Coronavirus Variants Rapid Response Network | Réseau de réponse rapide aux variants du coronavirus

COVID-END COVID-19 Evidence Network to support Decision-making ... in Canada

COVID-19 Living Evidence Synthesis #6

(Version 41: 14 September 2022)

Question

What is the effectiveness of available COVID-19 vaccines for adults, including variants of concern and over time frames up to 120 days?

Findings

For vaccine effectiveness in variants of concern (VOC), we present a visual summary of evidence in Table 1 and Table 2 and details in Table 3.

Methods are presented in Box 1 and in the following appendices:

1) reference list
2) glossary
3) data-extraction template
4) process for assigning variant of concern to studies
5) research question and critical appraisal process
6) detailed description of the narrative summary statement.

Overall, 605 studies were appraised and 195 used to complete this summary. The reasons for excluding the remaining 410 studies are reported in the second section of Appendix 2.

Three new studies have been added since the previous edition of this living evidence synthesis, all of which are signaled by a last-updated date of 14 September 2022 (highlighted in yellow). The new studies included results for: VOC Omicron (5) - 2 reporting results by sub-lineage.

Studies examining effectiveness of vaccines in children and adolescents, including those covering periods beyond 120 days, are captured in a third synthesis, COVID-END living evidence synthesis 8. The most recent version of all three syntheses (6,8,10) can always be found on the COVID-END website.

Box 1: Our approach

We retrieved candidate studies and updates to living evidence syntheses on vaccine effectiveness using the following mechanisms: 1) PubMed via COVID-19+ Evidence Alerts; 2) systematic scanning of pre-print servers; 3) updates to the COVID-END inventory of best evidence syntheses; and 4) cross-check with updates from the VESPa team. We included studies and updates to living evidence syntheses identified up to two days before the version release date. We did not include press releases unless a preprint was available. A full list of included and excluded studies is provided in **Appendix 1**. A glossary is provided in **Appendix 2**.

Prioritized outcome measures: Infection, severe disease (as defined by the study investigators), death, and transmission.

Data extraction: We prioritized variant-confirmed and vaccine-specific data over total study population data (variant assumed and/or vaccine unspecified). We extracted data from each study in duplicate using the template provided in **Appendix 3**. Relevance to VOC is determined directly, when reported by study authors, or indirectly where reasonable assumptions can be made about the variant prevalent in the jurisdiction at the time of the study as described in **Appendix 4**.

Critical appraisal: We assessed risk of bias, direction of effect, and certainty of evidence. **Risk of bias:** assessed in duplicate for individual studies using an adapted version of ROBINS-I. **Direction of vaccine effect:** "protection" was applied to mean estimates or range of mean estimates of effect that are greater than or equal to 70% with lower limit of 95% CI of 50% for infection and 90% with lower limit of 95% CI of 70% for severe disease or death (as determined by WHO). **Certainty of evidence:** assessed for the collection of studies for each vaccine according to variant of concern using a modified version of GRADE. Details of the research question for this synopsis and the critical appraisal process are provided in **Appendix 5**.

Summaries: We summarized the evidence by presenting narrative evidence profiles across studies, with or without pooling, as appropriate. A template for the summary statements used on page 1 under "Findings" and in Table 1 under each VOC is provided in **Appendix 6**.

We update this document on the third Wednesday of every month and post it on the COVID-END website.

Highlights of changes this week

- Two studies reported VE of BNT162b2 [Pfizer] and CoronaVac [Sinovac] against infection (ref 219), and severe disease, and death (ref 217) due to VOC Omicron BA.2
- One study reported VE of 3 doses of BNT162b2 [Pfizer] or mRNA-1273 [Moderna] relative to 2 doses of an mRNA vaccine (ref 218)

VOC Omicron

new definition for threshold for protection added June 22, 2022: For infection – point estimate of 70% with lower limit of 95% CI of 50% or higher; For severe disease or death – point estimate of 90% with lower limit of 95% CI of 70% or higher

3 Doses

We have low certainty evidence that **3 doses** of **BNT162b2 [Pfizer]** reached threshold for protection against infection from VOC **Omicron** up to 60 days after 3rd dose (58 to 74% – range of means), but dropped below threshold at or before 90 days after 3rd dose (35 to 35.7% - range of means).

We have low certainty evidence that **3 doses** of **BNT162b2 [Pfizer]** reached threshold for protection against symptomatic infection from VOC **Omicron** up to 14 days after 3rd dose (75.5% [95% CI, 56.1 to 86.3] – 1 Obs), but dropped below threshold at or before 35 days after 3rd dose (54 to 69% – range of means).

We have low certainty evidence that **3 doses** of **BNT162b2 [Pfizer]** reached threshold for protection against severe, critical, or fatal disease from VOC **Omicron** up to 49 days after 3rd dose (90.8% [95% CI, 81.5 to 95.5] – 1 Obs) and remained above threshold up to 63 days after 3rd dose (75 to 91% - range of means).

We have low certainty evidence that **3 doses** of **BNT162b2 [Pfizer]** reached threshold for protection against death from VOC **Omicron** up to 30 days after 3rd dose (82% [95% CI, 72 to 92] – 1 Obs); and remained above threshold up to 60 days after 3rd dose (85% [95% CI, 79 to 90]- 1 Obs) and at up to 90 days after 3rd dose (86% [95% CI, 80 to 92] – 1 Obs).

We have low certainty evidence that **3 doses** of **mRNA-1273 [Moderna]** did not reach threshold for protection against infection by VOC **Omicron** up to 30 days after 3rd dose (46 to 64% - range of means) and remained below threshold at 60 days after 3rd dose (60 to 61% - range of means) and 90 days after 3rd dose (57% [95% CI, 51 to 62%] – 1 Obs).

We have low certainty evidence that **3 doses** of **mRNA-1273 [Moderna]** reached threshold for protection against symptomatic infection by VOC **Omicron** up to 35 days after 3rd dose (55 to 71% - range of means) but dropped below threshold at or before 42 days after 3rd dose (38.6% [95% CI, 19.4 to 53.1] – 1 Obs).

We have low certainty evidence that **3 doses** of **mRNA-1273 [Moderna]** did not reach threshold for protection against severe, critical, or fatal disease from VOC **Omicron** up to 42 days after 3rd dose (80.8% [95% CI, -51.9 to 97.6] – 1 Obs).

We have low certainty evidence that **3 doses** of **ChAdOx1 [AstraZeneca]** did not reach threshold for protection against symptomatic infection from VOC **Omicron** at 30 days after 3rd dose (52 to 56% - range of means) and remained below threshold at 60 days after 3rd dose (44 to 47% - range of means).

We have low certainty evidence that **2 doses** of **ChAdOx1 [AstraZeneca] followed by BNT162b2 [Pfizer]** did not reach threshold for protection against symptomatic infection from VOC **Omicron** at 60 days after 3rd dose (16 to 53% - range of means).

We have low certainty evidence that **2 doses** of **ChAdOx1 [AstraZeneca] followed by BNT162b2 [Pfizer]** did not reach threshold for protection against severe disease from VOC **Omicron** up to 60 days after 3rd dose (66.7% [95% CI, 61 to 71.6] – 1 Obs).

We have low certainty evidence that **2 doses** of **ChAdOx1 [AstraZeneca] followed by mRNA-1273 [Moderna]** did not reach threshold for protection against symptomatic infection from VOC **Omicron** at 60 days after 3rd dose (18 to 61% - range of means).

We have low certainty evidence that **3 doses** of **CoronaVac [Sinovac]** did not reach threshold for protection against symptomatic infection from VOC **Omicron** up to 59 days after 3rd dose (15.0% [95% CI, 2.0 to 18.0] – 1 Obs) and low certainty evidence that **3 doses** of **CoronaVac [Sinovac]** did not reach threshold for protection against severe disease from VOC **Omicron** up to 59 days after 3rd dose (71.3% [95% CI, 60.3 to 79.2]- 1 Obs).

We have low certainty evidence that **2 doses** of **CoronaVac [Sinovac] followed by BNT162b2 [Pfizer]** did not reach threshold for protection against symptomatic infection from VOC **Omicron** at 30 days after 3rd dose (63.6% [95% CI, 62.8 to 64.3] – 1 Obs) and remained below threshold at 60 days after 3rd dose (49 to 87% - range of means) and 90 days after 3rd dose (31.3% [95% CI, -1.0 to 53.3] – 1 Obs).

We have low certainty evidence that **2 doses** of **CoronaVac [Sinovac] followed by BNT162b2 [Pfizer]** reached threshold for protection against severe disease from VOC **Omicron** at 30 days after 3rd dose (89.4% [95% CI, 87.8 to 90.7]- 1 Obs) and remained above threshold at 60 to 90 days after 3rd dose (89.3% [95% CI, 88.8 to 89.8] – 1 Obs).

2 Doses

We have low certainty evidence that **2 doses** of **BNT162b2 [Pfizer]** did not reach threshold for protection against infection from VOC **Omicron** up to 44 days after 2nd dose (26 to 55% - range of means) and remained below threshold up to 60 days after 2nd dose (6 to 49% - range of means).

We have low certainty evidence that **2 doses** of **BNT162b2 [Pfizer]** did not reach threshold for protection against symptomatic infection from VOC **Omicron** up to 60 days after 2nd dose (32 to 49% – range of means) and remained below threshold up to 90 days after 2nd dose (27 to 36% - range of means).

We have low certainty evidence that **2 doses** of **BNT162b2 [Pfizer]** did not reach threshold for protection against death from VOC **Omicron** at 60 days after 2nd dose (62% [95% CI, 33 to 90) – 1 Obs]) and remained below threshold at 90 days after 2nd dose (88% [95% CI, 71 to 105] – 1 Obs).

We have low certainty evidence that **2 doses** of **mRNA-1273 [Moderna]** did not reach threshold for protection against infection from VOC **Omicron** up to 30 days after 2nd dose (37.9% [95% CI, 34.4 to 41.2] – 1 Obs) and remained below threshold up to 60 days after 2nd dose (48% [95% CI, 44 to 52] – 1 Obs).

We have low certainty evidence that **2 doses** of **mRNA-1273 [Moderna]** did not reach threshold for protection against symptomatic infection from VOC **Omicron** up to 30 days after 2nd dose (44.8% [95% CI, 16 to 63.8] – 1 Obs) and remained below threshold up to 60 days after 2nd dose (52.8% [95% CI, 48.2 to 57.1).

We have low certainty evidence that **2 doses** of **ChAdOx1 [AstraZeneca]** did not reach threshold for protection against infection from VOC **Omicron** up to 60 days after 2nd dose (51% [95% CI, 23 to 69] – 1 Obs).

We have low certainty evidence that **2 doses** of **ChAdOx1 [AstraZeneca]** did not reach threshold for protection against symptomatic infection from VOC **Omicron** up to 60 days after 2nd dose (33.7% [95% CI, 25 to 41.5] – 1 Obs) and remained below threshold up to 90 days after 2nd dose (28.6% [95% CI, 20.9 to 35.6).

We have low certainty evidence that **one dose of Ad26.COV2.S [Johnson & Johnson] followed by one dose of BNT162b2 [Pfizer]** did not reach threshold for protection against symptomatic infection from VOC **Omicron** up to 30 days after 2nd dose (58.9% [95% CI, 54.6 to 62.8] – 1 Obs) and low certainty evidence that **one dose of Ad26.COV2.S[Johnson & Johnson] followed by one dose of mRNA-1273 [Moderna]** did not reach threshold for protection against symptomatic infection from VOC **Omicron** up to 30 days after 2nd dose (63.7% [95% CI, 59.7 to 67.3] – 1 Obs).

We have low certainty evidence that **one dose of Ad26.COV2.S [Johnson & Johnson]** did not reach threshold for protection against infection from VOC **Omicron** up to 60 days after dose (47% [95% CI, 45 to 49] – 1 Obs).

Table 1a: Visual summary of evidence for COVID-19 vaccines for Variant of Concern – Omicron [2 doses: 30 to 120 days since last dose; 3 doses: 1 to 90 days since last dose]

Percentages indicate level of effectiveness from 0% (no effect) to 100% (full protection): ranges of estimated means are provided when ≥ 1 study is available; estimated mean value is provided for single studies

Colour indicates **Level of Certainty** based on the evidence.
Please note: prior to LES 6.34 moderate certainty evidence was coloured orange and low certainty evidence was coloured yellow

High certainty evidence	Moderate certainty evidence	Low certainty evidence
pooling of low to moderate risk of bias RCTs or pooling of observational studies with low risk of bias and consistent findings	single RCT with low to moderate risk of bias or >one observational study with low to moderate risk of bias and at least partially consistent findings	single RCT or observational study with serious risk of bias or multiple low to serious risk of bias observational studies with inconsistent findings

Outcome (vaccine)	Variant	Number of Doses	Time since Last Dose* (days)	Vaccine Effectiveness
Infection – Omicron (3 doses: up to 90 days after 3rd dose)				
AZ followed by mRNA vaccine	Omicron	2/1	at least 7	58.6% (55.5 to 61.6)
Pfizer or Moderna		3	30	57.6 to 57.7%
Pfizer		3	30	34 to 55%
Moderna		3	30	46 to 64%
Pfizer		3	60	58 to 74%
Moderna		3	60	60 to 61%
Pfizer or Moderna		3	60	54.4 to 55.3%
Pfizer		3	90	35 to 35.7%
Moderna		3	90	57% (51 to 62)
Pfizer or Moderna		3	90	57.9 to 58.3%
CoronaVac followed by Pfizer		2/1	90	31.3% (-1.0 to 53.3)
Infection – Omicron (2 doses: 30 to 120 days after 2nd dose)				
Pfizer	Omicron	2	44	26 to 55%
Moderna		2	44	36.7% (-70 to 76.4)
Pfizer		2	60	6 to 49%
Moderna		2	60	48% (44 to 52)
Pfizer or Moderna		2	60	6 to 39%
AstraZeneca		2	60	51% (23 to 69)
Johnson & Johnson		1	60	47% (45 to 49)
Moderna		2	90	24 to 30%
Pfizer or Moderna		2	90	25.5% (9 to 38.6)
Pfizer or Moderna		2	120	13 to 26%
Symptomatic Infection – Omicron (3 doses: up to 90 days after 3rd dose)				
Pfizer	Omicron	3	14	75.5% (56.1 to 86.3)
Pfizer		3	30	54 to 69%
Moderna		3	30	55 to 71%

Outcome (vaccine)	Variant	Number of Doses	Time since Last Dose* (days)	Vaccine Effectiveness
AstraZeneca		3	30	52 to 56%
Johnson & Johnson		2	30	28% (18.3 to 36/5)
CoronaVac followed by Pfizer		2/1	30	63.6% (62.8 to 64.3)
Pfizer		3	30 to 60	37 to 59%
AstraZeneca		3	30 to 60	44 to 47%
AZ followed by Pfizer		2/1	60	16 to 53%
AZ followed by Moderna		2/1	60	18 to 61%
CoronaVac		3	60	15.0% (12.0 to 18.0)
CoronaVac followed by Pfizer		2/1	60	49 to 87%
Pfizer or Moderna		3	14 to 63	44 to 74%
Pfizer		3	up to 104	40 to 60%
Johnson & Johnson		2	60 to 120	29.3% (23.2 to 34.9)
Moderna		3	42 to 120	39 to 67%
CoronaVac followed by Pfizer		2/1	61 to 90	32.5% (31.7 to 33.3)
Symptomatic Infection - Omicron (2 doses: 30 to 120 days after 2nd dose)				
Moderna	Omicron	2	30	44.8% (16 to 63.8)
Johnson & Johnson		1	30	17.9% (4.3 to 29.5)
J&J followed by Pfizer		1/1	30	58.9% (54.6 to 62.8)
J&J followed by Moderna		1/1	30	63.7% (59.7 to 67.3)
Pfizer		2	60	32 to 49%
Moderna		2	60	52.8% (48.2 to 57.1)
AstraZeneca		2	60	33.7% (25 to 41.5)
Pfizer		2	90	27 to 36%
Moderna		2	90	35.6% (32.7 to 38.4)
AstraZeneca		2	90	28.6% (20.9 to 35.6)
Pfizer		2	120	26 to 34%
Pfizer or Moderna		2	14 to 149	45 to 56%
Severe Disease – Omicron (2 or 3 doses)				
Pfizer	Omicron	3	7 to 42	90.6% (77.8 to 96)
Moderna		3	7 to 42	80.5% (-51.9 to 97.6)
Pfizer		3	60	75 to 91%
Pfizer or Moderna		3	60	68.8% (-87 to 94.8)
AZ followed by Pfizer		2/1	60	66.7% (61 to 71.6)
CoronaVac		3	8-59	71.3% (60.3 to 79.2)
CoronaVac followed by Pfizer		2/1	14 to 30	89.4% (87.8 to 90.7)
CoronaVac followed by Pfizer		2/1	30 to 60	85 to 90%
CoronaVac followed by Pfizer		2/1	60 to 90	89.3% (88.8 to 89.8)
Death – Omicron (2 or 3 doses)				
Pfizer	Omicron	2	30 to 60	62% (33 to 90)
Pfizer		2	60 to 90	88% (71 to 105)
Pfizer		2	90 to 120	57% (35 to 78)

Outcome (vaccine)	Variant	Number of Doses	Time since Last Dose* (days)	Vaccine Effectiveness
Pfizer		3	14 to 30	82% (72 to 92)
Pfizer		3	30 to 60	85% (79 to 90)
Pfizer		3	60 to 90	86% (80 to 92)

Table 1b: Visual summary of evidence for COVID-19 vaccines for Variant of Concern – Delta [2 doses: 30 to 120 days since last dose; 3 doses: 1 to 90 days since last dose] – Last Updated April 29, 2022 and will not further updated)

Percentages indicate level of effectiveness from 0% (no effect) to 100% (full protection): ranges of estimated means are provided when ≥ 1 study is available; estimated mean value is provided for single studies

Colour indicates **Level of Certainty** based on the evidence.

High certainty evidence	Moderate certainty evidence	Low certainty evidence
pooling of low to moderate risk of bias RCTs or pooling of observational studies with low risk of bias and consistent findings	single RCT with low to moderate risk of bias or >one observational study with low to moderate risk of bias and at least partially consistent findings	single RCT or observational study with serious risk of bias or multiple low to serious risk of bias observational studies with inconsistent findings

Outcome (vaccine)	Variant	Number of Doses	Time since Last Dose* (days)	Vaccine Effectiveness
Infection – Delta (3 doses: up to 90 days after 3rd dose)				
AZ followed by Pfizer	Delta	2/1	7	82% (68 to 90)
Sinovac followed by Pfizer		2/1	7	93 to 98%
Sinovac followed by AZ		2/1	7	86% (74 to 93)
Pfizer		3	>7	75% (72.5 to 77.8)
Moderna		3	>7	85% (71.8 to 91.9)
Moderna, followed by Pfizer		2/1	>7	87.1% (80.1 to 91.6)
Pfizer followed by Moderna		2/1	>7	68.2% (57.6 to 76.1)
Pfizer or Moderna		3	>14	91 to 95%
Pfizer		3	30	81 to 93%
Moderna		3	30	83 to 96%
Pfizer		3	60	90% (89 to 90)
Moderna		3	60	92% (91 to 93)
Infection – Delta (2 doses: 30 to 120 days after 2nd dose)				
Pfizer		2	60	73 to 87%
Moderna		2	60	71 to 94%
AstraZeneca		2	60	60% (57 to 62)
Pfizer		2	90	67 to 74%
Moderna		2	90	79 to 83%
Pfizer		2	120	53 to 85%
Moderna		2	120	81 to 88%
AstraZeneca		2	120	65 to 72%
AZ followed by mRNA vaccine		1/1	120	86% (81 to 89)
Pfizer or Moderna		2	>14	63 to 70%
Symptomatic Infection – Delta (3 doses: up to 90 days after 3rd dose)				
Sinovac		3	14	78.8% (76.8 to 80.6)

AZ followed by Pfizer	Delta	2/1	14	93 to 94%
Sinovac followed by Pfizer		2/1	14	96.5% (96.2 to 96.7)
Sinovac followed by AZ		2/1	14	93.2% (92.9 to 93.6)
Pfizer or Moderna		3	>7	96% (93 to 98)
Symptomatic Infection – Delta (2 doses: 30 to 120 days after 2nd dose))				
Pfizer	Delta	2	30 to 60	74 to 76%
Pfizer		2	60 to 90	69 to 72%
AstraZeneca		1	60 to 90	65% (48 to 76)
Johnson & Johnson		1	60 to 90	52% (33 to 66)
Moderna		2	70 to 98	90%
AstraZeneca		2	119	41 to 49%
AZ followed by mRNA vaccine		1/1	120	66% (41 to 80)
Pfizer or Moderna		2	14 to 149	80 to 89%
Severe Disease – Delta (2 or 3 doses)				
Pfizer	Delta	2	44 to 98	91.1% (90 to 92)
Moderna		2	60	97.8% (83.7 to 99.7)
Moderna		2	90	75 to 93%
Pfizer		2	120	68 to 72%
Moderna		2	120	91.5% (60.8 to 98.1)
AstraZeneca			120	70.5% (67 to 73.7)
Sinovac followed by Pfizer		2/1	14	96 to 97%
Sinovac followed by AZ		2/1	14	98.9% (98.5 to 99.2)
Pfizer or Moderna		2	>7	99% (97 to 99)
Death – Delta (2 or 3 doses)				
Johnson & Johnson	Delta	1	120	89.4% (52.3 to 97.6)
Pfizer or Moderna		2	>14	58 to 88%
Sinovac followed by Pfizer		2/1	14	96.8% (93.9 to 98.3)
Sinovac followed by AZ		2/1	14	98.1% (97.3 to 98.6)

