 2023

Vaccination status (months since last dose)	Total tests	SARS-CoV-2 positive, N (%)	Adjusted VE (95% CI)
Pfizer, 1 dose (partial series; ages 3–4 years) *July 4, 2022–April 8, 2023*			
Unvaccinated	23,376	6,381 (27)	**Ref**
1 monovalent dose (2 weeks–1 month)*	448	114 (25)	**20 (0 to 36)**
Pfizer, 2 doses (partial series; ages 3–4 years) *July 25, 2022–April 8, 2023*			
Unvaccinated	18,492	4,469 (24)	**Ref**
2 monovalent doses (2 weeks–3 months)*	951	140 (15)	**40 (28 to 50)**
Pfizer, 3 doses (complete series; ages 3–4 years)** *September 19, 2022–April 8, 2023*			
Unvaccinated	8,610	1,445 (17)	**Ref**
3 monovalent doses (2 weeks–6 months)*	478	64 (13)	**27 (4 to 45)**



Updated from: Fleming-Dutra, Ciesla, Roper, et al. MMWR February 16, 2023.

*Test registrants who report receiving COVID-19 vaccines are asked to report the total number of doses and manufacturer(s) of vaccines received and for the most recent dose, month and year of receipt; therefore, the number of months between a vaccine dose and testing is a whole number calculated as the difference between the month and year of testing and the month and year of the vaccine dose. For doses received in the same month or the month before SARS-CoV-2 testing, an additional question was asked to specify whether the dose was received ≥2 weeks before testing, and only doses received ≥2 weeks before testing were included. 18%, 19% and 21% of children who received 1, 2, and 3 doses of Pfizer, respectively, reported a prior infection >90 days before the current test.

**There was insufficient power to stratify Pfizer-BioNTech 3-dose VE estimates by time since vaccination.

Limitations

- Vaccine coverage is low in children aged ≤5 years. VE estimates may be less stable when vaccine coverage is low.
- Prevalence of prior infection in children is high*; consequently, VE in this analysis reflects the current situation among young children in the United States.
- Low vaccination coverage in this age group may impact future ability to estimate VE, including against more severe outcomes.
- The goal of the U.S. COVID-19 vaccination program is to prevent severe disease; however, VE against symptomatic infection provides important insight into vaccine protection, especially before VE estimates for key questions are available.

*https://covid.cdc.gov/covid-data-tracker/#pediatric-seroprevalence; 92% seroprevalence in children 6 months -17 years nationally by December 2022.

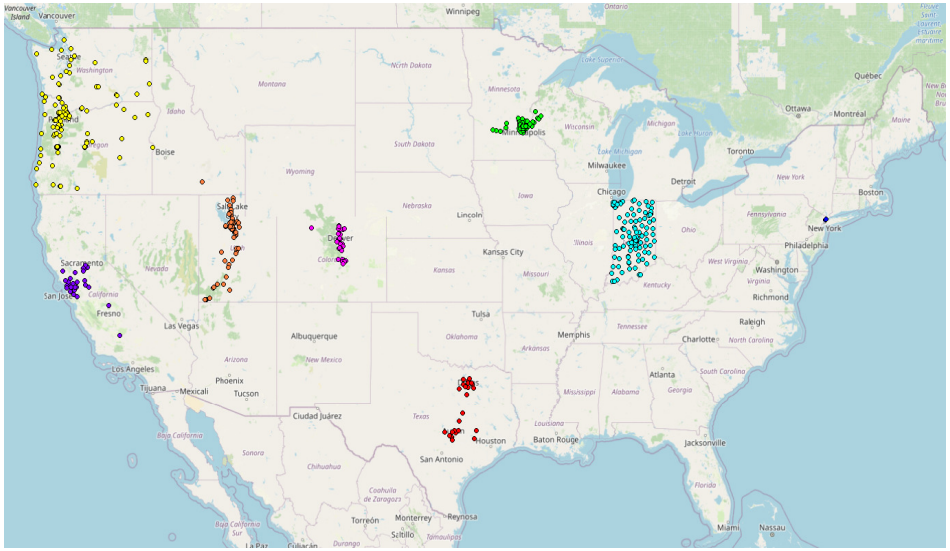
Conclusions

- Complete monovalent primary series vaccination helped provide protection for children aged 3–5 years against *symptomatic* SARS-CoV-2 infection for at least the first 3 months after vaccination.
- Waning of monovalent Moderna primary series appears to occur by 4–6 months after the second dose.
- Initial protection and waning patterns are similar to those observed in older children and adults in the first months after vaccination.
- Waning of monovalent Pfizer-BioNTech VE against symptomatic infection could not be assessed but is also likely based on analyses in older children and adults.
- Children should stay up to date with COVID-19 vaccines.
- CDC will continue to monitor VE in this age group, including against severe disease and for bivalent doses.

Updated estimates of bivalent VE against emergency department/urgent care encounters and hospitalizations among adults aged ≥18 years, VISION Network

Updated analyses based on: Tenforde MW, Weber ZA, Natarajan K, et al. Early Estimates of Bivalent mRNA Vaccine Effectiveness in Preventing COVID 19 Associated Emergency Department or Urgent Care Encounters and Hospitalizations Among Immunocompetent Adults VISION Network, Nine States, September November 2022. MMWR Morb Mortal Wkly Rep 2023;71:1637 1646. DOI: http://dx.doi.org/10.15585/mmwr.mm7153a1

VISION Multi-State Network of Electronic Health Records

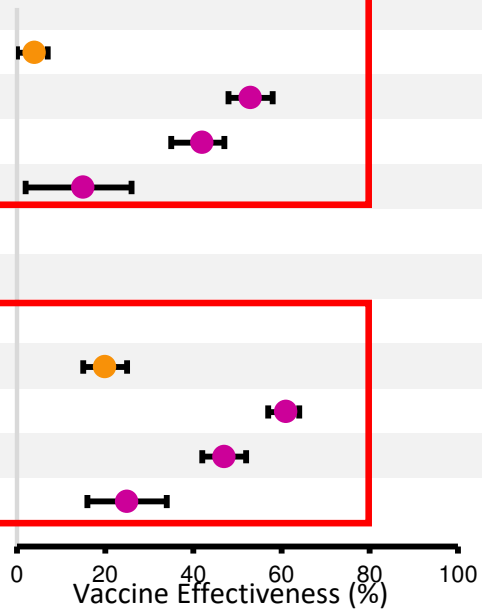


- **Cases**: COVID-like illness (CLI) with positive PCR for SARS-CoV-2 within 14 days before or 72 hours after the admission or encounter
- **Controls**: CLI with negative PCR for SARS-CoV-2

- Variant periods designated for analysis based on time when novel sublineage became predominant at study site
- VE adjusted for age, sex, race, ethnicity, geographic region, calendar time, and local rates of SARS-CoV-2 circulation
- Vaccination documented by electronic health records and state and city registries

VISION: *Absolute* VE of monovalent and bivalent booster against *ED/UC encounters* among immunocompetent adults aged ≥18 years, by age group – September 2022 – March 2023*

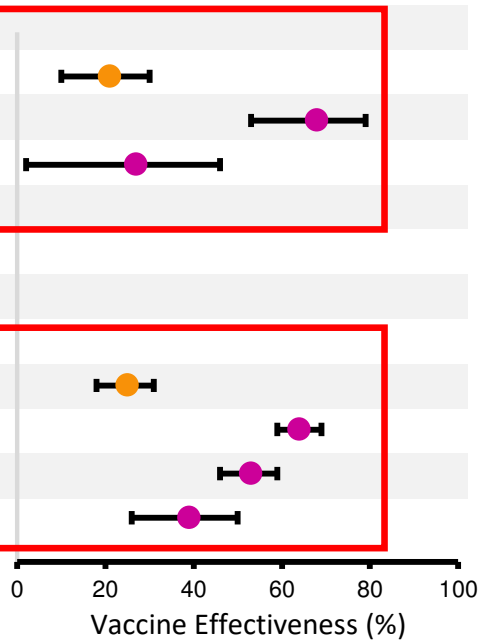
mRNA Dosage Pattern	Total tests	SARS-CoV-2-test-positive, N (%)	Median interval since last dose, days (IQR)	Adjusted VE (95% CI)
Aged 18-64 years				
Unvaccinated (ref)	55,418	5,699 (10)	--	**Ref**
Monovalent doses only, last dose ≥2 months earlier	81,766	8,518 (10)	391 (311-518)	**4 (0-7)**
Bivalent booster, 7-59 days earlier	6,744	399 (6)	33 (20-46)	**53 (48-58)**
Bivalent booster, 60-119 days earlier	5,834	428 (7)	84 (71-100)	**42 (35-47)**
Bivalent booster, 120-179 days earlier	2,352	243 (10)	139 (129-153)	**15 (2-26)**
Aged ≥65 years				
Unvaccinated (ref)	10,559	1,833 (17)	--	**Ref**
Monovalent doses only, last dose ≥2 months earlier	42,019	5,721 (14)	343 (215-441)	**20 (15-25)**
Bivalent booster, 7-59 days earlier	9,103	724 (8)	35 (21-47)	**61 (57-64)**
Bivalent booster, 60-119 days earlier	9,086	935 (10)	86 (73-101)	**47 (42-52)**
Bivalent booster, 120-179 days earlier	3,857	483 (13)	139 (129-153)	**25 (16-34)**