*****approximate because studies did not use the same s frames

Table 2: Visual summary of evidence for COVID-19 vaccines for variants of concern (up to 30 days after 2 doses)

Percentages indicate level of effectiveness from 0% (no effect) to 100% (full protection): ranges of estimated means are provided when ≥ 1 study is available; estimated mean value is provided for single studies

Colour indicates **Level of Certainty** based on the evidence
Please note: prior to LES 6.34 moderate certainty evidence was coloured orange and low certainty evidence was coloured yellow

High certainty evidence	Moderate certainty evidence	Low certainty evidence
pooling of low to moderate risk of bias RCTs or pooling of observational studies with low risk of bias and consistent findings	single RCT with low to moderate risk of bias or >one observational study with low to moderate risk of bias and at least partially consistent findings	single RCT or observational study with serious risk of bias or multiple low to serious risk of bias observational studies with inconsistent findings

Outcome (and vaccine)	Vaccine Effectiveness (2 doses unless otherwise stated) up to 30 days after last dose for each combination of vaccine, variant, and outcome				
	Alpha	**Beta**	**Gamma**	**Delta**	**Omicron**
Any Infection					
Pfizer	78 to 95%		93%	42 to 93%	
Moderna	86 to 100%	96%	95%	59 to 91%	38%
Pfizer or Moderna (2 doses)					40%
AstraZeneca (AZ)	62 to 79%		90%	45 to 83%	11%
Johnson & Johnson				3 to 71%*	
JnJ followed by an mRNA vaccine					48%
Novavax					
Sinovac			66%	60 to 74%	
AZ followed by Pfizer or Moderna	82 to 91%		96%	88%	
Sinovac followed by AZ				74% (43 to 99)	
Symptomatic Infection (reported when data on "any infection" is limited)					
Pfizer		84 to 88%	84 to 88%	63 to 94%	
Moderna			88%	87%	
AstraZeneca		10%**	65%	61 to 92%	
Johnson & Johnson				51%*	
Novavax	86%	43%**			
Sinovac				59%	
Covaxin				50%	
AZ followed by Pfizer or Moderna				67 to 79%	
Transmission					
Pfizer	70 to 82%			31 to 63% (unvacc contact) 10 to 40%	

Outcome (and vaccine)	Vaccine Effectiveness (2 doses unless otherwise stated) up to 30 days after last dose for each combination of vaccine, variant, and outcome				
				(vacc contact)	
Moderna	88%			62 to 77%	
AstraZeneca	58 to 63%			36%	
Johnson & Johnson	77%*				
Novavax					
Sinovac					
AZ followed by Pfizer or Moderna				86%	
Severe Disease (may include death for some studies)					
Pfizer	92 to 100%			82 to 98%	
Moderna	96%	96%		93 to 100%	
AstraZeneca			76%		
Johnson & Johnson		82%*		93%	
Novavax					
Sinovac				46 to 89%	
Death					
Pfizer	91 to 97%			90%	
Moderna					
AstraZeneca				91%*	
Johnson & Johnson				90%	
Novavax					
Sinovac			86%	77%	

*single dose

**mean estimate of effect less than the lowest acceptable limit for vaccine effectiveness as determined by WHO

AZ, AstraZeneca; unvacc, unvaccinated; vacc, vaccinated; JnJ, Johnson & Johnson

Table 3a: Key findings about vaccine effectiveness for VOC Omicron (revised 25 May 2022)

VOC	Vaccine	Findings
3 Doses – VOC Omicron		
Omicron **(3 doses)** **(any time frame)**	**Pfizer/ BioNTech Comirnaty [BNT162b2]**	BNT162b2 (3 doses) provided protection against infection by VOC Omicron at the following number of days after the 3rd dose: • 34 to 54.6% up to 30 days (RME) • 58 to 74% up to 60 days (RME) • 35 to 35.7% up to 90 days (RME) (9 Obs) [137][147][160][167][168][169][187][205][216]; *last update 2022-09-14* BNT162b2 (3 doses) provided protection against symptomatic infection by VOC Omicron at the following number of days after 3rd dose: • 67.2% (95% CI, 66.5 to 67.8) at 14 to 30 days • 54 to 69% at 28 to 35 days (RME) • 37 to 59% at 30 to 60 days (RME) • 40 to 60% at up to 104 days (RME) (6 Obs) [136][162][199][200][201][208]; *last update 2022-06-22* BNT162b2 (3 doses) provided protection against severe, critical, or fatal disease by VOC Omicron at the following number of days after 3rd dose: • 90.6% (95% CI, 77.8 to 96) at 7 to 42 days • 75 to 91% up to 63 days (RME) (2 Obs) [162][199]; *last update 2022-05-12* BNT162b2 (3 doses) provided protection against death by VOC Omicron at the following number of days after 3rd dose: • 82% (95% CI, 72 to 92) at 14 to 30 days • 85% (95% CI, 79 to 90) at 30 to 60 days • 86% (95% CI, 80 to 92) at 60 to 90 days (1 Obs) [199]; *last update 2022-05-12* **BA.1** BNT162b2 (3 doses) provided protection against symptomatic infection by VOC Omicron BA.1 the following number of days after 3rd dose: • 59.9% (95% CI, 51.2 to 67.0) up to 30 days (1 Obs) [175]; *last update 2022-03-30* BNT162b2 (3 doses) provided protection against severe disease by VOC Omicron BA.1 the following number of days after 3rd dose: • 94% (95% CI, 76 to 98) up to 90 days (1 Obs)[197]; *last update 2022-05-12* **BA.2** BNT162b2 (3 doses) provided protection against mild/moderate infection by VOC Omicron BA.2 the following number of days after 3rd dose: • 71.6% (95% CI, 43.5 to 85.7) at median of 35 days • 41.4% (95% CI, 23.2 to 55.2) up to 90 days (2 Obs) [182][219]; *last update 2022-09-14*

VOC	Vaccine	Findings
		BNT162b2 (3 doses) provided protection against symptomatic infection by VOC Omicron BA.2 the following number of days after 3rd dose: • 43.7% (95% CI, 36.5 to 50.0) up to 30 days (1 Obs) [175]; *last update 2022-03-30* BNT162b2 (3 doses) provided protection against severe disease by VOC Omicron BA.2 the following number of days after 3rd dose: • 82 to 90.5% at 60 to 90 days (RME) (2 Obs)[197][217]; *last update 2022-09-14* BNT162b2 (3 doses) provided protection against death by VOC Omicron BA.2 at the following number of days after 3rd dose: • 98.1 to 98.9% (95% CI, 95.3 to 99.7) at median of 35 days (2 Obs) [182][217]; *last update 2022-09-14*
Omicron **(3 doses)** **(any time frame)**	**Moderna Spikevax [mRNA-1723]**	mRNA-1273 (3 doses) provided protection against infection by VOC Omicron at the following number of days after 3rd dose: • 46.4 to 64% at 7 to 30 days (RME) • 60 to 61% up to 60 days (RME) • 57% (95% CI, 51 to 62) up to 90 days (8 Obs) [147][148][160][167][169][187][205][216]; *last update 2022-09-14* mRNA-1273 (3 doses) provided protection against symptomatic infection by VOC Omicron at the following number of days after 3rd dose: • 55% to 71% at 28 to 35 days (RME) • 39% to 67% at 42 to 120 days (RME) (3 Obs) [136][162][208]; *last update 2022-06-22* mRNA-1273 (3 doses) provided protection against severe, critical, or fatal disease by VOC Omicron at the following number of days after 3rd dose: • 80.8% (95% CI, -51.9 to 97.6) at 7 to 42 days (1 Obs) [162]; *last update 2022-03-02* **BA.1** mRNA-1273 (3 doses) provided protection against symptomatic infection by VOC Omicron BA.1 the following number of days after 3rd dose: • 51.5% (95% CI, 32.3 to 65.2) up to 30 days (1 Obs) [175]; *last update 2022-03-30* **BA.2** mRNA-1273 (3 doses) provided protection against symptomatic infection by VOC Omicron BA.2 the following number of days after 3rd dose: • 39.4% (95% CI, 24.8 to 51.2) up to 30 days (1 Obs) [175]; *last update 2022-03-30*
Omicron **(3 doses)** **(any time frame)**	**Pfizer/ BioNTech Comirnaty [BNT162b2]** **OR**	BNT162b2 or mRNA-1273 (3 doses) provided protection against VOC Omicron for the following outcomes after the 3rd dose: • 57.6 to 57.7% from infection at 14 to 30 days (RME) • 54.4 to 55.3% from infection at 31 to 60 days (RME) • 57.9 to 58.3% from infection at 61 to 90 days (RME) • 65 to 94% from infection at 14 to 179 days (RME) • 62% (95% CI, 48 to 72) from symptomatic infection >7 days

VOC	Vaccine	Findings
	Moderna Spikevax [mRNA-1723]	• 44 to 74% from symptomatic infection 14 to 63 days (RME) • 68.8% (95% CI, -87 to 94.8) from severe disease 14 to 63 days • 85% (95% CI, 60 to 94) from death at 14 to 179 days (7 Obs)[184][188][193][196][200][215][220]; *last update 2022-09-14* **BA.1** BNT162b2 or mRNA-1273 (3 doses) provided protection against VOC Omicron for the following outcomes after the 3rd dose: • 38.1% (95% CI, 18.6 to 52.9) from infection up to 14 days (1 Obs) [204]; *last update 2022-05-12*
Omicron **(3 doses)** **(any time frame)**	**AstraZeneca [ChAd0x1] Vaxzevria Serum Institute of India [Covishield]**	ChAdOx1 (3 doses) provided protection against VOC Omicron for the following outcomes after 3rd dose: • 52 to 56% from symptomatic infection 14 to 30 days (RME) • 44 to 47% from symptomatic infection 30 to 69 days (RME) • -27.2% (95% CI, -131.6 to 30.1) from symptomatic infection 70 to 104 days (2 Obs) [136][201]; *last update 2022-06-22*
Omicron **(2 doses)** **(any time frame)**	**Johnson & Johnson [AD26.COV 2.S]**	Ad26.COV2.S provided minimal protection against symptomatic infection by VOC Omicron at the following number of days after 2nd dose: • 28% (95% CI, 18.3 to 36.5) at 14 to 30 days • 29.3% (95% CI, 23.2 to 34.9) at 60 to 120 days (1 Obs) [208]; *last update 2022-06-22*
Omicron **(3 doses)** **(any time frame)**	**Sinovac [CoronaVac]**	CoronaVac (3 doses) provided protection against symptomatic infection by VOC Omicron the following number of days after 3rd dose: • 15.0% (95% CI, 12.0 to 18.0) at 8-59 days (1 Obs) [189]; *last update 2022-04-13* CoronaVac (3 doses) provided protection against severe disease by VOC Omicron the following number of days after 3rd dose: • 71.3% (95% CI, 60.3 to 79.2) at 8-59 days (1 Obs) [189]; *last update 2022-04-13* **BA.2** CoronaVac (3 doses) provided protection against mild/moderate infection by VOC Omicron BA.2 the following number of days after 3rd dose: • 32.4 to 50.7% at 30 to 90 days (RME) (2 Obs) [182][219]; *last update 2022-09-14* CoronaVac (3 doses) provided protection against severe disease by VOC Omicron BA.2 the following number of days after 3rd dose: • 71.3 to 84.6% up to 66 days (RME) (2 Obs) [189][217]; *last update 2022-09-14* CoronaVac (3 doses) provided protection against death by VOC Omicron BA.2 at the following number of days after 3rd dose: • 97 to 98.5% (95% CI, 95.3 to 99.6) at 35 to 53 days (RME) (2 Obs) [182][217]; *last update 2022-09-14*

VOC	Vaccine	Findings
Omicron **(2 doses followed by mRNA vaccine)** **(any time frame)**	**AstraZeneca [ChAd0x1] Vaxzevria Serum Institute of India [Covishield]**	ChAdOx1 (2 doses) followed by BNT162b2 provided protection against VOC Omicron for the following outcomes after 3rd dose: • 58.6% (95% CI, 55.5 to 61.6) from infection at least 7 days • 16 to 53% from symptomatic infection at 14 to 63 days (RME) • 66.7% (95% CI, 61 to 71.6) from severe disease 14 to 63 days (3 Obs) [136][167][200]; *last update 2022-06-22* ChAdOx1 (2 doses) followed by mRNA-1273 provided protection against VOC Omicron for the following outcomes after 2nd dose: • 18 to 61% (95% CI, -6.7 to 37.2) from symptomatic infection at 14 to 63 days (2 Obs) [136][200]; *last update 2022-06-22*
Omicron **(2 doses followed by mRNA vaccine)** **(any time frame)**	**Sinovac [CoronaVac]**	CoronaVac (2 doses), followed by BNT162b2 provided protection against VOC Omicron for the following outcomes after 3rd dose: • 31.3% (95% CI, -1.0 to 53.3) from infection up to 90 days • 63.6% (95% CI, 62.8 to 64.3) from symptomatic infection at 14 to 30 days • 49 to 87% from symptomatic infection at 30 to 60 days (RME) • 32.5% (95% CI, 31.7 to 33.3) from symptomatic infection at 61 to 90 days • 89.4% (95% CI, 87.8 to 90.7) from severe disease at 14 to 30 days • 85 to 90% from severe disease at 30 to 60 days (RME) • 91.7% (95% CI, 37.5 to 98.9) from severe disease at mean of 66 days (BA.2) • 89.3% (95% CI, 88.8 to 89.8) from severe disease at 61 to 90 days (4 Obs) [189][213][217][219]; *last update 2022-09-14*
2 Doses – VOC Omicron		
Omicron **(2 doses)** **(any time frame)**	**Pfizer/ BioNTech Comirnaty [BNT162b2]**	BNT162b2 (2 doses) provided protection against infection by VOC Omicron at the following number of days after 2nd dose: • 26 to 55% up to 44 days (RME) • 6 to 49% up to 60 days (RME) • -77 to 30% up to 164 days (RME) (6 Obs) [137][147][160][169][187][205]; *last update 2022-05-25* BNT162b2 (2 doses) provided protection against symptomatic infection by VOC Omicron at the following number of days after 2nd dose: • 61.9% (95% CI, 49.9 to 71.1) up to 30 days • 32 to 49% at 30 to 60 days (RME) • 27 to 36% at 60 to 90 days (RME) • 26 to 34% up to 120 days (RME) (3 Obs) [136][162][199]; *last update 2022-06-22* BNT162b2 (2 doses) provided protection against death by VOC Omicron at the following number of days after 2nd dose: • 62% (95% CI, 33 to 90) at 30 to 60 days • 88% (95% CI, 71 to 105) at 60 to 90 days • 57% (95% CI, 35 to 78) at 90 to 120 days (1 Obs) [199]; *last update 2022-05-12* **BA.1** BNT162b2 (2 doses) provided protection against symptomatic infection by VOC Omicron BA.1 the following number of days after 2nd dose:

VOC	Vaccine	Findings
		• 46.6% (95% CI, 33.4 to 57.2) at 30 to 90 days (1 Obs) [175]; *last update 2022-03-30* BNT162b2 (2 doses) provided protection against severe disease by VOC Omicron BA.1 the following number of days after 2nd dose: • 84% (95% CI, 37 to 96) up to 90 days (1 Obs)[197]; *last update 2022-05-12* **BA.2** BNT162b2 (2 doses) provided protection against infection by VOC Omicron BA.2 the following number of days after 2nd dose: • 27.6% (95% CI, -6.3 to 50.7) up to 90 days after 2nd dose (1 Obs) [219]; *last update 2022-09-14* BNT162b2 (2 doses) provided protection against symptomatic infection by VOC Omicron BA.2 the following number of days after 2nd dose: • 51.7% (95% CI, 43.2 to 58.9) at 30 to 90 days (1 Obs) [175]; *last update 2022-03-30* BNT162b2 (2 doses) provided protection against severe disease by VOC Omicron BA.2 the following number of days after 2nd dose: • 43% (95% CI, 0 to 79) up to 90 days (1 Obs)[197]; *last update 2022-05-12*
Omicron **(2 doses)** **(any time frame)**	**Moderna Spikevax [mRNA-1723]**	mRNA-1273 (2 doses) provided protection against infection by VOC Omicron at the following number of days after 2nd dose: • 37.9% (95% CI, 34.4 to 41.2) up to 30 days • 36.7% (95% CI, -69.9 to 76.4) up to 44 days • 48% (95% CI, 44 to 52) up to 60 days • 23.7 to 30.4% up to 90 days (RME) • -39% to 14% up to 164 days (RME) • 15.2% (95% CI, 0 to 30.7) at 91 to 180 days • 0% (95% CI, 0 to 1.2) at 181 to 270 days (6 Obs) [137][148][160][169][187][205]; *last update 2022-05-25* mRNA-1273 (2 doses) provided protection against symptomatic infection by VOC Omicron at the following number of days after 2nd dose: • 44.8% (95% CI, 16 to 63.8) at 28 to 35 days • 52.8% (95% CI, 48.2 to 57.1) at 35 to 63 days • 35.6% (95% CI, 32.7 to 38.4) at 70 to 98 days (2 Obs) [136][162]; *last update 2022-06-22* **BA.1** mRNA-1273 (2 doses) provided protection against symptomatic infection by VOC Omicron BA.1 the following number of days after 2nd dose: • 71.0% (95% CI, 24.0 to 89.0) at 30 to 90 days (1 Obs) [175]; *last update 2022-03-30* **BA.2** mRNA-1273 (2 doses) provided protection against symptomatic infection by VOC Omicron BA.2 the following number of days after 2nd dose:

VOC	Vaccine	Findings
		• 35.9% (95% CI, -5.9 to 61.2) at 30 to 90 days (1 Obs) [175]; *last update 2022-03-30*
Omicron **(2 doses)** **(any time frame)**	**Pfizer/ BioNTech Comirnaty [BNT162b2]** **OR** **Moderna Spikevax [mRNA-1723]**	BNT162b2 or mRNA-1273 (2 doses) provided protection against VOC Omicron for the following outcomes after 2nd dose: • 39.9% from infection 14 to 30 days (RME) • 6 to 39% from infection 30 to 60 days (RME) • 25.5% (95% CI, 9 to 38.6) from infection 61 to 90 days • 13 to 26% from infection 60 to 119 days (RME) • -38% to 26% from infection up to 179 days (RME) • -16% (95% CI, -62 to 17) from infection ≥240 days • 45% to 56% from symptomatic infection 14-149 days • 60% (95% CI, 49 to 68) from death 14 to 179 days (6 Obs) [147][184][193][196][215][220]; *last update 2022-09-14* **BA.1** BNT162b2 or mRNA-1273 (2 doses) provided protection against VOC Omicron BA.1 for the following outcomes after the 3rd dose: • 28.5% (95% CI, 20 to 36.2) from infection up to 14 days (1 Obs) [204]; *last update 2022-05-12*
Omicron **(2 doses)** **(any time frame)**	**AstraZeneca [ChAd0x1] Vaxzevria Serum Institute of India [Covishield]**	ChAdOx1 (2 doses) provided protection against VOC Omicron for the following outcomes after 2nd dose: • 11.4% (95% CI, -18.8 to 34.6) from infection at 14 days • 51% (95% CI, 23 to 69) from infection up to 60 days • 33.7% (95% CI, 25 to 41.5) from symptomatic infection at 35 to 63 days • 28.6% (95% CI, 20.9 to 35.6) from symptomatic infection at 70 to 98 days (3 Obs) [136][160][169]; *last update 2022-02-22*
Omicron **(2 doses)** **(any time frame)**	**Sinovac [CoronaVac]**	**BA.2** CoronaVac (2 doses) provided protection against infection by VOC Omicron BA.2 the following number of days after 2nd dose: • 22.7% (95% CI, -15.2 to 48.2) up to 90 days after 2nd dose (1 Obs) [219]; *last update 2022-09-14*
Omicron **(1 dose followed by mRNA vaccine)** **(any time frame)**	**Johnson & Johnson [AD26.COV 2.S]**	Ad26.COV2.S followed by BNT162b2 provided protection against symptomatic infection by VOC Omicron at the following number of days after 2nd dose: • 58.9% (95% CI, 54.6 to 62.8) at 14 to 30 days • 51.5% (95% CI, 48.3 to 54.5) at 60 to 120 days (1 Obs) [208]; *last update 2022-06-22* Ad26.COV2.S followed by mRNA-1273 provided protection against symptomatic infection by VOC Omicron at the following number of days after 2nd dose: • 63.7% (95% CI, 59.7 to 67.3) at 14 to 30 days • 56.7% (95% CI, 53.9 to 59.3) at 60 to 120 days (1 Obs) [208]; *last update 2022-06-22* Ad26.COV2.S followed by an mRNA vaccine provided protection against VOC Omicron for the following outcomes after 3rd dose: • 48% (95% CI, 42.5 to 53.7) from infection at least 7 days (1 Obs) [167]; *last update 2022-03-16*