*Unpublished CDC data.

VISION: *Absolute* VE of monovalent and bivalent booster against *hospitalization* among immunocompetent adults aged ≥18 years, by age group – September 2022 – March 2023*

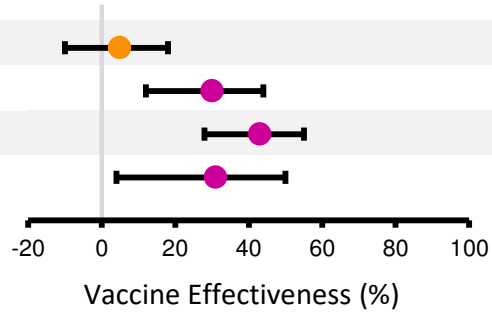
mRNA Dosage Pattern	Total tests	SARS-CoV-2-test-positive, N (%)	Median interval since last dose, days (IQR)	Adjusted VE (95% CI)
Aged 18-64 years				
Unvaccinated (ref)	7,126	565 (8)	--	**Ref**
Monovalent doses only, last dose ≥2 months earlier	9,621	659(7)	388 (300-522)	**21 (10-30)**
Bivalent booster, 7-59 days earlier	839	28 (3)	33 (21-46)	**68 (53 to 79)**
Bivalent booster, 60-119 days earlier	746	56 (8)	84 (70-101)	**27 (2 to 46)**
Bivalent booster, 120-179 days earlier	268	21 (8)	137 (128-150)	**
Aged ≥65 years				
Unvaccinated (ref)	6,687	1,132 (17)	--	**Ref**
Monovalent doses only, last dose ≥2 months earlier	20,474	2,735 (13)	354 (232-460)	**25 (18 to 31)**
Bivalent booster, 7-59 days earlier	3,494	264 (8)	35 (21-47)	**64 (59 to 69)**
Bivalent booster, 60-119 days earlier	3,561	358 (10)	86 (73-102)	**53 (46 to 59)**
Bivalent booster, 120-179 days earlier	1,472	158 (11)	139 (128-152)	**39 (26 to 50)**



*Unpublished CDC data. **Not included due to imprecise estimates (confidence intervals >50 percentage points).

VISION: *Absolute* VE of bivalent booster against *hospitalization* among immunocompromised adults aged ≥18 years – September 2022 – March 2023*

mRNA Dosage Pattern	Total tests	SARS-CoV-2-test-positive, N (%)	Median interval since last dose, days (IQR)	Adjusted VE (95% CI)
Unvaccinated (ref)	2,763	295 (11)	--	**Ref**
Monovalent doses only, last dose ≥2 months earlier	9,232	977 (11)	343 (225-452)	**5 (-10 to 18)**
Bivalent booster, 7-59 days earlier	1,518	134 (9)	33 (19-46)	**30 (12 to 44)**
Bivalent booster, 60-119 days earlier	1,610	125 (8)	87 (73-102)	**43 (28 to 55)**
Bivalent booster, 120-179 days earlier	723	59 (8)	139 (129-152)	**31 (4 to 50)**



*Unpublished CDC data.

Characteristics of patients with COVID-19-associated hospitalizations, — VISION Network, 10 States, October 29, 2022–March 29, 2023

Characteristic	All hospitalizations N=9499	Critical hospitalizations* N=1839
Age, median (IQR), years	75 (65–84)	74 (63–83)
Female sex, No. (%)	4818 (50.7)	881 (47.9)
No. of categories of underlying medical conditions, median (IQR)**	3 (2–4)	4 (3–5)
Immunocompromising condition, No. (%)	1677 (17.7)	438 (23.8)
COVID-19 vaccination status, No. (%)		
Unvaccinated	2842 (29.9)	625 (34.0)
Complete primary series	2273 (23.9)	451 (24.5)
Primary series + 1 booster dose	2388 (25.1)	445 (24.2)
Primary series + 2 booster doses	1320 (13.9)	218 (11.9)
Primary series + 3 booster doses	668 (7.0)	97 (5.3)
Primary series + 4 booster doses	8 (0.1)	3 (0.2)
Received mRNA bivalent dose***	1567 (16.5)	269 (14.6)

*Admitted to an intensive care unit and/or in-hospital death.
**Categories of underlying medical conditions include pulmonary, cardiovascular, cerebrovascular, neurological or musculoskeletal, endocrine or metabolic, hematologic, renal, hepatic, and immune.
***Any mRNA vaccine doses received on or after September 2, 2022 were considered to be bivalent.
Note: this analysis includes recipients of mRNA or Janssen primary series

Updated estimates of bivalent VE against hospitalizations among adults aged ≥65 years, IVY Network

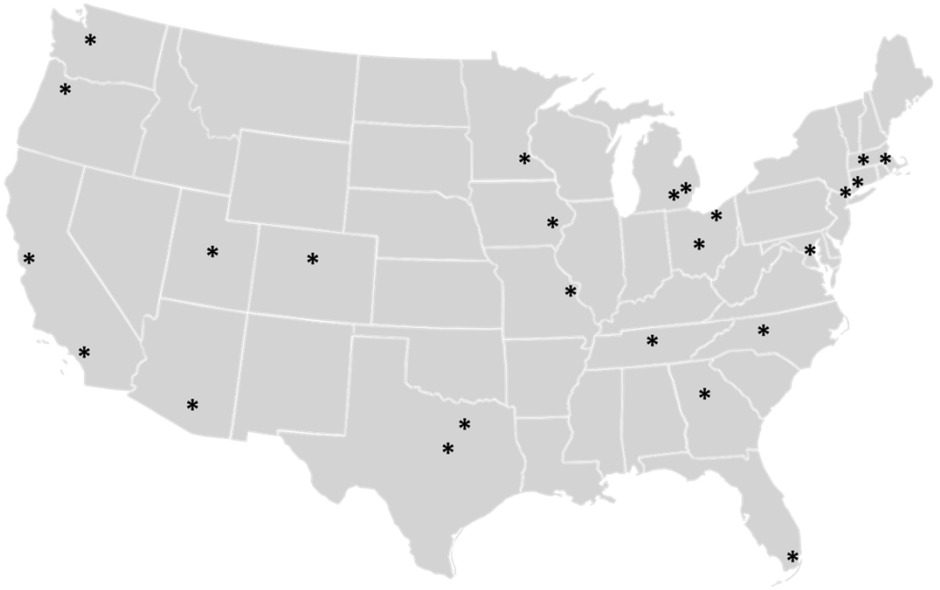
Updated analyses based on: Surie D, DeCuir J, Zhu Y, et al. Early Estimates of Bivalent mRNA Vaccine Effectiveness in Preventing COVID 19 Associated Hospitalization Among Immunocompetent Adults Aged ≥65 Years IVY Network, 18 States, September 8 November 30, 2022. MMWR Morb Mortal Wkly Rep 2022;71:1625 1630. DOI: http://dx.doi.org/10.15585/mmwr.mm715152e2

IVY Network — 25 hospitals, 20 U.S. States

- **Design**: Prospective, case-control
- **Period**: September 8, 2022–April 1, 2023
- **Population**: Adults aged ≥18 years hospitalized with COVID-like illness (CLI)*
- **Cases:** CLI and test positive for SARS-CoV-2 by RT-PCR or antigen test within 10 days of illness
- **Controls:** CLI and test negative for SARS-CoV-2 and influenza by RT-PCR within 10 days of illness
- **VE adjustments:** Age, sex, race and ethnicity, admission date (biweekly), and HHS region