VOC	Vaccine	Findings
Omicron **(1 dose)** **(any time frame)**	**Johnson & Johnson [AD26.COV 2.S]**	Ad26.COV2.S provided protection against VOC Omicron for the following outcomes after 1st dose: • 47% (95% CI, 45 to 49) from infection up to 60 days • 17.9% (95% CI, 4.3 to 29.5) from symptomatic infection 14 to 30 days after dose • 8.4% (95% CI, 1.5 to 14.8) from symptomatic infection 60 to 120 days after dose (2 Obs) [169][208]; *last update 2022-06-22*
Relative VE - VOC Omicron		
Omicron **Relative VE for primary series vaccine doses compared to primary series plus booster vaccine doses (instead of an unvaccinated group)**	**Any vaccine**	**The results in this section should be reviewed with caution. Study populations that received booster doses are commonly very different from populations who did not receive or were not yet eligible for booster doses which increases the risk of bias** BNT162b2 (4 doses) showed relative VE for the following outcomes compared to BNT162b2 (3 doses): • 45 to 63% from infection 21 to 27 days after 4th dose (RME) • 56% (95% CI, 53.4 to 58.5) from infection 35 to 41 days after 4th dose • 27.1% (95% CI, 4.2 to 44.5) from infection 63 to 69 days after 4th dose • 55% (95% CI, 53 to 58) from symptomatic infection 7 to 30 days after 4th dose • 62 to 83% from severe disease 7 to 27 days after 4th dose (RME) • 70.3% (95% CI, 37.4 to 85.9) from severe disease 28 to 48 days after 4th dose • 87.1% (95% CI, 0 to 98.4) from severe disease 49 to 69 days after 4th dose • 74 to 78% from death 7 to 40 days after 4th dose (RME) (3 Obs) [178][183][190]; last update *2022-05-25* BNT162b2 (3 doses) showed relative VE for the following outcomes compared to BNT162b2 (2 doses): • 31.7% (95% CI, 30 to 33.4) from infection at 15 to 60 days • 39 to 51% from infection up to 90 days after 3rd dose (RME) • 11% (95% CI, 7 to 14) from infection up to 120 days after 3rd dose • 70% (95% CI, 51 to 81) from symptomatic infection median 30 days after 3rd dose • 49.4 to 85.2% from severe disease 15 to 60 days after 3rd dose (RME) • 88% (95% CI, 68 to 96) from severe disease or death up to 120 days after 3rd dose • 79.1% (95% CI, 71.2 to 84.9) from death mean of 80 days after 3rd dose (6 Obs) [195][202][207][210][211][218]; last update *2022-09-14* mRNA-1273 (3 doses) showed relative VE for the following outcomes compared to mRNA-1273 (2 doses): • 41.3% (95% CI, 39.4 to 43.1) at 15 to 60 days after 3rd dose • 44.6% (95% CI, 42.5 to 46.6) from infection mean 80 days after 3rd dose • 27% (95% CI, 24 to 30) from infection up to 120 days after 3rd dose • 97.5% (95% CI, 89.7 to 99.4) from severe disease at 15 to 60 days after 3rd dose

VOC	Vaccine	Findings
		• 72% (95% CI, 24 to 90) from severe disease or death up to 120 days after 3rd dose • 75.2% (95% CI, 62.9 to 83.5) from death mean of 80 days after 3rd dose (3 Obs) [207][210][218]; last update *2022-09-14* BNT162b2 or mRNA-1273 (3 doses) showed relative VE for the following outcomes compared to 2 doses of BNT162b2 or mRNA-1273: • 56% (95% CI, 39 to 67) from infection 14 days after 3rd dose • 34.9 to 54% (95% CI, 48 to 60) from infection 14 to 59 days after 3rd dose (RME) • 47% (95% CI, 37 to 56) from infection 60 to 89 days after 3rd dose • 70% (95% CI, 51 to 81) from symptomatic infection • 87.3% (95% CI, 72.8 to 94.1) from severe disease at 15 to 60 days after 3rd dose (4 Obs) [174][195][204][218]; last update *2022-09-14* ChAdOx1 (3 doses) showed relative VE for the following outcomes compared to BNT162b2 (2 doses): • 30.1% (95% CI, 28.4 to 31.8) from infection up to 90 days (1 Obs) [202]; last update *2022-05-12* ChAdOx1 (2 doses) + BNT162b2 showed relative VE for the following outcomes compared to BNT162b2 (2 doses): • 53.0% (95% CI, 51.6 to 54.3) from infection up to 90 days • 52.9% (95% CI, 36.9 to 64.8) from severe disease mean 49 days after 3rd dose (2 Obs) [202][211]; last update *2022-07-20* CoronaVac (3 doses) showed relative VE for the following outcomes compared to BNT162b2 (2 doses): • 33.4% (95% CI, 31.9 to 34.9) from infection up to 90 days (1 Obs) [202]; last update *2022-05-12* CoronaVac (2 doses) + BNT162b2 showed relative VE for the following outcomes compared to BNT162b2 (2 doses): • 47.6% (95% CI, 46.9 to 48.3) from infection up to 90 days (1 Obs) [202]; last update *2022-05-12* CoronaVac (2 doses) + ChAdOx1 showed relative VE for the following outcomes compared to BNT162b2 (2 doses): • 49.0% (95% CI, 46.7 to 51.3) from infection up to 90 days (1 Obs) [202]; last update *2022-05-12*
Hybrid Immunity (protection against VOC Omicron provided by previous infection plus vaccination)		
Omicron		**BNT162b2**
		BNT162b2 (3 doses) plus prior infection provided protection against VOC Omicron for the following outcomes after 3rd dose: • 70 to 76.3% from symptomatic infection 14 to 63 days (any subtype) (RME) • 74.4% (95% CI, 63.4 to 82.2) from symptomatic infection median 42 days (BA.1)

VOC	Vaccine	Findings
		• 77.3% (95% CI, 72.4 to 81.4) from symptomatic infection median 42 days (BA.2) • 95.7% (95% CI, 90.6 to 98) from severe disease at 14 to 63 days (any subtype) (2 Obs) [176][191]; last update *2022-03-30*
		BNT162b2 (2 doses + prior infection) provided protection against VOC for the following outcomes after 2nd dose: • 60% (95% CI, 58 to 62) from infection at 14 to 43 days (any subtype) • 43% (95% CI, 39 to 46) from infection at 44 to 73 days (any subtype) • 66.5% (95% CI, 65.5 to 67.5) from symptomatic infection at 14 to 63 days (any subtype) • 90.9% (95% CI, 84 to 94.8) from severe disease at 14 to 63 days (any subtype) (3 Obs) [176][191][209] *last update 2022-03-30*
		mRNA-1273
		mRNA-1273 (3 doses + prior infection) provided protection against VOC Omicron for the following outcomes after 3rd dose: • 79.4% (95% CI, 66.1 to 87.5) from symptomatic infection unknown median days (any subtype) • 77.2% (95% CI, 38.5 to 91.5) from symptomatic infection unknown median days (BA.1) • 69.8% (95% CI, 50.1 to 81.7) from symptomatic infection unknown median days (BA.2) (1 Obs) [176]; *last update 2022-03-30*
		mRNA-1273 (2 doses + prior infection) provided protection against VOC Omicron for the following outcome after 2nd dose: • 44.3% (95% CI, 30.4 to 55.4) from symptomatic infection unknown median days (BA.1) • 47.9% (95% CI, 40.8 to 54.1) from symptomatic infection unknown median days (BA.2) (1 Obs) [176]; *last update 2022-03-30*
		BNT162b2 or mRNA-1273
		BNT162b2 or mRNA-1273 (3 doses) + infection provided protection against VOC Omicron for the following outcomes after 3rd dose: • 36.3% (95% CI, -71.8 to 76.4) from infection up to 14 days • 83% (95% CI, 81 to 84) from infection up to 60 days (2 Obs) [198][204]; *last update 2022-07-20* BNT162b2 or mRNA-1273 (3 doses) + prior infection provided protection against VOC Omicron (BA.5) for the following outcomes after 3rd dose: • 93.6% (95% CI, 92.1 to 94.8) unknown number of days (prior Omicron infection) • 46.9% (95% CI, 27 to 61.3) unknown number of days (prior Delta infection) • 65.4% (95% CI, 49.8 to 76.2) unknown number of days (prior Alpha infection) (1 Obs) [214]; *last update 2022-08-17* BNT162b2 or mRNA-1273 (3 doses) + prior infection provided protection against VOC Omicron (BA.2) for the following outcomes after 3rd dose:

VOC	Vaccine	Findings
		• 96.3% (95% CI, 95.8 to 96.7) unknown number of days (prior Omicron infection) • 77.2% (95% CI, 72.2 to 81.3) unknown number of days (prior Delta infection) • 74.5% (95% CI, 68.7 to 79.2) unknown number of days (prior Alpha infection) (1 Obs) [214]; *last update 2022-08-17*
		BNT162b2 or mRNA-1273 (2 doses) + infection provided protection against VOC Omicron for the following outcomes after 2nd dose: • 82% (95% CI, 80 to 84) from infection up to 60 days • 67% (95% CI, 65 to 68) from infection up to 150 days (1 Obs) [198]; *last update 2022-07-20*
		ChAdOx1
		ChAdOx1 (3 doses + prior infection) provided protection against VOC Omicron for the following outcomes after 3rd dose: • 72.9% (95% CI, 72.2 to 73.5) from symptomatic infection at 14 to 63 days (any subtype) • 97.5% (95% CI, 96.6 to 98.1) from severe disease at 14 to 63 days (any subtype) (1 Obs)[191]; *last update 2022-06-22*
		ChAdOx1 (2 doses + prior infection) provided protection against VOC Omicron for the following outcomes after 2nd dose" • 49% (95% CI, 46.6 to 51.3) from symptomatic infection at 14 to 63 days • 90.2% (95% CI, 77.4 to 95.8) from severe disease at 14 to 63 days (1 Obs)[191]; *last update 2022-06-22*
		CoronaVac
		CoronaVac (3 doses + prior infection) provided protection against VOC Omicron for the following outcomes after 3rd dose: • 74% (95% CI, 73.1 to 74.8) from symptomatic infection at 14 to 63 days • 95.9% (95% CI, 94.1 to 97.1) from severe disease at 14 to 63 days (1 Obs) [191]; *last update 2022-06-22*
		CoronaVac (2 doses + prior infection) provided protection against VOC Omicron for the following outcomes after 2nd dose: • 49.3% (95% CI, 46.5 to 52) from symptomatic infection at 14 to 63 days • 78.4% (95% CI, 48.2 to 91) from severe disease at 14 to 63 days (1 Obs) [191]; *last update 2022-06-22*
		Ad26.COV2.S
		Ad26.COV2.S (2 doses + prior infection) provided protection against VOC Omicron for the following outcomes after 2nd dose: • 47.2% (95% CI, 45.2 to 49.2) from symptomatic infection 14 to 63 days • 97.5% (95% CI, 91.3 to 99.3) from severe disease at least 14 to 63 days (1 Obs) [191]; *last update 2022-06-22*
Transmission – VOC Omicron		
Omicron **Transmission Household or close contacts of index case**	**Pfizer/ BioNTech Comirnaty [BNT162b2]**	BNT162b2 or mRNA-1273 (2 doses) hh contacts showed VES: • 16% (95% CI, 0 to 37) at least 7 days after 2nd dose BNT162b2 or mRNA-1273 (3 doses) hh contacts showed VES: • 47% (95% CI, 17 to 64) at least 7 days after 3rd dose (1 Obs) [161]; *last update 2022-03-02*

VOC	Vaccine	Findings
Omicron **Transmission Household or close contacts of index case**	**Moderna Spikevax [mRNA-1723]**	BNT162b2 or mRNA-1273 (2 doses) hh contacts showed VES: • 16% (95% CI, 0 to 37) at least 7 days after 2nd dose BNT162b2 or mRNA-1273 (3 doses) hh contacts showed VES: • 47% (95% CI, 17 to 64) at least 7 days after 3rd dose (1 Obs) [161]; *last update 2022-03-02*

Table 3b: Key findings about vaccine effectiveness for VOC Delta (revised 25 May 2022)
(Last updated 27 April 2022 – will not be updated further)

3 Doses - VOC Delta		
Delta **(3 doses)** **(any time frame)**	**Pfizer/ BioNTech Comirnaty [BNT162b2]**	BNT162b2 (3 doses) provided protection against the following outcomes compared to unvaccinated: • 81 to 93% from infection up to 30 days after 3rd dose (RME) • 90% (95% CI, 89 to 90) up to 60 days after 3rd dose • 75% (95% CI, 72.5 to 77.8) from infection from 7 days after 3rd dose (6 Obs) [137][139][147][160][169] [186]; *last update 2022-04-13* BNT162b2 (3 doses) provided protection against symptomatic infection compared to unvaccinated: • 94% (95% CI, 93.4 to 94.6) – at least 14 days after 3rd dose (age 50+) (1 Obs) [126]; *last update 2021-12-15* BNT162b2 (3 doses) provided protection against infection by VOC Delta compared to 2 doses: • 84.0% (95% CI, 79 to 88) at 14 to 20 days after 3rd dose • 45.7% (95% CI, 37.9 to 53.5) median of 30 days after 3rd dose (2 Obs) [93][132]; *last update 2021-12-15* BNT162b2 (3 doses) provided protection against the following outcomes by VOC Delta compared to 2 doses: • Rate ratio 11.3 to 12.3 from infection at least 12 days after 3rd dose • Rate ratio 17.9 to 19.5 from severe illness at least 12 days after 3rd dose • Rate ratio 14.7 (95% CI, 10 to 21.4) from death at least 12 days after 3rd dose • 90% (95% CI, 86 to 93) from death unclear number of days after 3rd dose (3 Obs)[100][134][135]; *last update 2022-01-05* BNT162b2 or mRNA-1273 (3 doses) provided protection against VOC Delta for the following outcomes after 3rd dose: • 91 to 95% against infection >14 days (RME) • 96% (95% CI, 93 to 98) against symptomatic infection >7 days • 76% (95% CI, 46 to 89) against death 14 to 179 days (3 Obs)[184][188][193]; *last update 2022-05-12*
Delta **(3 doses)** **(any time frame)**	**Moderna Spikevax [mRNA-1723]**	mRNA-1273 (3 doses) provided protection against infection by VOC Delta compared to unvaccinated: • 83 to 95.7% up to 30 days after 3rd dose (RME) • 92% (95% CI, 91 to 93) up to 60 days after 3rd dose • 85% (95% CI, 71.8 to 91.9) from 7 days after 3rd dose (7 Obs) [137][139][147][148][160][169][186]; *last update 2022-04-13*

		mRNA-1273 (3 doses) provided protection against infection by VOC Delta compared to 2 doses: • 46.6% (95% CI, 36.4 to 55.3) median of 16 days after 3rd dose (1 Obs) [132]; *last update 2021-12-15*
Delta **2 doses followed by 1 dose of another vaccine** **(any time frame)**	**AstraZeneca [ChAd0x1] Vaxzevria Serum Institute of India [Covishield]**	ChAdOx1 (2 doses) followed by BNT162b2 provided protection against VOC Delta for the following outcomes: • 82% (95% CI, 68 to 90) from infection at least 7 days after 3rd dose • 93.1 to 93.8% from symptomatic infection at least 14 days after 3rd dose (RME) (3 Obs) [126][136][139]; *last update 2022-01-18* ChAdOx1 (2 doses) followed by mRNA-1273 provided protection against VOC Delta for the following outcomes: • 91% (95% CI, 63 to 98) from infection at least 7 days after 3rd dose (1 Obs) [139]; *last update 2022-01-05*
Delta **(3 doses)** **(any time frame)**	**Sinovac [CoronaVac]**	CoronaVac (3 doses) provided protection against VOC Delta for the following outcome ≥ 14 days after 3rd dose: • 78.8% (95% CI, 76.8 to 80.6) from symptomatic infection (1 Obs) [154]; *last update 2022-02-02*
Delta **2 doses followed by 1 dose of another vaccine** **(any time frame)**	**Pfizer/ BioNTech Comirnaty [BNT162b2]**	BNT162b2 (2 doses), followed by mRNA-1273 provided protection against VOC Delta for the following outcomes: • 68.2% (95% CI, 57.6 to 76.1) against infection at >1 week compared to no vaccination (1 Obs) [18]; *last update 2022-04-13*
Delta **2 doses followed by 1 dose of another vaccine** **(any time frame)**	**Moderna Spikevax [mRNA-1723]**	mRNA-1273 (2 doses), followed by BNT162b2 provided protection against VOC Delta for the following outcomes: • 87.1% (95% CI, 80.1 to 91.6) against infection at >1 week compared to no vaccination (1 Obs) [186]; *last update 2022-04-13*
Delta **2 doses followed by 1 dose of another vaccine** **(anytime frame)**	**Sinovac [CoronaVac]**	CoronaVac (2 doses) followed by BNT162b2 provided protection against VOC Delta for the following outcomes at least 7 days after 3rd dose: • 92.7 to 98% from infection (RME) • 96.5% (95% CI, 96.2 to 96.7) from symptomatic infection • 97.3% (95% CI, 96.1 to 98.1) from severe disease (hospitalization or death) • 96.2% (95% CI, 94.6 to 97.3) from ICU admission • 96.8% (95% CI, 93.9 to 98.3) from death (3 Obs) [155][164][165]; *last update 2022-03-02*

		CoronaVac (2 doses) followed by ChAdOx1 provided protection against VOC Delta for the following outcomes at least 7 days after 3rd dose: • 86% (95% CI, 74 to 93) from infection • 93.2% (95% CI, 92.9 to 93.6) from symptomatic infection • 98.9% (95% CI, 98.5 to 99.2) from ICU admission • 98.1% (95% CI, 97.3 to 98.6) from death (2 Obs) [155][164]; *last update 2022-03-02*
1 to 2 Doses – VOC Delta		
Delta (1-2 doses) **(up to 30 days)**	**Pfizer/ BioNTech Comirnaty [BNT162b2]**	BNT162b2 provided protection against VOC Delta for the following outcome at least 14 to 21 days after 1st dose: • 30 to 65% from infection (RME) • 33 to 47.5% from symptomatic infection (RME) • 87 to 94% from hospitalization (RME) • 100% (95% CI, not reported) against severe, critical, or fatal disease BNT162b2 provided protection against VOC Delta for the following outcome at least 7 days after 2nd dose: • 42 to 93% from infection (RME) • 63 to 94% from symptomatic infection (RME) • 82 to 98% from severe, critical, or fatal disease (RME) • 90% from death (RME) (27 Obs) [29][38][42][47][57][63][64][71][74][76][84][88][92][97][102][109][110][111][118][119][121][123][133][138][156][160][163][168]; *last update 2022-04-13*
Delta (1-2 doses) **(up to 30 days)**	**Moderna Spikevax [mRNA-1723]**	mRNA-1273 provided protection against VOC Delta for the following outcomes at least 14 days after 1st dose: • 75 to 86.7% from infection (RME) • 72% (95% CI, 57 to 82) from symptomatic infection • 96% (95% CI, 72 to 99) from hospitalization • 93 to 100% from severe, critical, or fatal disease (RME) mRNA-1273 provided protection against VOC Delta for the following outcomes 14 days after 2nd dose: • 59 to 91% from infection (RME) • 87% (95% CI, 84 to 88) from symptomatic infection • 93 to 100% from severe, critical, or fatal disease(RME) (20 Obs) [47][57][63][64][71][74][97][101][102][109][110][111][118][121][123][133][138][140][160] [186]; *last update 2022-04-13*
Delta (1-2 doses) **(up to 30 days)**	**AstraZeneca [ChAd0x1] Vaxzevria Serum Institute of India [Covishield]**	ChAdOx1 provided protection against VOC Delta for the following outcome at least 21 days after 1st dose: • 18 to 46% from infection (RME) • 33 to 58% from symptomatic infection (RME) • 71% (95% CI, 51 to 83) from hospitalization ChAdOx1 provided protection against VOC Delta for the following outcome at least 7 days after 2nd dose: • 44.8 to 83% from infection (RME) • 61 to 92% from symptomatic infection (RME) • 92% (95% CI, 75 to 97) from hospitalization • 91% (95% CI, 83 to 94) from death

		(13 Obs) [29][38][42][47][71][92][118][119][123][131][141][160][164]; *last update 2022-03-02*
Delta (1 dose) **(up to 30 days)**	**Johnson & Johnson [AD26.COV 2.S]**	Ad26.COV2.S provided protection against VOC Delta for the following outcomes ≥ 14 days after dose: • 3% to 71% against infection (RME) • 50.9% (95% CI, 35.5 to 63.0) from symptomatic infection • 92.5% (95% CI, 54.9 to 99.6) from ICU admission • 90.5% (95% CI, 31.5 to 99.6) from death (6 Obs) [97][109][110][111][117][133]; *last update 2021-12-15*
Delta (1-2 doses) **(up to 30 days)**	**Sinovac [CoronaVac]**	CoronaVac provided protection against VOC Delta for the following outcome at least 7 days after 2nd dose: • 60 to 74% from infection (RME) • 59% (95% CI, 16 to 81.6) from symptomatic infection • 46 to 89% from severe disease (RME) • 76.5% (95% CI, 72.9 to 79.6) from death (3 Obs) [91][156][164]; *last update 2022-03-02* CoronaVac followed by ChAdOx1 provided protection against VOC Delta for the following outcomes at least 7 days after 2nd dose: • 74% (95% CI, 43 to 99) from infection (1 Obs) [164]; *last update 2022-03-02*
Delta **1 dose followed by an mRNA vaccine** **(up to 30 days)**	**AstraZeneca [ChAd0x1] Vaxzevria Serum Institute of India [Covishield]**	ChAdOx1 followed by BNT162b2 at least 14 days after 2nd dose provided protection against VOC Delta for the following outcomes: • 67% (95% CI, 59 to 73) against symptomatic infection (1 Obs) [121]; *last update 2021-12-01* ChAdOx1 followed by mRNA-1273 at least 14 days after 2nd dose provided protection against VOC Delta for the following outcomes: • 79% (95% CI, 62 to 88) against symptomatic infection (1 Obs) [121]; *last update 2021-12-01* ChAdOx1 followed by either BNT162b2 or mRNA-1273 at least 14 days after 2nd dose provided protection against VOC Delta for the following outcomes: • 88% (95% CI, 85 to 89) against infection (1 Obs) [123]; *last update 2021-12-01* ChAdOx1 followed by BNT162b2 provided protection against infection by VOC Delta compared to ChAdOx1 (homologous): • HR 0.61 (95% CI, 0.52 to 0.71) unreported number of days after 2nd dose (1 Obs) [128]; *last update 2021-12-01*
Delta (2 doses) **(>30 days)**	**Pfizer/ BioNTech Comirnaty [BNT162b2]**	BNT162b2 showed a higher risk of infection by VOC Delta in participants fully vaccinated (≥14 days after 2nd dose) longer than or equal to 146 days ago vs fully vaccinated less than 146 days ago [OR 2.06 (95% CI, 1.69 to 2.51)] (1 Obs) [69]; *last update 2021-08-25* BNT162b2 provided protection against infection by VOC Delta for the following number of days after 2nd dose: • 73 to 87% up to 60 days (RME) • 67 to 74% from 21 to 98 days (RME) • 53 to 85% up to 120 days (RME) • 57 to 84% up to 150 days (RME)