IVY

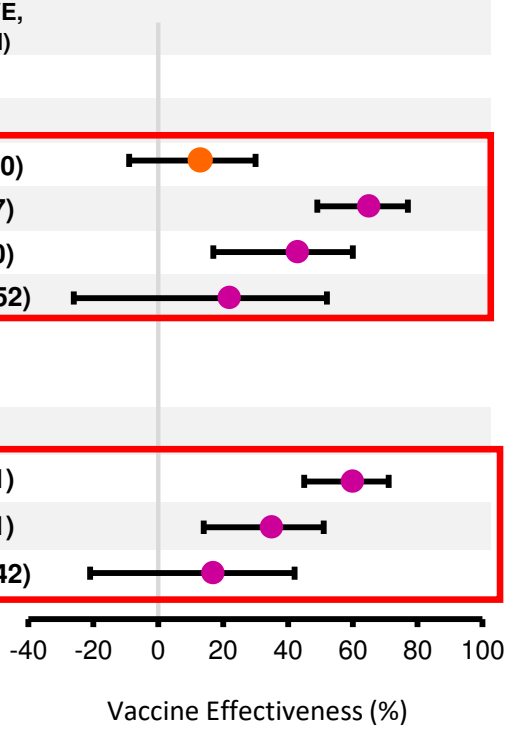
INVESTIGATING RESPIRATORY VIRUSES IN THE ACUTELY ILL



*COVID-like illness (CLI) is defined as presence of any one of the following: fever, cough, shortness of breath, chest imaging consistent with pneumonia, new or worsening hypoxemia

Absolute and relative VE against COVID-19 *hospitalizations* among immunocompetent adults aged *≥65 years* — IVY Network, September 8, 2022 – April 1, 2023

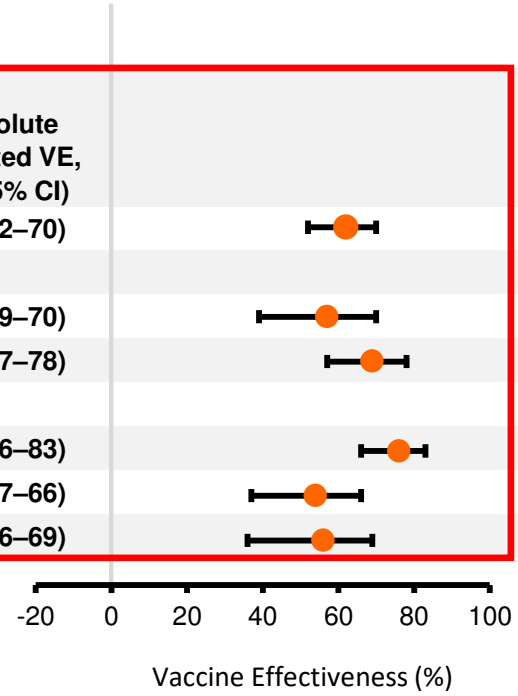
	Vaccinated cases, no./total no. (%)	Vaccinated controls, no./total no. (%)	Median time since last dose, days (IQR)	Adjusted VE, % (95% CI)
Absolute VE				
Unvaccinated (Ref)			--	
Monovalent doses only, last dose ≥2 months earlier	783/997 (79)	884/1101 (80)	373 (259–476)	**13 (-9 to 30)**
Bivalent booster dose, 7–59 days earlier	61/275 (22)	175/392 (45)	34 (19–49)	**65 (49–77)**
Bivalent booster dose, 60–119 days earlier	105/319 (33)	183/400 (46)	89 (73–103)	**43 (17–60)**
Bivalent booster dose, 120–179 days earlier	73/287 (25)	92/309 (30)	141 (129–154)	**22 (-26 to 52)**
Relative VE				
Monovalent doses only, last dose ≥2 months earlier (Ref)				
Bivalent booster dose, 7–59 days earlier	61/844 (7)	175/1059 (17)	34 (19–49)	**60 (45–71)**
Bivalent booster dose, 60–119 days earlier	105/888 (12)	183/1067 (17)	89 (73–103)	**35 (14–51)**
Bivalent booster dose, 120–179 days earlier	73/856 (9)	92/976 (9)	141 (129–154)	**17 (-21 to 42)**



Estimates of monovalent VE against invasive mechanical ventilation and death among adults aged ≥18 years, IVY Network

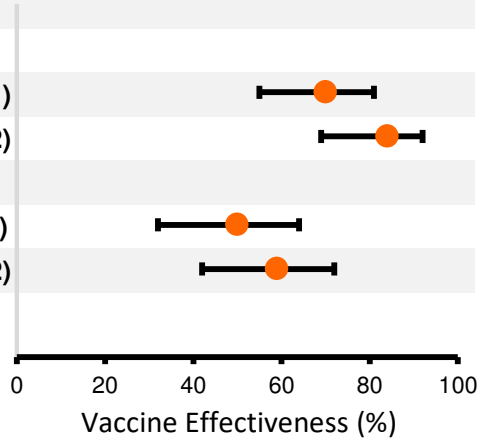
IVY: Effectiveness of 2-4 monovalent mRNA COVID-19 vaccine doses against COVID-19 invasive mechanical ventilation or death among immunocompetent adults aged *≥18 years* — IVY Network, February 1, 2022 – January 31, 2023

	Vaccinated cases, no./total no. (%)	Vaccinated controls, no./total no. (%)	Median time since last dose, days (IQR)	Absolute adjusted VE, % (95% CI)
Overall	216/362 (60)	3080/4059 (76)	248 (138–378)	**62 (52–70)**
Age group, yrs			--	
18–64	85/163 (52)	1421/2095 (68)	263 (144–380)	**57 (39–70)**
≥65	131/199 (66)	1659/1964 (84)	238 (133–375)	**69 (57–78)**
Time since last dose to illness, days				
7–179	63/209 (30)	1112/2091 (53)	109 (68–145)	**76 (66–83)**
180–364	95/241 (39)	1110/2089 (53)	269 (220–317)	**54 (37–66)**
≥365	58/204 (28)	858/1837 (47)	455 (402–549)	**56 (36–69)**



Effectiveness of monovalent mRNA COVID-19 vaccines against COVID-19 invasive mechanical ventilation or death among immunocompetent adults aged *≥18 years* — IVY Network, February 1, 2022 – January 31, 2023

	Vaccinated cases, no./total no. (%)	Vaccinated controls, no./total no. (%)	Median time since last dose, days (IQR)	Absolute adjusted VE, % (95% CI)
Time since last dose to illness, by no. of doses received				
7–179 days before illness				
2 doses	6/152 (4)	108/1087 (10)	114 (72–153)	–*
3 doses	42/188 (22)	633/1612 (39)	116 (75–147)	**70 (55–81)**
4 doses§	15/91 (17)	353/860 (41)	94 (55–135)	**84 (69–92)**
≥180 days before illness				
2 doses	81/227 (36)	953/1932 (49)	418 (326–531)	**50 (32–64)**
3 doses	66/212 (31)	901/1880 (48)	292 (235–366)	**59 (42–72)**
4 doses§	4/80 (5)	108/615 (18)	223 (197–258)	–*



*VE estimate not reported because of insufficient sample size

§Logistic regression models for VE of 4 monovalent doses were restricted to patients aged ≥50 years admitted during April 5, 2022–January 31, 2023

Limitations of VE against severe disease

- For estimates of ***absolute*** vaccine effectiveness, if unvaccinated are meaningfully different from vaccinated individuals (e.g., by COVID-19 risk factors), estimates may be biased.
- For estimates of ***relative*** vaccine effectiveness, residual protection from prior doses is an important consideration.
- Information on prior infection is limited, although we know rates of prior infection in the U.S. population are high.
- VE against COVID-19-associated hospitalization may underestimate protection against more severe COVID-19 disease.

Conclusions: updates to VE of bivalent COVID-19 boosters

- Bivalent boosters are helping provide additional protection against emergency department/urgent care encounters and hospitalization, though evidence of waning
- For most people who received monovalent doses and are eligible for a bivalent booster, more than a year has elapsed since their last monovalent dose. Because of waning, they may have limited remaining protection.
- Vaccines provide durable protection against the most critical illness (mechanical ventilation and death)
- CDC will continue ongoing monitoring of VE, including for all outcomes of interest and for all authorized vaccines in the U.S. (Pfizer-BioNTech, Moderna, Janssen, Novavax) with a focus on assessing new policy recommendations and VE in populations at higher risk of severe COVID-19

Acknowledgements

CDC COVID-19 Vaccine Effectiveness and Policy Team

- Amadea Britton
- Allison Ciesla
- Monica Godfrey
- Eric Griggs
- Katherine Fleming-Dutra
- Morgan Najdowski
- Sara Oliver
- Amanda Payne
- Lauren Roper
- Laura Steinhardt
- Evelyn Twentyman
- Megan Wallace
- Ryan Wiegand

VE platforms teams, including:

- Sarah Ball
- Jennifer DeCuir
- Monica Dickerson
- Margaret Dunne
- Matthew Levy
- Patrick Mitchell
- Palak Patel
- Caitlin Ray
- Sarah Reese
- Zach Smith
- Diya Surie
- Zack Weber
- Mark Tenforde

And many more!!!

For more information, contact CDC
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