		(10 Obs) [76][84][123][137][152][156] [158][163][169][185]; *last update 2022-05-12* BNT162b2 provided protection against symptomatic infection by VOC Delta for the following number of days after 2nd dose: • 74 to 76% at 30 to 60 days (RME) • 69 to 72% at 60 to 89 days (RME) • 47% (95% CI, 39 to 55) – at 121 to 180 days • 70.1% (95% CI, 68.9 to 71.2) – at 7 months (210 days) (5 Obs) [92][114][124][141][181]; *last update 2022-03-30* BNT162b2 provided protection against severe, critical, or fatal disease by VOC Delta for the following number of days after 2nd dose: • 91.1% (95% CI, 90 to 92) at 44 to 98 days • 68 to 72% up to 120 days • 92 to 94% - age 40 to 59 up to 150 days (RME) • 57 to 86% - age 60+ up to 150 days (RME) (5 Obs) [76][125][156] [158][163]; *last update 2022-03-02* BNT162b2 provided protection against death by VOC Delta for the following number of days after 2nd dose: • 81 to 89% up to 150 days (RME) (3 Obs) [124][125][156]; *last update 2022-02-02* BNT162b2 provided protection against infection by VOC Delta at the following intervals between doses: • 92% (95% CI, 91 to 93) at 14 to 27 days after 2nd dose (interval 7+ weeks) • 90% (95% CI, 88 to 91) at 4 months after 2nd dose (interval 7+ weeks) (1 Obs) [123]; *last update 2021-11-17* BNT162b2 or mRNA-1273 (2 doses) provided protection against VOC Delta for the following outcomes after 2nd dose: • 63% to 70% against infection >14 days (RME) • 80 to 89% against symptomatic infection 14-149 days (RME) • 99% (95% CI, 97 to 99) against severe disease >7 days • 58 to 88% against death >14 days (RME) (4 Obs)[184][192][193][194]; *last update 2022-05-12*
Delta (2 doses) **(>30 days)**	**Moderna Spikevax [mRNA-1723]**	mRNA-1273 provided protection against infection by VOC Delta the following number of days after 2nd dose: • 71 to 94% up to 60 days (RME) • 79 to 83% up to 90 days (RME) • 81 to 88% at 120 days (RME) • 63.6% (95% CI, 51.8 to 72.5) at 91 to 180 days • 65 to 88% at 151 to 180 days (RME) • 61.4% (95% CI, 56.8 to 65.5) at 181 to 270 days • 52.9% (95% CI, 43.7 to 60.5) at >270 days (8 Obs) [101][123][137][143][152][157][158][169]; *last update 2022-03-16* mRNA-1273 provided protection against symptomatic infection by VOC Delta the following number of days after 2nd dose: • 91% (95% CI, 85 to 95) – at 30 to 59 days (age 30-59)

		• 90% – at 70 to 98 days (RME) • 71% (95% CI, 56 to 81) – at 121 to 180 days • 81.9% (95% CI, 81 to 82.7) – at 7 months (210 days) (4 Obs) [92][114][124][141]; *last update 2022-01-05* mRNA-1273 provided protection against severe disease by VOC Delta the following number of days after 2nd dose: • 97.8% (95% CI, 83.7 to 99.7) at 60 days • 74.5 to 93.4% up to 90 days (RME) • 91.5% (95% CI, 60.8 to 98.1) up to 120 days (RME) • 85.2% (95% CI, 82.7 to 87.7) at 150 days (3 Obs)[143][157][158]; *last update 2022-02-16* mRNA-1273 provided protection against death by VOC Delta the following number of days after 2nd dose: • 96% (95% CI, 91.9 to98) at 60 days • 93.7% (95% CI, 90.2 to 95.9) at 210 days (1 Obs) [124]; *last update 2022-02-02* mRNA-1273 provided protection against infection by VOC Delta at the following intervals between doses: • 92% (95% CI, 90 to 94) at 14 to 27 days after 2nd dose (interval 7+ weeks) • 91% (95% CI, 87 to 94) at 4 months after 2nd dose (interval 7+ weeks) (1 Obs) [123]; *last update 2021-11-17*
Delta **(2 doses)** **(>30 days)**	**AstraZeneca [ChAd0x1] Vaxzevria Serum Institute of India [Covishield]**	ChAdOx1 provided protection against infection by VOC Delta the following number of days after 2nd dose: • 21% (95% CI, 18 to 24) at 21 to 42 days • 65 to 72% (95% CI, 66 to 77) at 120 days (RME) (3 Obs) [123][169][185]; *last update 2022-05-12* ChAdOx1 provided protection against symptomatic infection by VOC Delta the following number of days after 2nd dose: • 63 to 67% – at 30 to 59 days (RME) • 65% (95% CI, 48 to 76) – at 60 to 89 days • 41 to 49% – at 120 days (17 weeks) (RME) • 69.7% (95% CI, 68.7 to 70.5) – at 140 days (4 Obs) [92][114][141][142]; *last update 2022-01-05* ChAdOx1 provided protection against severe disease by VOC Delta the following number of days after 2nd dose: • 79.0% (95% CI, 75.9 to 81.7) at 56 to 63 days • 70.5% (95% CI, 67 to 73.7) at 112 to 119 (1 Obs)[142]; *last update 2022-01-05* ChAdOx1 provided protection against infection by VOC Delta at the following intervals between doses: • 85% (95% CI, 60 to 94) at 14 to 27 days after 2nd dose (interval 7+ weeks) • 72% (95% CI, 66 to 77) at 84+ days after 2nd dose (interval 7+ weeks) (1 Obs) [123]; *last update 2021-11-17*
Delta (1 dose)	**Johnson & Johnson**	Ad26.COV2.S provided protection against the following outcomes by VOC Delta the following number of days after dose:

(>30 days)	**[AD26.COV 2.S]**	• 60% (95% CI, 57 to 62) from infection up to 60 days • 74% (95% CI, 70 to 76) from infection at ≥150 days • 89.4% (95% CI, 52.3 to 97.6) from death at 120 days (3 Obs) [124][152][169]; *last update 2022-03-16* Ad26.COV2.S provided protection against symptomatic infection by VOC Delta the following number of days after dose: • 50% (95% CI, 36 to 62) – at 30 to 59 days • 52% (95% CI, 33 to 66) – at 60 to 89 days • 64.3% (95% CI, 62.3 to 66.1) – at 150 days (2 Obs) [124][141]; *last update 2022-01-05*
Delta **(2 doses)** **(>30 days)**	**Sinovac [CoronaVac]**	CoronaVac provided protection against the following outcomes by VOC Delta the following number of days after the 2nd dose: • 30% (95% CI, 18.4 to 39.9) from infection up to 150 days • 30.2% (95% CI, 7.6 to 47.3) from ICU admission up to 150 days • 75.7% (95% CI, 67.0 to 82.1) from death up to 150 days (1 Obs) [156]; *last update 2022-02-02*
Delta **ChAdOx1 (1 dose) followed by mRNA vaccine**	**AstraZeneca [ChAd0x1] Vaxzevria Serum Institute of India [Covishield]**	ChAdOx1 followed by an mRNA provided protection against infection by VOC Delta the following number of days after 2nd dose: • 86% (95% CI, 81 to 89) at 120 days (1 Obs) [123]; *last update 2021-11-17* ChAdOx1 followed by an mRNA provided protection against symptomatic infection by VOC Delta the following number of days after 2nd dose: • 67% (95% CI, 59 to 73) at least 14 days (BNT162b2) • 79% (95% CI, 62 to 88) at least 14 days (mRNA-1273) • 66% (95% CI, 41 to 80) – > 120 days (17 weeks) (2 Obs) [114][121]; *last update 2022-01-05*
Transmission – VOC Delta		
Delta **Transmission Household or close contacts of index case**	**Pfizer/ BioNTech Comirnaty [BNT162b2]**	Fully vaccinated index cases by BNT162b showed VET to unvaccinated (hh contact): • 31 to 63% (RME) Fully vaccinated index cases by BNT162b showed VET to fully vaccinated household contacts: • 10 to 40% (RME) Fully vaccinated index cases by BNT162b showed VET to hh contacts (unclear status): • 65% (95% CI, 52 to 74) Fully vaccinated hh contacts by BNT162b showed VES: • 46% (95% CI, 40 to 52) (vaccinated index case) • 61% (95% CI, 59 to 63) (unvaccinated index case) • 62 to 90% from infection (unclear status of index case) (RME) • 100% (95% CI, not reported) from severe disease (5 Obs) [105][107][108][129][149]; *last update 2021-01-18* BNT162b2 or mRNA-1273 (2 doses) hh contacts showed VES: • 46% (95% CI, 28 to 58) at least 7 days after 2nd dose

		BNT162b2 or mRNA-1273 (3 doses) hh contacts showed VES: • 62% (95% CI, 38 to 78) at least 7 days after 3rd dose (1 Obs) [161]; *last update 2022-03-02*
Delta **Transmission Household or close contacts of index case**	**Moderna Spikevax [mRNA-1723]**	Fully vaccinated household contacts by mRNA-1273 showed VES (unclear status of index): • 62 to 77% from infection (RME) (2 Obs) [108][129]; *last update 2021-12-01* BNT162b2 or mRNA-1273 (2 doses) hh contacts showed VES: • 46% (95% CI, 28 to 58) at least 7 days after 2nd dose BNT162b2 or mRNA-1273 (3 doses) hh contacts showed VES: • 62% (95% CI, 38 to 78) at least 7 days after 3rd dose (1 Obs) [161]; *last update 2022-03-02*
Delta **Transmission Household or close contacts of index case**	**AstraZeneca [ChAd0x1] Vaxzevria Serum Institute of India [Covishield]**	Fully vaccinated index cases by ChAdOx1 showed VET for household contacts (unclear status): • 36% (95% CI, 28 to 43) from infection Fully vaccinated household contacts by ChAdOx1 showed VES (unclear status of index): • 55 to 72% from infection (RME) (2 Obs)[107][108]; *last update 2021-11-03*
Delta **Transmission Household or close contacts of index case**	**ChAdOx1 followed by mRNA vaccine**	Fully vaccinated household contacts by ChAdOx1 followed by mRNA showed VES (unclear status of index): • 86% (95% CI, 45 to 97) from infection (1 Obs)[108]; *last update 2021-11-03*

Table 3c: Key findings about vaccine effectiveness for VOC Delta
(Last updated 30 March 2022)

1 to 2 Doses – VOC Gamma or VOC Beta		
Gamma/Beta	**Pfizer/ BioNTech Comirnaty [BNT162b2]**	BNT162b2 provided protection against VOC Gamma/Beta for the following outcomes: • 84.2% (95% CI, 78.2 to 90.3) from symptomatic infection 15 to 30 days after 2nd dose • 68% (95% CI, 59.1 to 76.9) from symptomatic infection 30 to 60 days after 2nd dose • 61.2% (95% CI, 45.7 to 76.8) from symptomatic infection 60 to 90 days after 2nd dose (1 Obs) [181]; *last update 2022-03-30*
Gamma	**Moderna Spikevax [mRNA-1723]**	mRNA-1273 provided protection against VOC Gamma for the following outcomes 14 days after 1st dose: • 85% (95% CI, 71 to 92) from infection • 77% (95% CI, 63 to 86) from symptomatic infection • 89% (95% CI, 73 to 95) from hospitalization mRNA-1273 provided protection against VOC Gamma (or Beta) for the following outcomes 35-41 days after 1st dose: • 43% (95% CI, 22 to 59) from symptomatic infection mRNA-1273 provided protection against VOC Gamma for the following outcome ate least 7 days after 2nd dose: • 95% from infection (RME) • 88% (95% CI, 61 to 96) from symptomatic infection (4 Obs – 5 refs) [23][47][101][122][123]; *last update 2021-12-01*
Gamma	**AstraZeneca [ChAd0x1] Vaxzevria Serum Institute of India [Covishield]**	ChAdOx1 provided protection against VOC Gamma for the following outcomes at least 14 days after 1st dose: • 60% (95% CI, 48 to 69) from infection • 39.9% (95% CI, 39 to 41) from infection up to 126 days • 42 to 48% from symptomatic infection (RME) • 83% (95% CI, 66 to 92) from hospitalization • 71.8% (95% CI, 71 to 73) from death up to 126 days ChAdOx1 provided protection against VOC Gamma for the following outcomes at least 14 days after 2nd dose: • 90% (95% CI, 61 to 98) from infection • 68.5% (95% CI, 67 to 71) from infection up to 126 days • 65.4% (95% CI, 64.6 to 66.2) from symptomatic infection at 56 to 63 days after 2nd dose • 58.7% (95% CI, 56.7 to 60.5) from symptomatic infection at 112 to 119 days after 2nd dose • 75.6% (95% CI, 73.4 to 77.6) from severe disease at 56 to 63 days after 2nd dose • 50.5% (95% CI, 43.4 to 56.6) from severe disease at 112 to 119 days after 2nd dose • 80.1% (95% CI, 78 to 82) from death up to 126 days after 2nd dose (6 Obs)[47][116][122][123][142][179]; *last update 2022-03-30*
Gamma	**Johnson & Johnson**	Ad26.COV2-S provided protection against VOC Gamma for the following outcomes 28 days after dose:

	[AD26.COV 2.S]	• 50.9% (95% CI, 35.5 to 63.0) from symptomatic infection • 92.5% (95% CI, 54.9 to 99.6) from ICU admission • 90.5% (95% CI, 31.5 to 99.6) from death (1 Obs) [117], *last update 2021-11-17*
Gamma	**Sinovac [CoronaVac]**	CoronaVac provided protection against VOC Gamma for the following outcome ≥ 14 days after 2nd dose: • 65.9% (95% CI, 65.2 to 66.6) from infection CoronaVac provided protection against VOC Gamma for the following outcome ≥ 14 days after 2nd dose for people over age 70: • 41.6% (95% CI, 26.9 to 63.3) from symptomatic infection (2 Obs) [30][49]; *last update 2021-07-14*
Gamma	**ChAdOx1 followed by mRNA vaccine**	ChAdOx1 followed by either BNT162b2 or mRNA-1273 at least 14 days after 2nd dose provided protection against VOC Gamma for the following outcomes: • 96% (95% CI, 70 to 99) against infection (1 Obs) [123]; *last update 2021-11-17*
Gamma	**Sputnik V Gam-Covid-Vac [rAd26-rAd5]**	rAd26-rAd5 provided protection against VOC Gamma for the following outcomes: • 39.5% (95% CI, 39 to 40) from infection up to 126 days after 1st dose • 68.8% (95% CI, 68 to 70) from death up to 126 days after 1st dose • 64% (95% CI, 63 to 65) from infection up to 126 days after 2nd dose • 80.7% (95% CI, 79 to 82) from death up to 126 days after 2nd dose (1 Obs) [179]; *last update 2022-03-30*
Gamma	**Sinopharm [BBIBP-CorV]**	BBIBP-CorV provided protection against VOC Gamma for the following outcomes: • 22.6% (95% CI, 20 to 25) from infection up to 126 days after 1st dose • 61.8% (95% CI, 59 to 64) from death up to 126 days after 1st dose • 43.6% (95% CI, 42 to 45) from infection up to 126 days after 2nd dose • 73.4% (95% CI, 71 to 75) from death up to 126 days after 2nd dose (1 Obs) [179]; *last update 2022-03-30*
Beta	**Moderna Spikevax [mRNA-1723]**	mRNA-1273 provided protection against VOC Beta for the following outcomes 14 days after 1st dose: • 61.3% (95% CI, 56.5 to 65.5) from infection • 77% (95% CI, 63 to 86) from symptomatic infection • 89% (95% CI, 73 to 95) from hospitalization • 81.6% (95% CI, 71.0 to 88.8) from severe, critical, or fatal disease (combined with Alpha) mRNA-1273 provided protection against VOC Beta for the following outcomes 35-41 days after 1st dose: • 43% (95 CI, 22 to 59) from symptomatic infection mRNA-1273 provided protection against VOC Beta for the following outcome 7 days after 2nd dose: • 96.4% (95% CI, 91.9 to 98.7) from infection • 88% (95% CI, 61 to 96) from symptomatic infection • 95.7% (95% CI, 73.4 to 99.9) from severe, critical, or fatal disease (combined with Alpha) (2 Obs – 3 refs) [23][47][50]; *last update 2021-07-14*
Beta	**AstraZeneca [ChAd0x1] Vaxzevria**	ChAdOx1 provided protection against VOC Beta for the following outcome 14 days after 1st dose: • 48% (95% CI, 28 to 63) from symptomatic infection

	Serum Institute of India [Covishield]	• 83% (95% CI, 66 to 92) from hospitalization ChAdOx1 provided protection against VOC Beta for the following outcome after 2 doses: • 10.4% (95% CI, -76.8 to 54.8) from mild to moderate disease (1 RCT, moderate quality; 1 Obs) [4][47]; *last update 2021-07-07*
Beta	**Novavax [NVX-CoV2373**	NVX-CoV2373 provided protection against VOC Beta for the following outcome after 7 days after 2nd dose: • Post-hoc: 43% (95% CI, -9.8 to 70.4) from symptomatic infection (1 RCT, moderate quality), [17]; *last update 2021-07-14*

Table 3d: Key findings about vaccine effectiveness for VOC Alpha
(Last updated 01 December 2021 – will not be updated further)

1 or 2 Doses – VOC Alpha		
Alpha	**Moderna Spikevax [mRNA-1723]**	mRNA-1273 provided protection against VOC Alpha for the following outcomes 14-41 days after 1st dose: • 58.9 to 88.1% from infection (RME) • 60 to 61% from symptomatic infection (RME) • 81.6% (95% CI, 71.0 to 88.8) from severe, critical, or fatal disease (combined with Beta) mRNA-1273 provided protection against VOC Alpha for the following outcomes at least 7 days after 2nd dose: • 86 to 100% from infection (RME) • 90 to 95.7% from symptomatic infection (RME) • 95.7% (95% CI, 73.4 to 99.9) from severe, critical, or fatal disease (combined with Beta) (10 Obs – 11 refs) [8][23][31][34][37][47][50][60][74][101][102]; *last update 2021-10-20*
Alpha	**AstraZeneca [ChAd0x1] Vaxzevria Serum Institute of India [Covishield]**	ChAdOx1 provided protection against VOC Alpha for the following outcome 14 days after 1st dose: • 64% (95% CI, 60 to 68) from symptomatic infection • 85% (95% CI, 81 to 88) from hospitalization ChAdOx1 provided protection against VOC Alpha for the following outcome 21 to 28 days after 1st dose: • 44 to 74% from infection (RME) ChAdOx1 provided protection against confirmed VOC Alpha for the following outcome at least 14 days after 2 doses: • 62 to 79% from infection (RME) (1 RCT, moderate quality; 5 Obs)[9][10][5][47][70][71][]; *last update 2021-08-25*
Alpha	**Novavax [NVX-CoV2373**	NVX-CoV2373 provided protection against VOC Alpha for the following outcome after 2 doses: • 89.7% (95% CI, 80.2 to 94.6) from symptomatic infection. • No hospitalizations or deaths in vaccinated group • Post hoc: 86.3% (95% CI, 71.3 to 93.5) from confirmed Alpha symptomatic infection (1 RCT, moderate quality), [19]; *last update 2021-06-16*
Alpha	**ChAdOx1 followed by mRNA vaccine**	ChAdOx1 followed by BNT162b2 or mRNA-1273 at least 14 days after 2nd dose provided protection against VOC Alpha for the following outcomes: • 88% (95% CI, 83 to 92) against infection (1 Obs) [70]; *last search date* 2021-08-25
Transmission – VOC Alpha		
Alpha **Transmission Household or close contacts of index case**	**Pfizer/ BioNTech Comirnaty [BNT162b2]**	BNT162b2 reduced transmission of VOC Alpha (VET) from a vaccinated index case (14 to 21 days after 1st dose) to household contacts compared to households of unvaccinated index cases: • 30 to 49% from infection (RME) BNT162b2 reduced transmission of VOC Alpha (VET) from a vaccinated HCW (10 weeks after 1st dose) to household spouse: • 42.9% (95% CI, 22.3 to 58.1) from infection Fully vaccinated index cases showed VET for household contacts (unclear status):

		• 70 to 82% from infection (RME) Fully vaccinated household contacts showed VES (unclear status of index): • 65 to 94% from infection (RME) (8 Obs) [6][14][33][40][48][104][107][108]; *last update 2021-11-03*
Alpha **Transmission Household or close contacts of index case**	**Moderna Spikevax [mRNA-1723]**	mRNA-1273 reduced transmission of VOC Alpha (VET) from a vaccinated HCW (10 weeks after 1st dose) to household spouse: • 42.9% (95% CI, 22.3 to 58.1) from infection Fully vaccinated index cases by mRNA-1273 showed VET for household contacts (unclear status): • 88% (95% CI, 50 to 97) from infection Fully vaccinated household contacts by mRNA-1273 showed VES (unclear status of index): • 86 to 91% from infection (RME) (3 Obs)[33][104][108]; *last update 2021-11-03*
Alpha **Transmission Household or close contacts of index case**	**AstraZeneca [ChAd0x1] Vaxzevria Serum Institute of India [Covishield]**	ChAdOx1 reduced transmission of VOC Alpha (VET) from a vaccinated index case (14 to 21 days after 1st dose) to household contacts compared to households of unvaccinated index cases: • 30 to 47% from infection (RME) Fully vaccinated index cases by ChAdOx1 showed VET to household contacts (unclear status): • 58 to 63% from infection (RME) Fully vaccinated household contacts by ChAdOx1 showed VES (unclear status of index case): • 38 to 87% from infection (RME) (6 Obs) [6][14][40][104][107][108]; *last update 2021-12-01*
Alpha **Transmission Household or close contacts of index case**	**Johnson & Johnson [AD26.COV 2.S]**	Fully vaccinated index cases by Ad26.COV2.S showed VET for household contacts (unclear status): • 77% (95% CI, 6 to 94) from infection Fully vaccinated household contacts by Ad26.COV2.S showed VES (unclear status of index): • 12% (95% CI, -71 to 54) from infection (1 Obs) [104]; *last update 2021-11-03*

Table 3e: Key findings about vaccine effectiveness for VOC (multiple in same study)
(Last updated 19 January 2022 – will be not updated further)

Studies Covering Time Frame for More than One VOC (insufficient data to divide them into separate VOC)		
Alpha to Delta	**Pfizer/ BioNTech** **Comirnaty [BNT162b2]**	BNT162b2 provided protection against infection by VOC Alpha to Delta at least 7 days after 2nd dose: • 69.7% (95% CI, 68.6 to 70.8) BNT162b2 or mRNA-1273 provided protection against VOC Alpha to Delta for the following outcomes ≥ 14 days after 2nd dose: • 57% (95% CI, 53 to 60) from infection at 144 days after 2nd dose • 68% (95% CI, 64 to 71) from symptomatic infection at 42 to 69 days after 2nd dose • 39% (95% CI, 29 to 48) from symptomatic infection at 98 to 148 days after 2nd dose

Studies Covering Time Frame for More than One VOC (insufficient data to divide them into separate VOC)		
		• 92% (95% CI, 85 to 96) from severe disease in people with no risk conditions • 72% (95% CI, 51 to 84) from severe disease with very high risk conditions • 95% (95% CI, 88 to 98) from death at 14 to 41 days after 2nd dose • 86 to 93% from death at 70 to 148 days after 2nd dose(RME) BNT162b2 showed OR 1.61 (95% CI, 1.45 to 1.79) for infection comparing fully vaccinated Jan to Feb (VOC_Alpha) vs fully vaccinated Mar to May (VOC Delta). (5 Obs) [95][96][127][144][145]; *last update* 2022-01-12
Alpha to Delta	**Pfizer/ BioNTech (3 doses)** **Comirnaty [BNT162b2]**	BNT162b2 (3 doses) provided protection against VOC Alpha to Delta for the following outcomes compared to unvaccinated: • 88% (95% CI, 86 to 89) from infection at least 14 days after 3rd dose (age>18) BNT162b2 (3 doses) provided protection against VOC Alpha to Delta for the following outcomes: • 75% (95% CI, 71 to 78) from infection at least 14 days after 3rd dose compared to 2 doses (given at least 6 months previously) (age>18) (1 Obs) [146]; *last update 2022-01-05*
Alpha to Delta	**Moderna Spikevax [mRNA-1723]**	mRNA-1273 provided protection against infection by VOC Alpha to Delta at least 7 days after 2nd dose: • 78.2% (95% CI, 76.7 to 79.6) mRNA-1273 or BNT162b2 provided protection against VOC Alpha to Delta for the following outcomes ≥ 14 days after 2nd dose: • 73% (95% CI, 70 to 76) from infection at 144 days after 2nd dose • 92% (95% CI, 85 to 96) from severe disease in people with no risk conditions • 72% (95% CI, 51 to 84) from severe disease with very high risk conditions • 93% (95% CI, 81 to 97) from death at 144 days after 2nd dose (3 Obs) [95][127][145]; *last update 2022-01-05*
Alpha to Delta	**AstraZeneca [ChAd0x1] Vaxzevria Serum Institute of India [Covishield]**	ChAdOx1 provided protection against infection by VOC Alpha to Delta at least 7 days after 2nd dose: • 43.4% (95% CI, 4.4 to 66.5) ChAdOx1 provided protection against VOC Alpha to Delta for the following outcomes ≥ 14 days after 2nd dose: • 94% (95% CI, 90 to 96) from severe disease in people with no risk conditions • 63% (95% CI, 46 to 75) from severe disease with very high risk conditions • 33% (95% CI, 23 to 42) from symptomatic infection at 42 to 69 days after 2nd dose

Studies Covering Time Frame for More than One VOC (insufficient data to divide them into separate VOC)		
		• 34% (95% CI, 10 to 52) from symptomatic infection at 70 to 140 days after 2nd dose • 95% (95% CI, 90 to 97) from death at least 14 days after 2nd dose (2 Obs) [95][127][144]; *last update 2022-01-05*
Alpha to Delta	**Johnson & Johnson [AD26.COV2.S]**	Ad26.COV2.S provided protection against VOC Alpha to Delta for the following outcomes ≥ 14 days after 2nd dose: • 36% (95% CI, 30 to 42) from infection at 144 days after 2nd dose • 72% (95% CI, 49 to 85) from death at 144 days after 2nd dose (1 Obs) [145]; *last update 2022-01-05*
Alpha to Delta	**Heterologous mRNA vaccines ChAdOx1 followed by mRNA vaccine**	Heterologous mRNA vaccines provided protection against infection by VOC Alpha to Delta at least 7 days after the 2nd dose: • 84.7% (83.1 to 86.1) ChAdOx1 followed by either BNT162b2 or mRNA-1273 provided protection against infection by VOC Alpha to Delta at least 7 days after 2nd dose: • 60.7% (95% CI, 57.5 to 63.6) (1 Obs) [127]; *last update 2021-12-01*
Alpha to Delta **Maintenance hemodialysis** (not updated after Nov 5, 2021)	**Moderna Spikevax [mRNA-1723]**	mRNA-1273 or BNT162b showed OR of 8.89 (95% CI, 5.92 to 13.34) for unvaccinated vs fully vaccinated against infection (VOC Alpha) mRNA-1273 or BNT162b showed OR of 2.27 (95% CI, 1.72 to 3.00) for unvaccinated vs fully vaccinated against infection (VOC Delta) (1 Obs) [106]; *last update 2021-11-03*
Alpha or Beta **Immunosuppressed, renal transplant** (not updated after Nov 5, 2021)	**Pfizer/ BioNTech** **Comirnaty [BNT162b2]**	BNT162b2 or mRNA-1273 provided protection against infection by VOC Alpha or Beta at the following number of days after 2nd dose: • 46.6% (95% CI, 0.0 to 73.7) ≥14 days • 66.0% (95% CI, 21.3 to 85.3) ≥42 days • 73.9% (95% CI, 33 to 98.9) ≥56 days BNT162b2 or mRNA-1273 provided protection against severe, critical, or fatal disease by VOC Alpha or Beta at the following number of days after 2nd dose: • 72.3% (95% CI, 0.0 to 90.9) ≥14 days • 85% (95% CI, 35.7 to 96.5) ≥42 days • 83.8% (95% CI, 31.3 to 96.2) ≥56 days (1 Obs) [90]; *last update 2021-09-22*
Alpha or Beta **Immunosuppressed, renal transplant** (not updated after Nov 5, 2021)	**Moderna Spikevax [mRNA-1723]**	mRNA-1273 or BNT162b2 provided protection against infection by VOC Alpha or Beta at the following number of days after 2nd dose: • 46.6% (95% CI, 0.0 to 73.7) ≥14 days • 66.0% (95% CI, 21.3 to 85.3) ≥42 days • 73.9% (95% CI, 33 to 98.9) ≥56 days mRNA-1273 or BNT162b2 provided protection against severe, critical, or fatal disease by VOC Alpha or Beta at the following number of days after 2nd dose:

Studies Covering Time Frame for More than One VOC (insufficient data to divide them into separate VOC)		
		• 72.3% (95% CI, 0.0 to 90.9) ≥14 days • 85% (95% CI, 35.7 to 96.5) ≥42 days • 83.8% (95% CI, 31.3 to 96.2) ≥56 days (1 Obs) [90]; *last update 2021-09-22*
Alpha or Beta **Previously infected** (not updated after Nov 5, 2021)	**Pfizer/ BioNTech Comirnaty [BNT162b2]**	BNT162b2 (2 doses) after prior infection provided protection against VOC Alpha (or Beta) for the following outcomes: • 85% (95% CI, 80 to 89) against re-infection compared to BNT162b2 without prior infection (1 Obs) [72]; *last update 2021-08-25*
Alpha or Beta **Previously infected** (not updated after Nov 5, 2021)	**Moderna Spikevax [mRNA-1723]**	mRNA-1273 (2 doses) after prior infection did not offer additional protection against VOC Alpha (or Beta) for the following outcomes: • 15% (95% CI, -105 to 66) against re-infection compared to mRNA-1273 without prior infection (1 Obs) [72]; *last update 2021-08-25*
Beta to Delta	**Pfizer/ BioNTech Comirnaty [BNT162b2]**	BNT162b2 provided protection against infection by VOC Beta to VOC Delta for the following number of days after the 2nd dose: • 65.8% (95% CI, 63.8 to 67.7) at 5 to 9 weeks • 29.7% (95% CI, 21.7 to 36.9) at 15 to 19 weeks • 0% (95% CI, 0 to 0) 20 to 24 weeks BNT162b2 provided protection against hospitalization or death by VOC Beta to VOC Delta for the following number of days after the 2nd dose: • 94.2% (95% CI, 91.0 to 96.5) at 5 to 9 weeks • 86.4% (95% CI, 69.9 to 94.8) at 15 to 19 weeks • 95.3% (95% CI, 70.5 to 99.9) at 20 to 24 weeks (1 Obs) [98]; *last update* 2021-10-06
Beta or Gamma **HCW** (not updated after Nov 5, 2021)	**Pfizer/ BioNTech Comirnaty [BNT162b2]**	BNT162b2 provided protection against VOC Beta or Gamma for the following outcomes 14 to 42 days after 1st dose: • 37.2% (95% CI, 16.6 to 52.7) from infection BNT162b2 provided protection against VOC Beta or Gamma for the following outcome 7 days after 2nd dose: • 79.2% (95% CI, 64.6 to 87.8) from infection (1 Obs)[27]; *last update 2021-06-01*
Beta or Gamma **Transmission Vaccinated HCW vs unvaccinated community**	**Pfizer/ BioNTech Comirnaty [BNT162b2]**	BNT162b2 reduced transmission of VOC Beta or Gamma from vaccinated HCW (VET) compared to unvaccinated community ≥14 days after 1st dose: • 54.7% (95% CI, 44.8 to 62.9) from infection BNT162b2 reduced transmission of VOC Beta or Gamma from vaccinated HCW (VETompared to unvaccinated community ≥7 days after 2nd dose: • 84.8% (95% CI, 75.2 to 90.7) from infection (1 Obs) [27]; *last update 2021-06-08*

Table 3f: Key findings about vaccine effectiveness for VOC (Special Populations)
(Last updated 03 November 2021 – will be not updated further

Special Populations		
Delta **Adolescents** (moved to Pediatric/Adolescent LES)	**Pfizer/ BioNTech Comirnaty [BNT162b2]**	BNT162b2 provided protection against VOC Delta for the following outcomes at least 14 days after 1st dose: • 59% (95% CI, 52 to 65) from infection BNT162b2 provided protection against VOC Delta for the following outcomes at least 7 days after 2nd dose: • 90 to 92% against infection (RME) (2 Obs) [112][120]; *last update 2021-11-17*
Delta **HCW**	**Pfizer/ BioNTech Comirnaty [BNT162b2]**	BNT162b2 provided protection against VOC Delta for the following outcomes ≥ 14 days after 2nd dose: • 66% (95% CI, 26 to 84) (1 Obs) [81]; *last update 2021-09-22*
Delta **HCW**	**AstraZeneca [ChAd0x1] Vaxzevria Serum Institute of India [Covishield]**	ChAdOx1 provided protection against VOC Delta for the following outcomes at least 14 days after 2nd dose: • 54 to 85% from infection (RME) • 64% (95% CI, 38 to 78) from symptomatic infection (2 Obs) [59][66]; *last update* 2021-10-06
Delta **Previously infected, (65+)**	**Pfizer/ BioNTech Comirnaty [BNT162b2]**	BNT162b2 (2 doses) provided protection against VOC Delta for the following outcomes compared to natural immunity after prior infection: • 66% (95% CI, 22 to 86) from infection (1 Obs) [103]; *last update 2021-10-20*
Delta **Previously infected (65+)**	**Moderna Spikevax [mRNA-1723]**	mRNA-1273 (2 doses) provided protection against VOC Delta for the following outcomes compared to natural immunity after prior infection: • 68% (95% CI, 30 to 86) from infection • 30% (-11 to 1) from death (1 Obs) [103]; *last update 2021-10-20*
Delta **Prison**	**Moderna Spikevax** **[mRNA-1723]**	mRNA-1273 provided protection against VOC Delta for the following outcomes at least 14 days after 2nd dose: 57% (95% CI, 42 to 67.5) (1 Obs) [113]; *last update 2021-11-03*
Gamma **HCW**	**Sinovac [CoronaVac]**	CoronaVac provided protection against VOC Gamma for the following outcomes ≥14 days after 1st dose: • 35.1% (95% CI, -6.6 to 60.5) from infection • 49.6% (95% CI, 11.3 to 71.4) from symptomatic infection (1 Obs)[18]; last update 2021-05-07
Gamma **LTC residents**	**Pfizer/ BioNTech Comirnaty [BNT162b2]**	BNT162b2 (or mRNA-1273) provided protection against VOC Gamma 14 days after 2nd dose: • 52.5% (95% CI, 26.9 to 69.1) against infection • 78.6% (95% CI, 47.9 to 91.2) against severe disease (1 Obs) [61]; *last update 2021-08-11*
Gamma **LTC residents**	**Moderna Spikevax [mRNA-1723]**	mRNA-1273 (or BNT162b2) provided protection against VOC Gamma for the following outcomes 14 days after 2nd dose: • 52.5% (95% CI, 26.9 to 69.1) against infection • 78.6% (95% CI, 47.9 to 91.2) against severe disease (1 Obs) [61]; *last update 2021-08-11*

Special Populations		
Gamma **Over 70 years**	**Pfizer/ BioNTech Comirnaty [BNT162b2]**	BNT162b2 provided protection against VOC Gamma for the following outcomes ≥ 21 days after 1st dose: • 61% (95% CI, 45 to 72) from infection (1 Obs)[35]; *last update 2021-07-07*
Gamma **Over 70 years**	**Moderna Spikevax [mRNA-1723]**	mRNA-1273 provided protection against VOC Gamma for the following outcome ≥21 days after 1st dose: • 61% (95% CI, 45 to 72) from infection (1 Obs) [35]; *last update 2021-06-23*
Alpha **HCW**	**Pfizer/ BioNTech Comirnaty [BNT162b2]**	BNT162b2 provided protection against VOC Alpha for the following outcomes 14 to 21 days after 1st dose: • 64 to 84% from infection (RME) BNT162b2 provided protection against VOC Alpha for the following outcomes at least 7 days after 2nd dose: • 90 to 97% from infection (RME) BNT162b2 provided protection against VOC Alpha for the following outcome 7 days after 2nd dose: • 86% (95% CI, 69 to 93) from asymptomatic infection [25] BNT162b2 provided protection against infection by VOC Alpha for the following number of days after 2nd dose: • 85% (95% CI, 68 to 93) at 14 to 119 days • 73% (95% CI, 49 to 86) ≥150 days (6 Obs)[11][34][45][46][56][81]; *last update 2021-11-17*
Alpha **HCW**	**AstraZeneca [ChAd0x1] Vaxzevria Serum Institute of India [Covishield]**	ChAdOx1 provided protection against VOC Alpha for the following outcomes at least 14 days after 1st dose: • 64% (95% CI, 50 to 74) from infection ChAdOx1provided protection against VOC Alpha for the following outcomes at least 14 days after 2nd dose: • 90% (95% CI, 62 to 98) from infection (1 Obs) [46]; *last update 2021-07-07*
Alpha **LTC residents**	**Pfizer/ BioNTech Comirnaty [BNT162b2]**	BNT162b2 provided protection against VOC Alpha for the following outcomes 7 days after 2nd dose: • 53% (95% CI, 29 to 69) from infection • 89% (95% CI, 81 to 93) from death (1 Obs)[32]; *last update 2021-10-06*
Alpha **Over 65 years, requiring home support**	**Pfizer/ BioNTech Comirnaty [BNT162b2]**	BNT162b2 provided protection against VOC Alpha for the following outcomes 7 days after 2nd dose: • 86% (95% CI, 78 to 91) from infection • 97% (95% CI, 88 to 99) from death (1 Obs)[32]; *last update 2021-07-07*
Alpha **Over 70 years**	**Pfizer/ BioNTech Comirnaty [BNT162b2]**	BNT162b2 provided protection against VOC Alpha for the following outcomes at least 21 days after 1st dose: • 41 to 67% from infection (RME) BNT162b2 provided protection against VOC Alpha for the following outcomes at least 7 days after 2nd dose: • 75 to 90% from infection (RME) (3 Obs)[28][35][51]; *last update 2021-10-06*
Alpha **Over 70 years**	**Moderna Spikevax [mRNA-1723]**	mRNA-1273 provided protection against VOC Alpha for the following outcome ≥21 days after 1st dose: • 67% (95% CI, 57 to 75) from infection

Special Populations		
		(1 Obs) [35]; *last update 2021-06-23*
Alpha **Over 80 years**	**AstraZeneca [ChAd0x1] Vaxzevria Serum Institute of India [Covishield]**	ChAdOx1 provided protection against VOC Alpha for the following outcomes at least 14 days after 2nd dose: • 88% (95% CI, 48 to 97) from symptomatic infection (1 Obs) [79]; *last update 2021-10-20*
Alpha **Pregnant**	**Pfizer/ BioNTech Comirnaty [BNT162b2]**	BNT162b2 provided protection against VOC Alpha for the following outcomes at least 28 days after 1st dose: • 78% (95% CI, 57 to 89) from infection BNT162b2 provided protection against VOC Alpha for the following outcomes 7 to 56 days after 2nd dose: • 86.1% (95% CI, 82.4 to 89.1) from infection • 89% (95% CI, 43 to 100) from hospitalization (2 Obs) [52][54]; *last update 2021-07-28*
Epsilon	**Pfizer/ BioNTech Comirnaty [BNT162b2]**	BNT162b2 provided protection against VOC Epsilon for the following outcome 15 days after 1st dose: • 58.9% (95% CI, −9.7 to 84.5) from infection BNT162b2 provided protection against VOC Epsilon for the following outcome 15 days after 2nddose: • 85.7% (67.2 to 93.9) from infection (2 Obs) [8][31]; *last update 2021-06-08*
Epsilon	**Moderna Spikevax [mRNA-1723]**	mRNA-1273 provided protection against VOC Epsilon for the following outcome 15 days after 1st dose: • 58.9% (95% CI, −9.7 to 84.5) from infection mRNA-1273 provided protection against VOC Epsilon for the following outcome 15 days after 2nddose: • 85.7% (67.2 to 93.9) from infection (2 Obs) [8][31]; *last update 2021-06-08*

Links to references are provided in Appendix 1

Iorio A, Little J, Linkins L, Abdelkader W, Bennett D, Lavis JN. COVID-19 living evidence synthesis #6 (version 6.41): What is the efficacy and effectiveness of available COVID-19 vaccines in general and specifically for variants of concern? Health Information Research Unit (HIRU); McMaster and Ottawa Knowledge Synthesis and Application Unit, 14 September 2022.

To help Canadian decision-makers as they respond to unprecedented challenges related to the COVID-19 pandemic, COVID-END in Canada is preparing rapid evidence responses like this one. The development and continued updating of this living evidence synthesis has been funded by the Canadian Institutes of Health Research (CIHR) and the Public Health Agency of Canada. The opinions, results, and conclusions are those of the team that prepared the living evidence synthesis, and independent of the Government of Canada, CIHR and the Public Health Agency of Canada. No endorsement by the Government of Canada, CIHR or Public Health Agency of Canada is intended or should be inferred.

Appendix 1: Summary of Study Findings and Appraisals

Section 1: included studies				
Ref	**Author**	**Bottom line**	**ROBINS-I***	**Design, Notes**
*Note: ROBINS-I score risk of bias: Low risk of bias indicates high quality				
1	Dagan	BNT162b2 showed VE 46% (95% CI, 40 to 51) against infection 14 to 20 days after 1st dose and VE 92% (95% CI, 88 to 95) 7 days after 2nd dose. BNT162b2 showed VE 92% (95% CI, 75 to 100) for severe disease at 7 days after 2nd dose.	Moderate	Data-linkage study in Israel; .5 M matched participants (2 M excluded – also (possible overlap with Haas); time and setting for VOC Alpha (estimated 80%).
2	Haas	BNT162b2 showed VE 95.3% (95% CI, 94.9 to 95.7) against infection; VE 97.5% (95% CI, 97.1 to 97.8) against severe or critical COVID-19-related hospitalization; VE 96.7% (95% CI, 96.0 to 97.3) against death 7 days after 2nd dose.	Serious	Data-linkage study in Israel; >6.5 M matched participants (possible overlap with Dagan) Updated May 14 due to final publication; sample confirmed VOC Alpha (estimated 94%).
3	Kustin *Delayed exclusion-only included infected	BNT162b2 showed lower relative VE (2.4:1) against Alpha. after 1st dose; and lower VE (8:1) against Beta after 2nd dose in a population with >90% of Alpha and <1% Beta	Moderate	Case-control study in Israel; small sample for Beta (no overlap CHS cohort); confirmed VOC Alpha and Beta.
4	Madhi	ChAdOx1 nCoV-19 showed VE 10.4% (95% CI, -76.8 to 54.8) against mild to moderate disease 14 days after 2nd dose.	Moderate quality (RCT)	RCT in South Africa; Underpowered for 20% efficacy (42 cases); VOC Beta.
5	Emary	ChAdOx1nCoV-19 showed VE 61.7% (95% CI, 36.7 to 76.9) against infection by VOC Alpha ≥ 15 days after 2nd dose.	Moderate quality (RCT)	RCT in UK; neutralization of Alpha 9 times lower; no sequencing for 45% of cases; 52 cases (19%) had VOC Alpha.
6	Shah	ChAdOx1nCoV-19 or BNT162b2 reduced infection in unvaccinated household contacts of vaccinated HCW by about 30% (HR, 0.70, 95% CI, 0.63 to 0.78) ≥ 14 days after 1st dose; ChAdOx1nCoV-19 or BNT162b2 reduced infection in HCW by about 55% (HR 0.45, 95% CI, 0.42 to 0.49) and hospitalization by 84% (HR 0.16, 95% CI, 0.09 to 0.27) ≥ 14 days after 1st dose.	Moderate	Data-linkage study in Scotland - (25% of cases had received 2 doses); time and setting for VOC Alpha.
7	Sadoff	Single dose Ad26.COV2.S showed VE 38.1% (95% CI, 4.2 to 60.4) at 14 days and VE 51.9% (95% CI, 19.1 to 72.2) at 28 days against moderate to severe disease and VE 81.7% (95% CI, 46.2 to 95.4) at 28 days	Moderate quality (RCT) Updated	RCT; over 40,000 participants; Argentina, Brazil, Chile, Colombia, Mexico, Peru, South Africa, and the

		against severe disease (confirmed VOC Beta). Single dose Ad26.COV2.S showed VE 36.4% (95% CI, 13.9 to 53.2) at 14 days and VE 36.5% (95% CI, 14.1 to 53.3) at 28 days against moderate to severe disease (confirmed VOC Gamma)	2022/03/16	United States; sequenced for VOC Alpha, Beta, Delta, Gamma.
8	Andrejko	BNT162b2 or mRNA-1273 showed VE 58.9% (95% CI, −9.7 to 84.5) at 15 days after 1st dose, and VE 85.7% (95% CI, 67.2 to 93.9) 15 days after 2nd dose against infection.	Serious	Test-negative study in California; 645 participants; 69% of population at time had VOC Alpha or Epsilon.
9	Glampson	ChAdOx1nCoV-19 showed VE 74% (95% CI, 65 to 81) against infection 28 days after 1st dose. BNT162b2 showed VE 78% (95% CI, 73 to 82) against infection 28 days after 1st dose.	Serious	Retrospective cohort in UK; 2M participants; time and setting for VOC Alpha.
10	Pritchard	ChAdOx1nCoV-19 or BNT162b2 showed VE 66% (95% CI, 59 to 72%) 21 days after 1st dose and 78% (95% CI, 68 to 85%) after 2nd dose against infection.	Serious	Survey of randomly selected private households with longitudinal follow-up in UK; 370,000 participants; sample confirmed VOC Alpha.
11	Hall (SIREN)	BNT162b2 vaccine showed VE of 70% (95% CI, 55 to 85) 21 days after 1st dose and 85% (95% CI, 74 to 96) 7 days after 2nd dose against infection in HCW.	Moderate	Prospective cohort with standardized testing for HCW over all of England; 23,000 participants; time and setting for VOC Alpha
12	Shrotri *Delayed exclusion – critical ROB	Similar effect sizes were seen for ChAdOx1 (aHR 0.32, 95% CI, 0.15 to 0.66) and BNT162b2 (aHR 0.35, 95% CI, 0.17 to 0.71) at 35-48 days after 1st dose.	Critical	Prospective cohort in England: 9160 of 10412 frail LTC residents; routine screening; time and setting for VOC Alpha
13	Hyams *Delayed exclusion – did not report clinical outcomes of interest for this LES	BNT162b2 showed VE 71.4% (95% CI, 43.1 to 86.2) against hospitalization 14 days after 1st dose; ChAdOx1nCoV-19 showed VE 80.4% (95% CI, 36.4 to 94.5) against hospitalization 14 days after 1st dose for 80+. When effectiveness analysis for BNT162b2 was restricted to the period covered by ChAdOx1nCoV-19, the estimate was 79.3% (95% CI, 47.0 to 92.5).		Test negative case-control study in Scotland. Single center; 466 participants, 80+; time and setting for VOC Alpha
14	Harris	BNT162b2 or ChAdOx1 reduced likelihood of VET by vaccinated HCW to household contacts by 40-50% 21 days after 1st dose.	Serious	Data-linkage and case-control study in England; 338,887 participants; time and setting for VOC Alpha
15	Goldberg	Prior infection (in unvaccinated) has similar VE against infection [94.8%], and severe illness [96.4%] as two doses of BNT162b2.	Serious	Data-linkage study in Israel; 6,351,903 participants; likely overlaps with Dagan

				and Haas; time and setting for VOC Alpha
16	Cavanaugh *Delayed exclusion – VOI instead of VOC	VE 66.2% (95% CI, 40.5% to 80.8%) against infection among LTC residents and 75.9% (95% CI, 32.5% to 91.4%) among HCW. VE 94.4% (95% CI, 73.9% to 98.8%) against hospitalization among residents; no HCW were hospitalized. Three residents died, two of whom were unvaccinated (VE 94.4%; 95% CI, 44.6% to 99.4%).	Critical	Outbreak analysis in LTC in Kentucky; small number of events; VOI R.1
17	Shinde	NVX-CoV2372 VE showed VE 50.4% (95% CI, 16.6 to 70.5) against symptomatic infection 7 days after 2nd dose.	Moderate quality (RCT)	RCT in South Africa; 4387 participants; 38/41 cases VOC Beta
18	Hitchings	CoronaVac showed VE of 35.1% (95% CI, -6.6 to 60.5) against infection in HCW after 1st dose.	Serious	Case-control study in HCWs in Manaus; 53,176 participants; 75% prevalence of Gamma; 776 (28%) of 2797 PCR were used for the case-controls; rate of previous infection high in the population
19	Heath	NVX-CoV2373 showed VE 89.7% (95% CI, 80.2 to 94.6) against symptomatic infection after 2nd dose. No hospitalizations or deaths in vaccinated group.	Moderate quality (RCT)	RCT; 15,187 participants in UK Post hoc: VE 86.3% (95% CI, 71.3 to 93.5) against Alpha variant; 10 cases in vaccinated participants; 66 infections confirmed Alpha; 11 infections no sequencing available
20	Ismail *Delayed exclusion – did not report clinical outcomes of interest for this LES	BNT162b2 showed VE 81% (95% CI, 76 to 85) against hospitalization 28 days after 1st dose and 93% (95% CI, 89 to 95) 14 days after the 2nd dose for people 80+. ChAdOx1 showed VE 73% (95% CI, 60 to 81) against hospitalization 28 days after 1st dose; sample size too small to report VE after 2nd dose for people 80+.		Screening study in UK; 13,907 hospitalized patients; results for age 80+; time and setting for VOC Alpha
21	Bernal (2) *Delayed exclusion – critical ROB	BNT162b2 showed VE 44% (95% CI, 32 to 53) after 1st dose and 69% (95% CI, 31 to 86) after 2nd dose against symptomatic infection in 70+. Single dose ChAdOx1 showed VE 55% (95% CI, 41 to 66) against death.	Critical	Data-linkage study in England; 48,096 cases above age 70+; 12.7% BNT162b2 and 8.2% ChAdOx1; VE also reported for 80+ and LTC; time and setting for VOC Alpha
22	Chodick	BNT162b2 showed VE 90% (95% CI, 79 to 95) against infection and VE 94% (95% CI, 88 to 97) against death 7-27 days after 2nd	Serious	Data-linkage study in Israel (Maccabi Health Care Organization); 1,178,597

		dose; 71% (95% CI, 37 to 87) in immunosuppressed.		participants; time and setting for VOC Alpha
23	Chung	BNT162b2 or mRNA-1273 showed VE 61% (95% CI, 56 to 66) against symptomatic infection by VOC Alpha 14 days after 1st dose and 90% (95% CI, 85 to 94) 7 days after 2nd dose; 43% (95% CI, 22 to 59) against symptomatic infection by VOC Beta or Gamma 14 days after 1st dose and 88% (95% CI, 61 to 96) 7 days after 2nd dose.	Moderate	Test-negative study in Ontario 324,033 participants; screening for variants started 2 months into study period; results also reported for age>70 and according to vaccine (but not according to confirmed variant)
24	Bailly *Delayed exclusion – critical ROB	BNT162b2 showed VE 50% (95% CI, 34 to 73) against infection with VOC Beta >28 days after 2 doses.	Critical	Outbreak in a single LTC in France; 90 participants; all samples genome sequenced for VOC Beta; 2 deaths in vaccinated group
25	Angel	BNT162b2 showed VE 97% (95% CI, 94 to 99) against symptomatic infection and 86% (95% CI, 69 to 93) against asymptomatic infection ≥ 7 days after 2 doses in HCW.	Serious	Retrospective cohort at a single centre tertiary medical centre in Israel, 6,710 participants; testing strategy was different between vaccinated and unvaccinated; time and setting for VOC Alpha
26	Bianchi *Delayed exclusion – critical ROB	BNT162b2 showed VE 61.9% (95% CI, 19.2 to 82) against infection 14 to 20 days after 1st dose; 96% (95% CI, 82.2 to 99.1) ≥ 7 days after 2nd dose in HCW.	Critical	Data-linkage, single centre medical centre in Italy, 2,034 participants; time and setting for VOC Alpha
27	Yassi	BNT162b2 (93%) or mRNA-1273 showed VE 37.2% (95% CI, 16.6 to 52.70) against infection by VOC Beta or Gamma 14 to 42 days after 1st dose and 79.2% (95% CI, 64.6 to 87.8) 7 days after 2nd dose in HCW.	Serious	Data-linkage, 25,558 Canadian HCW; evenly split between VOC Gamma and VOC Beta by end of study period
28	Bernal (1)	BNT162b2 showed VE 60% (95% CI, 40 to 73) against confirmed symptomatic infection by VOC Alpha at least 28 days after 1st dose and 90% (95% CI, 84 to 94) at least 14 days after 2nd dose for people 70+.	Serious	Test-negative in England, 156,930 participants; spike gene target failure as proxy for confirmed VOC Alpha
29	Bernal (3)	BNT162b2 showed VE 47.5% (95% CI, 41.6 to 52.8) at least 21 days after 1st dose and VE 93.7% (95% CI, 91.6 to 95.3) at least 14 days after 2nd dose against symptomatic infection by confirmed VOC Alpha. ChadOx1showed VE 48.7% (95% CI, 45.2 to 51.9) at least 21 days after 1st dose and VE 74.5% (95% CI, 68.4 to 79.4) at least 14 days after 2nd dose against symptomatic infection by confirmed VOC Alpha. BNT162b2 showed VE 35.6% (95% CI, 22.7	Serious	Test-negative in England; 19,109 sequenced cases: 14,837 VOC Alpha and 4,272 VOC Delta.

		to 46.4) at least 21 days after 1st dose and VE 88% (95% CI, 85.3 to 90.1) at least 14 days after 2nd dose against symptomatic infection by confirmed VOC Delta. ChAdOx1 showed VE 30% (95% CI, 24.3 to 35.3) at least 21 days after 1st dose and VE 67% (95% CI, 61.3 to 71.8) at least 14 days after 2nd dose against symptomatic infection by confirmed VOC Delta.		
30	Ranzani	CoronaVac reduced risk of symptomatic infection by VOC Gamma VE 41.6% (95% CI, 26.9 to 63.3) ≥ 14 days after 2nd dose for people 70+.	Serious	Test-negative in Brazil; 44,055 participants; sequencing not performed; effectiveness declined with age; time and setting for VOC Gamma
31	Andrejko (2)	BNT162b2 and mRNA-1273 showed VE 86.8% (95% CI, 68.6 to 94.7) and VE 86.10% (95% CI, 69.1 to 93.9), respectively, against infection 15 days after 2nd dose.	Serious	Test-negative in California; 1,023 participants; expansion of sample size and timeline since previous study by same authors; VOC Alpha, Epsilon
32	Emborg	BNT162b2 showed VE 53-86% against infection across high-risk groups, VE 75-87% against hospitalization across high-risk groups, VE 89% (95% CI, 81 to 93) against death in LTCF residents and VE 97% (95% CI, 88 to 99) against death in 65+ requiring personal care 7 days after 2nd dose.	Serious	Data-linkage population study of high-risk groups in Denmark; 864,096 participants; sample confirmed VOC Alpha
33	Salo	BNT162b2 showed VE 42.9% (95% CI, 22.3 to 58.1) against infection in unvaccinated household members of vaccinated HCW 10 weeks after 1st dose.	Moderate	Data-linkage for household contacts of HCW in Finland; 52,766 spouses of vaccinated HCW; time and setting for VOC Alpha
34	Shrestha	BNT162b2 or mRNA-1273 showed VE 97.1% (95% CI, 94.3 to 98.5) against infection ≥14 days after 2nd dose (based on multivariable model).	Moderate	Retrospective cohort of employees of a health care system in Ohio; 46,866 participants (60%) vaccinated by end of study; time and setting for VOC Alpha
35	Skowronski	BNT162b2 (85%) or mRNA-1273 showed VE 67% (95% CI, 57 to 75) against infection by confirmed VOC Alpha ≥21 days after 1st dose for 70+. BNT162b2 (85%) or mRNA-1273 showed VE 61% (95% CI, 45 to 72) against infection by confirmed VOC Gamma ≥21 days after 1st dose for 70+.	Serious	Test-negative in Canada; 16,993 specimens; out of 1,131 genetically sequenced: 45% VOC Alpha and 28% Gamma; results reported by vaccine but not according to confirmed variant
36	Abu-Raddad	BNT162b2 showed VE 89.5% (95% CI, 85.9 to 92.3) against infection, VE 100% (95% CI,	Serious	Test-negative in Qatar; 17,293 cases; sequencing

		81.7 to 100) against any severe, critical, or fatal disease by VOC Alpha ≥ 14 days after 2nd dose. BNT162b2 showed VE 75% (95% CI, 70.5 to 78.9) against infection, VE 100% (95% CI, 73.7 to 100) against severe, critical, or fatal disease by VOC Beta ≥ 14 days after 1st dose.		showed 50% VOC Beta and 45% VOC Alpha between February-March 2021
37	Akhrass *Delayed exclusion - failure to report outcomes of interest for this LES	BNT162b2 or mRNA-1273 showed overall VE 60.4% (95% CI, 30 to 77.6) against symptomatic infection ≥ 14 days after 1st dose; BNT162b2 or mRNA-1273 showed overall VE 95.7% (95% CI, 90 to 98.2) against symptomatic infection ≥ 14 days after 2nd dose.	Critical	Retrospective cohort of HCW at a single centre in Kentucky, USA; 2,134 participants; time and setting for VOC Alpha
38	Sheikh	BNT162b2 showed VE 30% (95% CI, 17 to 41) against confirmed VOC Delta infection and VE 33% (95% CI, 15 to 47) against symptomatic infection at least 28 days after 1st dose; VE 79% (95% CI, 75 to 82) against infection and VE 83% (95% CI, 78 to 87) against symptomatic infection at least 14 days after 2nd dose. ChAdOx1 showed VE 18% (95% CI, 9 to 25) against confirmed VOC Delta infection and VE 33% (95% CI, 23 to 41) against symptomatic infection at least 28 days after 1st dose; VE 60% (95% CI, 53 to 66) against infection and VE 61% (95% CI, 51 to 70%) against symptomatic infection at least 14 days after 2nd dose.	Serious	Test-negative in Scotland; 626,900 specimens; also compared hospitalization rates between S gene positive (VOC Delta) and S gene negative specimens within 14 days of positive test result (not summarized here)
39	Furer *Delayed exclusion – critical risk of bias	BNT162b2 reported no symptomatic infections in the vaccinated group (0/686) compared to 0.83% infections in the vaccinated general population control group.	Critical	Prospective cohort of adults with autoimmune inflammatory rheumatic diseases in Israel; 686 participants; time and setting for VOC Alpha
40	Martinez-Baz	BNT162b2 showed VE 65% (95% CI, 56 to 73) against infection and VE 94% (95% CI, 60 to 99) against hospitalization at least 14 days after 2nd dose in close contacts of COVID+ index cases. ChAdOx1 showed VE 44% (95% CI, 31 to 54) against infection and VE 92% (95% CI, 46 to 99) against hospitalization at least 14 days after 1st dose in close contacts of index cases. Second dose results not reported.	Serious	Prospective cohort of close contacts of COVID+ people in Spain; 20,961 participants; VOC Alpha confirmed for small sample; sample size for Moderna too small to report results separately
41	Chodick (2)	BNT162b2 showed VE 51.4% (95% CI, 16.3 to 71.8) against infection 13 to 24 days after	Serious	Data-linkage study in Israel (Maccabi Health Care

		1st dose.		Services); 351,897 participants; time and setting for VOC Alpha
42	Stowe	BNT162b2 showed VE 94% (95% CI, 46 to 99) at least 21 days after 1st dose and VE 96% (95% CI, 86 to 99) at least 14 days after 2nd dose against hospitalization by confirmed VOC Delta. ChAdOx1 showed VE 71% (95% CI, 51 to 83) at least 21 days after 1st dose and VE 92% (95% CI, 75 to 97) 14 days after 2nd dose against hospitalization by confirmed VOC Delta.	Serious	Same cohort as Bernal (3) with extended time frame for symptomatic infection and adding in data-linkage to hospitalization; 14,019 participants; sample confirmed VOC Delta
43	Saciuk	BNT162b2 showed VE 93% (95% CI, 92.6 to 93.4) against infection, VE 93.4% (95% CI, 91.9 to 94.7) against hospitalization and VE 91.1% (95% CI, 86.5 to 94.1) against death at least 7 days after 2nd dose	Serious	Retrospective cohort of members of a health management organization in Israel; 1,650,885 participants; time and setting for VOC Alpha
44	Zacay *Delayed exclusion – critical risk of bias	BNT162b2 showed VE 61% (95% CI, 49 to 71) at least 14 days after 1st dose and VE 89% (95% CI, 82 to 94) at least 7 days after 2nd dose against infection	Serious	Retrospective cohort of a subpopulation of members of a health management organization in Israel who had undergone repeated PCR testing; 6,286 participants; time and setting for VOC Alpha
45	Azamgarhi	BNT162b2 showed VE 70% (95% CI, 6 to 91) against infection at least 14 days after 1st dose	Serious	Single centre cohort study of HCW in UK; 2,260 participants; time and setting for VOC Alpha
46	Lumley	BNT162b2 (63%) or ChAdOx1showed VE 64% (95% CI, 50 to 74) 14 days after 1st dose and VE 90% (95% CI, 62 to 98) 14 days after 2nd dose against infection	Serious	Prospective cohort of HCWs in Oxfordshire, UK; 13,109 participants; confirmed VOC Alpha
47	Nasreen	BNT162b2 showed VE 89% (95% CI, 86 to 91) against symptomatic infection and VE 95% (95% CI, 92 to 97) against hospitalization at least 7 days after 2nd dose (VOC Alpha); VE 84% (95% CI, 69 to 92) against symptomatic infection and VE 95% (95% CI, 81 to 99) against hospitalization at least 7 days after 2nd dose (VOC Beta/Gamma); VE 87% (95% CI, 64 to 95) against symptomatic infection at least 7 days after 2nd dose (VOC Delta). BNT162b2 showed VE 78% (95% CI, 65 to 86) against hospitalization at least 7 days after 2nd dose (VOC Delta).	Moderate	Test-negative study in Ontario 421,073 participants (same population as for Chung but extended to May 2021 and more detailed with respect to reporting of VOC); screening for VOC Alpha, Beta/Gamma and Delta varied during study period

		mRNA-1273 showed VE 92% (95% CI, 86 to 96) against symptomatic infection and VE 94% (95% CI, 89 to 97) against hospitalization at least 7 days after 2nd dose (VOC Alpha). mRNA-1273 showed VE 77% (95% CI, 63 to 86) against symptomatic infection and VE 89% (95% CI, 73 to 95) against hospitalization at least 14 days after 1st dose (VOC Beta/Gamma); VE 72% (95% CI, 57 to 82) against symptomatic infection and VE 96% (95% CI, 72 to 99) against hospitalization at least 14 days after 1st dose (VOC Delta). ChAdOx1 showed VE 64% (95% CI, 60 to 68) against symptomatic infection and VE 85% (95% CI, 81 to 88) against hospitalization at least 14 days after 1st dose (VOC Alpha); VE 48% (95% CI, 28 to 63) against symptomatic infection and VE 83% (95% CI, 66 to 92) against hospitalization at least 14 days after 1st dose (VOC Beta/Gamma); VE 67% (95% CI, 44 to 80) against symptomatic infection and VE 88% (95% CI, 60 to 96) against hospitalization at least 14 days after 1st dose (VOC Delta).		
48	Gazit	BNT162b2 showed VE 80% (95% CI, 73 to 85) at least 7 days after 2nd dose against infection in vaccinated household members of a confirmed COVID+ case.	Serious	Retrospective cohort of household members (household = 2 adults with no children) of a health management organization in Israel; 173,569 households; time and setting for VOC Alpha
49	Jara	CoronaVac showed VE 65.9% (95% CI, 65.2 to 66.6) against infection and VE 86.3% (95% CI, 84.5 to 87.9) against death at least 14 days after 2nd dose.	Moderate	Prospective cohort in Chile; 10.2 million participants; time and setting for VOC Gamma
50	Chemaitelly	mRNA-1273 showed VE 88.1% (95% CI, 83.7 to 91.5) and VE 100% (95% CI, 91.8 to 100) against infection by confirmed VOC Alpha at least 14 days after 1st and 2nd dose, respectively. mRNA-1273 showed VE 61.3% (95% CI, 56.5 to 65.5) and VE 96.4% (95% CI, 91.9 to 98.7) against infection by confirmed VOC Beta at least 14 days after 1st and 2nd dose, respectively.	Serious	Test-negative in Qatar; >75,000 participants; sample sequenced for VOC Alpha and VOC Beta

		mRNA-1273 showed VE 81.6% (95% CI, 71.0 to 88.8) and VE 95.7% (95% CI, 73.4 to 99.9) against severe, critical, or fatal disease at least 14 days after 1st and 2nd dose, respectively (combined VOC Alpha and Beta).		
51	Baum	BNT162b2 or mRNA-1273 showed VE 41% (95% CI, 25 to 54) against infection ≥ 21 days after 1st dose; BNT162b2 or mRNA-1273 showed VE 75% (95% CI, 65 to 82) against infection ≥ 7 days after 2nd dose in age 70+. BNT162b2 or mRNA-1273 showed VE 41% (95% CI, 17 to 58) against infection ≥ 21 days after 1st dose; BNT162b2 or mRNA-1273 showed VE 77% (95% CI, 65 to 85) against infection ≥ 7 days after 2nd dose in chronically ill (age 16-69). ChAdOx1 showed VE 24% (95% CI, -1 to 43) against infection ≥ 21 days after 1st dose in chronically ill (age 16-69).	Serious	Data-linkage study in Finland; 901,092 participants age 70+ and 774,526 participants age 16 to 69 years with chronic illness; time and setting for VOC Alpha; results for mRNA vaccines not reported separately
52	Balicer	BNT162b2 showed VE 86.1% (95% CI, 82.4 to 89.1) against infection; VE 89% (95% CI, 43 to 100) against hospitalization 7 to 56 days after 2nd dose. Too few events to report VE for severe disease or death.	Serious	Data-linkage study of pregnant women over age 16 in Israel (same database as Dagan); 21,722 participants; time and setting for VOC Alpha.
53	Mateo-Urdiales	BNT162b2 (61%) or ChAdOx1 (31%) or mRNA-1273 (7%) or Ad26.COV_2-S (0.6%) showed VE 78% (95% CI, 76 to 79) against infection 42 to 49 days after at least 1st dose; VE 93% (95% CI, 89 to 96) against death 35 to 42 days after at least 1st dose.	Serious	Data-linkage study in Italy; 13,721,506 participants; time and setting for VOC Alpha. Results not reported by vaccine and some participants (42%) who also received 2nd dose were included in estimates.
54	Goldshtein	BNT162b2 showed VE 78% (95% CI, 57 to 89) against infection at least 28 days after 1st dose.	Serious	Data-linkage study of pregnant women in Israel (same database as Gazit); 15,060 participants; time and setting for VOC Alpha.
55	Mason	BNT162b2 showed VE 55.2% (95% CI, 40.8 to 66.8) and VE 70.1% (95% CI, 55.1 to 80.1) against infection 21 to 27 days and 35 to 41 days after 1st dose, respectively.	Moderate	Case-control study of age 80-83 vs 76-79 community-dwelling unvaccinated residents in England; time and setting for VOC Alpha
56	Fabiani	BNT162b2 showed VE 84.1% (95% CI, 39.7 to 95.8) and VE 85.4% (95% CI, -35.3 to 98.4) against infection 14 to 21 days and ≥21 days after 1st dose, respectively in HCW. BNT162b2 showed VE 95.1% (95% CI, 62.4	Serious	Retrospective cohort of HCW in Italy; 6,423 participants; time and setting for VOC Alpha

		to 99.4) against infection ≥7 days after 2nd dose in HCW.		
57	Chia	BNT162b2 or mRNA-1273 showed VE 92.7% (95% CI, 65.7 to 98.4) against severe disease (defined as requiring supplemental oxygen) > 14 days after 2nd dose.	Serious	Retrospective cohort of confirmed VOC Delta admitted to hospital (including asymptomatic) in Singapore; 218 participants; not reported by vaccine
58	Kaur *Delayed exclusion – critical ROB	Two doses of Covishield showed VE 87% (95% CI, 33 to 97) against severe disease when compared with one dose (timing of doses not reported).	Critical	Preliminary report of prospective cohort in India; 1500 participants; time and setting for VOC Delta
59	Pramod *Delayed exclusion – critical ROB	Covishield showed VE 49% (95% CI, 17 to 68) against infection 21 days after 1st dose and VE 54% (95% CI, 27 to 71) against infection 14 days after 2nd dose. Covishield showed VE 58% (95% CI, 28 to 75) against symptomatic infection 21 days after 1st dose and VE 64% (95% CI, 38 to 78) against symptomatic infection 14 days after 2nd dose.	Critical	Test-negative study in a single hospital site in India; 360 matched pairs (203 symptomatic pairs); time and setting for VOC Delta
60	Carazo	BNT162b2 or mRNA-1273 showed VE 60% (95% CI, 53.6 to 65.5) against infection by confirmed VOC Alpha 14 days after 1st dose. BNT162b2 or mRNA-1273 showed VE 92.6% (95% CI, 87.1 to 95.8) against infection by confirmed VOC Alpha 7 days after 2nd dose.	Serious	Test-negative study in Quebec, Canada; 58,476 participants; sample confirmed VOC Alpha; reported according to vaccine but not concurrently for VOC Alpha
61	Williams	BNT162b2 or mRNA-1273 showed VE 52.5% (95% CI, 26.9 to 69.1) against infection and VE 78.6% (95% CI, 47.9 to 91.2) against severe disease 14 days after 2nd dose in residents at LTCF. Two deaths in vaccinated residents but were palliative prior to infection. BNT162b2 or mRNA-1273 showed VE 66.2% (95% CI, 2.3 to 88.3) against infection 14 days after 2nd dose in staff at LTCF. None of the staff developed severe disease.	Serious	Outbreak in a single LTCF in Ontario; 60 residents and 83 staff; sample confirmed VOC Gamma
62	Hitchings(2) *Delayed exclusion – critical ROB	ChAdOx1 showed VE 33.4% (95% CI, 26.4 to 39.7) against symptomatic infection and VE 50.9% (95% CI, 33.6 to 63.8) against ICU admission and VE 61.8% (95% CI, 48.9 to 71.4) against death at least 28 days after 1st dose for 60+. ChAdOx1 showed VE 77.9% (95% CI, 69.2 to 84.2) against symptomatic infection and VE 89.9% (95% CI, 70.9 to 96.5) against ICU admission and VE 93.6% (95% CI, 81.9 to	Critical	Test-negative study in Sao Paulo, Brazil; 61,164 participants over age 60; time and setting for VOC Gamma

		97.7) against death at least 14 days after 2nd dose.		
63	Tang	BNT162b2 showed VE 65.5% (95% CI, 40.9 to 79.9) against infection ≥ 14 days after 1st dose; BNT162b2 showed VE 59.6% (95% CI, 50.7 to 66.9) against infection ≥ 14 days after 2nd dose. BNT162b2 showed VE 100% (95% CI, not reported) against severe, critical or fatal disease ≥ 14 days after 1st dose; BNT162b2 showed VE 97.3% (95% CI, 84.4 to 99.5) against severe, critical or fatal disease ≥ 14 days after 2nd dose. mRNA-1273 showed VE 79.7% (95% CI, 60.8 to 89.5) against infection ≥ 14 days after 1st dose; mRNA-1273 showed VE 86.1% (95% CI, 78.0 to 91.3) against infection ≥ 14 days after 2nd dose. mRNA-1273 showed VE 100% (95% CI, not reported) against severe, critical or fatal disease ≥ 14 days after 1st dose; mRNA-1273 showed VE 100% (95% CI, not reported) against severe, critical or fatal disease ≥ 14 days after 2nd dose.	Serious	Test-negative study in Qatar; 1,140,337 participants; weekly random sequencing of positive samples for VOC Delta
64	Puranik	BNT162b2 showed VE 42% (95% CI, 13 to 62) against infection 14 days after 2nd dose. mRNA-1273 showed VE 76% (95% CI, 58 to 87) against infection 14 days after 2nd dose.	Serious	Data-linkage study involving Mayo Clinic Health in USA; 25,859 matched triples from Minnesota only; time and setting for Delta at end of study time frame so only last month of data (July 2021) reported here
65	Elliot *Delayed exclusion – critical ROB	BNT162b2 or ChAdOx1 showed VE 64% (95% CI, 11 to 85) against infection unreported number of days after 2nd dose (Round 12: 2021-05-20 to 2021-06-07). BNT162b2 or ChAdOx1 showed VE 49% (95% CI, 22 to 67) against infection unreported number of days after 2nd dose (Round 13: 2021-06-24 to 2021-07-12).	Critical	Surveillance study in England; 121,872 participants; time and setting for VOC Delta; only included data from aged 18 to 64 years due to lowest risk for misclassification bias due to self-reported vaccination status
66	Issac	ChAdOx1 showed VE 85% (95% CI, 71 to 92) against infection 14 days after 2nd dose.	Serious	Prospective cohort of HCW at a single hospital in India; 342 participants; time and setting for VOC Delta.
67	Marco *Delayed	ChAdOx1 showed VE 23% (95% CI, not reported) against infection at least 21 days after 1st dose.	Critical	Outbreak study of prison inmates in Barcelona; 217 participants (184 inmates);

	exclusion – critical ROB			sequenced for VOC Alpha
68	Kale *Delayed exclusion – critical ROB	ChAdOx1 showed VE 60% (95% CI, 45 to 70) against infection at least 14 days after 2nd dose.	Critical	Prospective cohort of HCW at a single hospital in India; 1858 participants; sample sequenced for VOC Delta
69	Israel	BNT162b2 showed OR 2.06 (95% CI, 1.69 to 2.51) for infection comparing fully vaccinated ≥146 days vs fully vaccinated less than 146 days.	Moderate	Retrospective cohort of fully vaccinated members of a health management organization in Israel who underwent testing; 33,993 participants; time and setting for VOC Delta
70	Gram	ChAdOx1 showed VE 44% (95% CI, 29 to 56) against infection 21 to 27 days after 1st dose. No deaths in vaccinated participants. First dose ChAdOx1 followed by second dose BNT162b2 or mRNA-1273 showed VE 88% (95% CI, 83 to 92) against infection ≥ 14 days after 2nd dose.	Serious	Data-linkage study in Denmark; 5,542,079 participants; sequenced for VOC Alpha (includes heterologous vaccines)
71	Pouwels	BNT162b2 showed VE 59% (95% CI, 52 to 65%) against infection ≥21 days after 1st dose and VE 78% (95% CI, 68 to 84) against infection ≥ 14 days after 2nd dose (VOC Alpha age 18+). BNT162b2 showed VE 57% (95% CI, 50 to 63) against infection ≥21 days after 1st dose and VE 80% (95% CI, 77 to 83) against infection ≥ 14 days after 2nd dose (VOC Delta age 18+). ChAdOx1 showed VE 63% (95% CI, 55 to 69) against infection ≥21 days after 1st dose and VE 79% (95% CI, 56 to 90) against infection ≥ 14 days after 2nd dose (VOC Alpha age 18+). ChAdOx1 showed VE 46% (95% CI, 35 to 55) against infection ≥21 days after 1st dose and VE 67% (95% CI, 62 to 71) against infection ≥ 14 days after 2nd dose (VOC Delta age 18+). mRNA-1273 showed VE 75% (95% CI: 64 to 83) against infection ≥21 days after 1st dose (VOC Delta age 18 to 64).	Serious	Survey of randomly selected private households with longitudinal follow-up in UK; 743,526 participants; also reported for 18-64 years; sample sequenced for VOC Alpha and VOC Delta
72	Abu-Raddad (2)	BNT162b2 after prior infection showed VE 85% (95% CI, 80 to 89) against re-infection compared to BNT162b2 without prior	Serious	Retrospective matched cohorts (2) of fully vaccinated in Qatar;

		infection. mRNA-1273 after prior infection showed VE 15% (95% CI, -105 to 66) against re-infection compared to mRNA-1273 without prior infection.		151,076 participants; sample sequenced for VOC Alpha and VOC Beta
73	Gazit (2)	BNT162b2 showed OR 13.06 (95% CI, 8.08 to 21.11) against infection and OR 27.02 (95% CI, 12.7 to 57.5) against symptomatic disease compared to prior infection.	Moderate	Retrospective matched cohorts of fully vaccinated in Israel; 778,658 participants; time and setting for VOC Delta
74	Rosenberg	BNT162b2 (51%), mRNA-1273 (40%) or Ad26.COV2.S (9%) showed VE 91.7% against infection ≥14 days after 2nd dose (Week of May 3, 2021: VOC Alpha). BNT162b2 (51%), mRNA-1273 (40%) or Ad26.COV2.S (9%) showed VE 79.8% against infection ≥14 days after 2nd dose (Week of July 19, 2021: VOC Delta).	Serious	Surveillance report in New York, USA; >13 million participants; time and setting for VOC Delta (from 2% to 80% during study period)
75	Al-Qahtani *Delayed exclusion due to critical ROB	BNT162b2 ≥14 days after 2nd dose, showed VE 99.9% (95% CI, 99.2 to 100) against ICU admission, and VE 99.5% (95% CI, 98.4 to 99.8) against death (VOC Alpha and Delta). ChAdOx1 ≥14 days after 2nd dose, showed VE 99.2% (95% CI, 97.6 to 99.7) against ICU admission, and VE 99.6% (95% CI, 97.2 to 100) against death (VOC Alpha and Delta). BBIBP-CorV ≥14 days after 2nd dose, showed VE 95.4% (95% CI, 94.6 to 96.2) against ICU admission, and VE 94.3% (95% CI, 93.1 to 95.4) against death (VOC Alpha and Delta). Sputnik V ≥14 days after 2nd dose, showed VE 100% (95% CI, 99.2 to 100) against ICU admission, and VE 99.5% (95% CI, 98.5 to 99.9) against death (VOC Alpha and Delta).	Critical	Retrospective cohort of fully vaccinated (>14 days after 2nd dose) in Bahrain; 1,242,279 participants; time and setting for VOC Alpha (dominant before May 2021) and Delta (dominant after May 2021).
76	Goldberg (2)	BNT162b2 showed VE 50% (95% CI, 45 to 55) for those vaccinated in January 2021, and VE 73% (95% CI, 67 to 78) for those vaccinated in May 2021 against infection after the 2nd dose (VOC Delta age 16 to 39). BNT162b2 showed VE 58% (95% CI, 54 to 62) for those vaccinated in January 2021, and VE 80% (95% CI, 71 to 86) for those vaccinated in May 2021 against infection after the 2nd dose (VOC Delta age 40 to 59).	Serious	Data-linkage study of fully vaccinated in Israel; 4,785,245 participants; sequenced for VOC Delta (dominant after May 2021) (results over varying time periods since vaccination reported)

		BNT162b2 showed VE 57% (95% CI, 52 to 62) for those vaccinated in January 2021, and VE 75% (95% CI, 58 to 85) for those vaccinated in May 2021 against infection after the 2nd dose (VOC Delta age 60+). BNT162b2 showed VE 94% (95% CI, 87 to 97) for those vaccinated in January 2021, and VE 98% (95% CI, 94 to 99) for those vaccinated in March 2021 against severe, critical, or fatal disease after the 2nd dose (VOC Delta age 40 to 59). BNT162b2 showed VE 86% (95% CI, 82 to 90) for those vaccinated in January 2021, and VE 91% (95% CI, 85 to 95) for those vaccinated in March 2021 against severe, critical, or fatal disease after the 2nd dose (VOC Delta age 60+).		
77	Herlihy *Delayed exclusion – critical risk of bias	BNT162b2, mRNA-1273, or Ad26.COV2.S showed VE 78% (95% CI, 71 to 84) in Mesa County and VE 89% (95% CI, 88 to 91) in other Colorado counties against symptomatic infection an unreported number of days after 2nd dose (VOC Delta).	Critical	Surveillance report in Mesa County-Colorado, USA; 37,439 cases participants; sample sequenced for VOC Delta (43% to 88% during study period)
78	Ghosh *Delayed exclusion – critical risk of bias	ChAdOx1 showed unadjusted VE 75.2% (95% CI, 73.8 to 76.8) against infection ≥14 days after 1st dose, and unadjusted VE 54.6% (95% CI, 52.6 to 56.6) ≥14 days after 2nd dose against infection in HCW (VOC Alpha to Delta).	Critical	Retrospective cohort of Armed Forces HCW and frontline workers in India; 1,595,630 participants; time and setting for VOC Delta at end of study only.
79	Amirthalingam	BNT162b2 showed VE 77% (95% CI, 56 to 88) against symptomatic infection when 2nd dose given 19-29 days after 1st dose, and VE 94% (95% CI, 73 to 99) against symptomatic infection when 2nd dose given 85+ days after 1st dose (VOC Alpha age 80+). BNT162b2 showed VE 77% (95% CI, 66 to 85) against symptomatic infection when 2nd dose given 19-29 days after 1st dose, and VE 86% (95% CI, 70 to 94) against symptomatic infection when 2nd dose given 85+ days after 1st dose (VOC Alpha age 65 to 79). ChAdOx1 showed VE 96% (95% CI, 72 to 100) against symptomatic infection when 2nd dose given 19-29 days after 1st dose, and VE 88% (95% CI, 48 to 97) against symptomatic infection when 2nd dose given 85+ days after 1st dose after 2nd dose (VOC Alpha age 80+).	Moderate	Test-negative study in England; 750 participants; time and setting for VOC Alpha (dominant before May 2021) and Delta (dominant after May 2021). (results over varying time periods since vaccination reported)

		ChAdOx1 showed VE 66% (95% CI, 47 to 77) against symptomatic infection when 2nd dose given 19-29 days after 1st dose, and VE 73% (95% CI, 56 to 83) against symptomatic infection when 2nd dose given 85+ days after 1st dose after 2nd dose (VOC Alpha age 65 to 79).		
80	Butt (2) *Delayed exclusion – critical ROB	Unvaccinated participants had HR 2.84 (95% CI, 1.80 to 4.47) of severe disease compared to BNT162b2 ≥14 days after 2nd dose.	Critical	Case-control study in Qatar; 456 matched cases; time and setting for VOC Alpha
81	Fowlkes	BNT162b2 (65%), mRNA-1273 (33%), or Ad26.COV2.S (2%) showed VE 91% (95% CI, 81 to 96) against infection ≥ 14 days after 2nd dose (during time of VOC Alpha). BNT162b2 (65%), mRNA-1273 (33%), or Ad26.COV2.S (2%) showed VE 66% (95% CI, 26 to 84) against infection ≥ 14 days after 2nd dose (during time of VOC Delta). BNT162b2 (65%), mRNA-1273 (33%), or Ad26.COV2.S (2%) showed VE 85% (95% CI, 68 to 93) against infection 14-119 days after full vaccination) and VE 73% (95% CI, 49 to 86) against infection ≥150 days after full vaccination (during time of VOC Alpha to Delta).	Moderate	Prospective cohort of HCW and other essential frontline workers in 6 states in the USA; 7,112 participants; updated report to cover VOC Delta period
82	Bhattacharya *Delayed exclusion due to critical ROB	Covaxin (94%) and Covishield showed VE 83% (95% CI, 73 to 89) against symptomatic infection ≥ 14 days after 2nd dose. Covaxin (94%) and Covishield showed VE 93% (95% CI, 64 to 99) against ICU admission or death ≥ 14 days after 2nd dose.	Critical	Cross-sectional cohort of HCW and their families at a single site in India; 638 participants (55 inpatients); time and setting of VOC Delta
83	Nunes	BNT162b2 (45%) or mRNA-1273 (8%) showed VE 96% (95% CI, 92 to 98) against COVID-related death ≥14 days after 2nd dose (age 65 to 79). BNT162b2 (80%) or mRNA-1273 (2%) showed VE 81% (95% CI, 74 to 87) against COVID-related death ≥14 days after 2nd dose (age ≥80). BNT162b2 (80%) or mRNA-1273 (2%) showed VE 86% (95% CI, 68 to 93) against COVID-related death 14 to 41 days after 2nd dose and VE 74% (95% CI, 60 to 83) against COVID-related death ≥ 98 days after 2nd dose for HR 1.80 (0.77 to 4.25) (age ≥80).	Moderate	Data-linkage study of community-dwelling adults≥65 in Portugal; 2,050,950 participants; time and setting for VOC Alpha to VOC Delta

84	Tartof	BNT162b2 showed VE 75% (95% CI, 71 to 78) against infection 7 days after 2nd dose (confirmed VOC Delta). BNT162b2 showed VE 91% (95% CI, 88 to 92) against infection 7 days after 2nd dose (confirmed non-VOC Delta). BNT162b2 showed VE 93% (95% CI, 85 to 87) against infection 7 to 30 days after 2nd dose and VE 53% (95% CI, 39 to 65) against infection ≥ 127+ days after 2nd dose (confirmed VOC Delta). BNT162b2 showed VE 97% (95% CI, 95 to 99) against infection 7 to 30 days after 2nd dose and VE 67% (95% CI, 45 to 80) against infection ≥ 127+ days after 2nd dose (confirmed non-VOC Delta).	Moderate	Retrospective cohort of members of a health management organization in California; 3,436,957 participants; VOC Alpha to VOC Delta (only 28% confirmed Delta) (results over varying time periods since vaccination reported)
85	Li (3) *Delayed exclusion – critical ROB	CoronaVac (combined with other inactivated vaccines) showed VE 59% (95% CI, 16 to 81.6) against symptomatic infection and VE 100% against severe infection ≥14 days after 2nd dose.	Critical	Test-negative study in Guangzhou, China; 366 participants; sample sequenced for VOC Delta
86	Scobie *Delayed exclusion – critical ROB	BNT162b2 or mRNA-1273 (92%), or Ad26.COV2.S showed VE 90% (95% CI not reported) against infection and VE 93% (95% CI not reported) against death ≥ 14 days after 2nd dose (April to June: VOC Alpha). BNT162b2, mRNA-1273, or Ad26.COV2.S showed VE 76% (95% CI not reported) against infection and VE 90% (95% CI not reported) against death ≥ 14 days after 2nd dose (June to July: VOC Delta>50%).	Critical	Surveillance study in 13 states in the USA; 615,454; time and setting for VOC Alpha to VOC Delta
87	Satwik *Delayed exclusion due to critical ROB	ChAdOx1 showed VE 18% (95% CI, -10 to 38) against symptomatic infection; VE 37% (-24 to 68) against moderate to severe disease and VE 69% (95% CI, -160 to 97) against death ≥21 days after 1st dose. ChAdOx1 showed VE 28% (95% CI, 10 to 41) against symptomatic infection; VE 67% (44 to 81) against moderate to severe disease and VE 97% (95% CI, 43 to 99.8) against death ≥14 days after 2nd dose.	Critical	Retrospective cohort study of HCW at a single hospital in New Delhi, India; 4276 participants; sample sequenced for VOC Delta

88	Seppala	BNT162b2 (74%) or ChAdOx1 (22%) or mRNA-1273 (10%) showed VE 84.4% (95% CI, 81.8 to 86.5) against infection ≥7 days after 2nd dose (VOC Alpha). BNT162b2 (74%) or ChAdOx1 (22%) or mRNA-1273 (10%) showed VE 64.6% (95% CI, 60.6 to 68.2) against infection ≥7 days after 2nd dose (VOC Delta).	Serious	Population cohort in Norway; 4,204,859 participants; sequenced for VOC Alpha and VOC Delta
89	Polinski	Ad26.COV2.S showed VE* 67% (95% 60 to 73) against infection unknown number of days after dose (June to July: VOC Delta in high prevalence states). *unadjusted for substantial under-reporting of vaccination status	Serious	Data-linkage of members of a medical insurance group in USA; 1,914,670 participants; time and setting for VOC Alpha to Delta (only data for VOC Delta reported here)
90	Chemaitelly (2)	BNT162b2 or mRNA-1273 showed VE 46.6% (95% CI, 0.0 to 73.7) against infection ≥14 days after 2nd dose, VE 66.0% (95% CI, 21.3 to 85.3) ≥42 days after 2nd dose, and VE 73.9% (95% CI, 33 to 98.9) ≥56 days after 2nd dose (VOC Alpha and Beta). BNT162b2 or mRNA-1273 showed VE 72.3% (95% CI, 0.0 to 90.9) against severe, critical, or fatal disease ≥14 days after 2nd dose, VE 85% (95% CI, 35.7 to 96.5) ≥42 days after 2nd dose, and VE 83.8% (95% CI, 31.3 to 96.2) ≥56 days after 2nd dose (VOC Alpha and Beta).	Serious	Retrospective cohort of immunosuppressed kidney transplant recipients in Qatar; 782 participants; time and setting for VOC Alpha and VOC Beta.
91	Hu	Inactivated vaccines (CoronaVac) showed VE 89% (95% CI, 55 to 98) against severe, critical, or fatal disease ≥14 days after 2nd dose (VOC Delta).	Serious	Outbreak report of hospitalized cases in China; 476 participants; PCR population for VOC Delta.
92	Andrews	BNT162b2 showed VE 62.7% (61.7 to 63.8) against symptomatic infection 1 week after 2nd dose and VE 47.3% (45.0 to 49.6) 20+ weeks after 2nd dose (VOC Delta). ChAdOx1showed VE 92.4% (92.1 to 92.7) against symptomatic infection 1 week after 2nd dose and VE 69.7% (68.7 to 70.5) 20+ weeks after 2nd dose (VOC Delta). mRNA-1273 showed VE 95.2% (94.4 to 95.9) against symptomatic infection 1 week after 2nd dose and VE 90.3% (67.2 to 97.1) 10 to 14 weeks after 2nd dose (VOC Delta).	Moderate	Test-negative study in England; 1,475,391 participants; VOC Alpha to VOC Delta (only data for VOC Delta reported here)
93	Patalon	BNT162b2 (3 doses) showed relative VE 3% (95% CI, -5 to 10) against infection 0 to 6 days after 3rd dose; relative VE 84.0% (95% CI, 79 to 88) 14 to 20 days after 3rd dose	Moderate	Test-negative study of fully vaccinated in Israel comparing (2 doses versus 3 doses); 182,076

		compared to 2 doses.		participants; time and setting for VOC Delta
94	Kissling	BNT162b2 showed VE 87% (95% CI, 74 to 93) against symptomatic infection 14 days after 2nd dose.	Serious	Test-negative study of adults >65 years in primary care setting in I-MOVE group (England, France, Ireland, the Netherlands, Portugal, Scotland, Spain and Sweden); 4,964 participants; sample sequenced for VOC Alpha.
95	McKeigue	BNT162b2 or mRNA-1273 showed VE 92% (95% CI, 85 to 96) against severe disease in people with no risk conditions and VE 72% (95% CI, 51 to 84) against severe disease in people eligible for shielding at least 14 days after 2nd dose. ChAdOx1 showed VE 94% (95% CI, 90 to 96) against severe disease in people with no risk conditions and VE 63% (95% CI, 46 to 75) against severe disease in people eligible for shielding ≥ 14 days after 2nd dose.	Serious	Case-control study of people with clinical risk conditions in Scotland; 50,935 participants; time and setting for VOC Alpha to VOC Delta
96	Kertes	BNT162b2 showed OR 1.61 (95% CI, 1.45 to 1.79) for infection comparing fully vaccinated Jan to Feb vs fully vaccinated Mar to May.	Serious	Data-linkage study of people fully vaccinated 6 months previously in Israel; 1,423,098 participants; time and setting for VOC Alpha to VOC Delta
97	Barlow	BNT162b2 or mRNA-1273 showed VE 74% (95% CI, 65 to 82) against infection ≥ 14 days after 2nd dose. Ad26.COV2.S showed VE 51% (95% CI, -2 to 76) against infection ≥ 14 days after 2nd dose.	Serious	Test-negative study in Oregon; 1000 participants; time and setting for VOC Delta
98	Chemaitelly (3)	BNT162b2 showed VE 65.8% (95% CI, 63.8 to 67.7) against infection 5 to 9 weeks after 2nd dose; VE 29.7% (95% CI, 21.7 to 36.9) against infection 15 to 19 weeks after 2nd dose and VE 0% (95% CI, 0 to 0) against infection 20 to 24 weeks after 2nd dose. BNT162b2 showed VE 94.2% (95% CI, 91.0 to 96.5) against hospitalization or death 5 to 9 weeks after 2nd dose; VE 86.4% (95% CI, 69.9 to 94.8) against hospitalization or death 15 to 19 weeks after 2nd dose and VE 95.3% (95% CI, 70.5 to 99.9) against hospitalization or death 20 to 24 weeks after 2nd dose.	Serious	Test-negative study in Qatar; 1,472,761 participants; time and setting for VOC Beta to VOC Delta (results over varying time periods since vaccination reported)

99	Thompson (3)	BNT162b2 or mRNA-1273 showed VE 90% (95% CI, 86 to 93) against ICU admission ≥14 days after 2nd dose. BNT162b2 showed VE 92% (95% CI, 88 to 94) against hospitalization at 28 to 41 days after 2nd dose and VE 86% (95% CI, 74 to 93) ≥112 days after 2nd dose.	Serious	Test-negative study of adults ≥50 years in the USA; 76,463 participants; time and setting for VOC Alpha (results over varying time periods since vaccination reported)
100	Bar-On	BNT162b2 (3 doses) showed adjusted rate ratio of 11.3 (95% CI, 10.4 to 12.3) against any infection and adjusted rate ratio of 19.5 (95% CI, 12.9 to 29.5) against severe illness ≥12 days after 3rd dose compared to 2 doses.	Serious	Data-linkage study of fully vaccinated (age>60) (2 doses versus 3 doses) in Israel; 1,137,804 participants; time and setting for VOC Delta
101	Bruxvoort (2)	mRNA-1273 showed VE 98.4% (95% CI, 96.9 to 99.1) against infection ≥14 days after 2nd dose (VOC Alpha). mRNA-1273 showed VE 95.5% (95% CI, 90.9 to 97.8) against infection ≥14 days after 2nd dose (VOC Gamma). mRNA-1273 showed VE 86.7% (95% CI, 84.3 to 88.7) against infection ≥14 days after 2nd dose (VOC Delta). mRNA-1273 showed VE 94.1% (95% CI, 90.5 to 96.3) against infection 14 to 60 days after 2nd dose (VOC Delta). mRNA-1273 showed VE 80.0% (95% CI, 70.2 to 86.6) against infection 151 to 180 days after 2nd dose (VOC Delta).	Serious	Test-negative study in Kaiser Permanente group in California; 48,918 participants; sequenced for VOC Alpha, VOC Delta, VOC Gamma and VOI Mu (results not included in this LES) (results over varying time periods since vaccination reported)
102	Tande (2)	BNT162b2 or mRNA-1273 showed VE 91% (95% CI, 72 to 98) against infection ≥14 days after 2nd dose (January to March – VOC Alpha). BNT162b2 or mRNA-1273 showed VE 63% (95% CI, 44 to 76) against infection ≥14 days after 2nd dose (June to August – VOC Delta).	Serious	Point prevalence screening study in Mayo Clinic, USA; 46,008 participants; time and setting for VOC Alpha to VOC Delta
103	Young-Xu (2)	Two doses of BNT162b2 reduced risk of infection by HR 66% (95% CI, 22 to 86) compared to previously infected adults age 65+ (June to August VOC Delta). Two doses of mRNA-1273 reduced risk of infection by HR 68% (95% CI, 30 to 86) and death by HR 30% (95% CI, -11 to 1) compared to previously infected adults age 65+ (June to August VOC Delta).	Moderate	Retrospective cohort study of previously infected adults followed by Veterans Affairs in USA; 47,102 participants; time and setting for VOC Delta

104	de Gier (1)	Fully vaccinated index to unvaccinated (hh contact) showed VET 73% (95% CI: 65 to 79). BNT162b (case) showed VET 70% (95% CI, 61 to 77) when fully vaccinated. mRNA-1273 (case) showed VET 88% (95% CI, 50 to 97) when fully vaccinated. ChAdOx1 (case) showed VET 58% (95% CI, -12 to 84) when fully vaccinated. Ad26.COV2.S (case) showed VET 58% (95% CI, -12 to 84) when fully vaccinated. BNT162b showed VE 65% (95% CI, 60 to 70) when hh contact was fully vaccinated. mRNA-1273 showed VE 91% (95% CI, 79 to 97) when hh contact was fully vaccinated. ChAdOx1 showed VE 87% (95% CI, 77 to 93) when hh contact was fully vaccinated. Ad26.COV2.S showed VE 12% (95% CI, -71 to 54) when hh contact was fully vaccinated.	Serious	Retrospective cohort of household and close contacts in the Netherlands; 113,582 cases and 253,168 contacts; time and setting for VOC Alpha (hh = household)
105	de Gier (2)	Fully vaccinated index to unvaccinated (hh contact) showed VET 63% (95% CI: 46 to 75). BNT162b (>50%) or mRNA-1273 or ChAdOx1 or Ad26.COV2.S (case) showed VET 40% (95% CI, 20 to 54) when both case and contacts are fully vaccinated.	Serious	Retrospective cohort of household and close contacts in the Netherlands; 4,921 cases and 7,771 contacts; time and setting for VOC Delta
106	Manley	mRNA-1273 (50%) or BNT162b (48%) or Ad26.COV2.S (2%) showed OR of 8.89 (95% CI, 5.92 to 13.34) for unvaccinated vs fully vaccinated against infection (VOC Alpha) mRNA-1273 (50%) or BNT162b (48%) or Ad26.COV2.S (2%) showed OR of 2.27 (95% CI, 1.72 to 3.00) for unvaccinated vs fully vaccinated against infection (VOC Delta)	Serious	Retrospective cohort of maintenance dialysis patients in USA; 15,251 participants; time and setting for VOC Alpha to VOC Delta
107	Eyre	BNT162b2 (cases) showed VET 82% (95% CI, 71 to 88) against transmission after 2nd dose. (VOC Alpha) ChAdOx1 (cases) showed VET 63% (95% CI, 37 to 78) against transmission after 2nd dose. (VOC Alpha)	Serious	Retrospective cohort of contacts in England; 99,597cases and 151,821 contacts; S-gene proxy for VOC Alpha and VOC Delta

		BNT162b2 (contacts) showed VE 94% (95% CI, 90 to 96) against infection after 2nd dose. (VOC Alpha) ChAdOx1 (contacts) showed VE 71% (95% CI, 51 to 83) against infection after 2nd dose. (VOC Alpha) BNT162b2 (cases) showed VET 65% (95% CI, 52 to 74) against transmission after 2nd dose. (VOC Delta) ChAdOx1 (cases) showed VET 36% (95% CI, 28 to 43) against transmission after 2nd dose. (VOC Delta) BNT162b2 (contacts) showed VE 90% (95% CI, 87 to 92) against infection after 2nd dose. (VOC Delta) ChAdOx1 (contacts) showed VE 72% (95% CI, 68 to 75) against infection after 2nd dose. (VOC Delta).		
108	Martinez-Baz (2)	BNT162b2 (contacts) showed VE 71% (95% CI, 61 to 78) against infection after 2nd dose (VOC Alpha) mRNA-1273 (contacts) showed VE 86% (95% CI, 56 to 95) against infection after 2nd dose (VOC Alpha) ChAdOx1 (contacts) showed VE 38% (95% CI, -42 to 73) against infection after 2nd dose (VOC Alpha) BNT162b2 (contacts) showed VE 67% (95% CI, 59 to 74) against infection after 2nd dose (VOC Delta) mRNA-1273 (contacts) showed VE 77% (95% CI, 64 to 85) against infection after 2nd dose (VOC Delta) ChAdOx1 (contacts) showed VE 55% (95% CI, 39 to 67) against infection after 2nd dose (VOC Delta) ChAdOx1 followed by BNT162b2 (contacts) showed VE 86% (95% CI, 45 to 97) against infection (VOC Delta)	Serious	Prospective cohort of close contacts in Spain; 12,263 cases and 30,240 contacts; sequenced for VOC Alpha to VOC Delta (includes heterologous vaccines)
109	Cohn	BNT162b2 showed VE 49% (95% CI, 47 to 52) against infection at least 15 days after last	Serious	Data-linkage study of veterans in USA; 619,755

		dose (August: VOC Delta) mRNA-1273 showed VE 64% (95% CI, 62 to 66) against infection at least 15 days after last dose (August: VOC Delta) Ad26.COV2.S showed VE 3% (95% CI, -0.1 to 12) against infection at least 15 days after last dose (August: VOC Delta)		participants; time and setting for VOC Alpha to VOC Delta (only Delta reported here)
110	Rosenberg (2)	BNT162b2 showed VE 69% (95% CI, 67.4 to 70.6) against infection at least 15 days after last dose (August: VOC Delta; age 18-49) mRNA-1273 showed VE 78.4% (95% CI, 75.9 to 79.6) against infection at least 15 days after last dose (August: VOC Delta; age 18-49) Ad26.COV2.S showed VE 70.2% (95% CI, 67.4 to 73.0) against infection at least 15 days after last dose (August: VOC Delta; age 18-49) BNT162b2 showed VE 77.8% (95% CI, 67.4 to 70.6) against infection at least 15 days after last dose (August: VOC Delta; age 65+) mRNA-1273 showed VE 84.3% (95% CI, 82.8 to 85.7) against infection at least 15 days after last dose (August: VOC Delta; age 65+) Ad26.COV2.S showed VE 70.8% (95% CI, 65.7 to 76.0) against infection at least 15 days after last dose (August: VOC Delta; age 65+)	Serious	Prospective study in New York; 8,834,604 participants; time and setting for VOC Alpha to VOC Delta (only Delta reported here). Also compared VE over time since vaccination (results not reported here)
111	Robles-Fontan	BNT162b2 showed VE 56% (95% CI, 53 to 59) against infection at least 15 days after 2nd dose (October: VOC Delta) mRNA-1273 showed VE 71% (95% CI, 68 to 74) against infection at least 15 days after 2nd dose (October: VOC Delta) Ad26.COV2.S showed VE 27% (95% CI, 17 to 37) against infection at least 15 days after last dose (October: VOC Delta)	Serious	Data-linkage study in Puerto Rico; 1,913,454 person-years; time and setting for VOC Alpha to VOC Delta (only results for Delta reported here)
112	Glatman-Freedman (2)	BNT162b2 showed VE 91.5% (95% CI, 88.2 to 93.9) against infection at least 8 days after 2nd dose in adolescents age 12 to 15 years. There were no deaths in either group.	Serious	Population cohort in Israel of adolescents age 12 to 15 years; 2,034,591 vaccinated person-days and 13,623,714 unvaccinated person-days; time and setting for VOC Delta

113	Chin	mRNA-1273 showed VE 56.6% (95% CI, 42 to 67.5) against infection at least 14 days after 2nd dose.	Serious	Outbreak report from a prison in California; 827 participants; sample sequenced for VOC Delta
114	Nordstrom	BNT162b2 showed VE 47% (95% CI, -39 to 55) against symptomatic infection 121 to 180 days after second dose. mRNA-1273 showed VE 71% (95% CI, 56 to 81) against symptomatic infection 121 to 180 days after second dose. ChAdOx1 showed VE 41% (95% CI, 29 to 51) against symptomatic infection to 120 days after second dose. ChAdOx1 followed by mRNA vaccine showed VE 66% (95% CI, 41 to 80) against symptomatic infection >120 days after second dose. BNT162b2 or mRNA-1273 or ChAdOx1 showed VE 42% (95% CI, -35 to 75) against severe disease (hospitalization or death) >180 days after second dose	Serious	Case-control study in Sweden; 1,684,958 participants; time and setting for VOC Alpha to VOC Delta (only Delta results reported here) (includes heterologous vaccines) (results over varying time periods since vaccination reported)
116	Ranzani (2)	ChAdOx1 showed VE 42.4% (95% CI, 24.6 to 56.0) against symptomatic infection 21 days after 1st dose.	Low	Test-negative study in Brazil; 9,197 tests; time and setting for VOC Gamma to Delta
117	Ranzani(3)	Ad26.COV2.S showed VE 50.9% (95% CI, 35.5 to 63.0) against symptomatic infection, VE 92.5% (95% CI, 54.9 to 99.6) against ICU admission, and VE 90.5% (95% CI, 31.5 to 99.6) against death 28 days after dose.	Serious	Test-negative study in Brazil; 11,817 tests; time and setting for VOC Gamma to Delta
118	Chadeau-Hyam	BNT162b2 showed VE 71.3% (95% CI, 56.6 to 81.0) against infection unreported number of days after 2nd dose (Round 13 and Round 14) mRNA-1273 showed VE 75.1% (95% CI, 22.7 to 92.0) against infection unreported number of days after 2nd dose (Round 13 and Round 14) ChAdOx1showed VE 44.8% (95% CI, 22.5 to 60.7) against infection unreported number of days after 2nd dose (Round 13 and Round 14)	Serious	Surveillance study in England; 87,966 participants who consented to data-linkage for vaccine status; sequenced for VOC Delta
119	Sheikh (2)	BNT162b2 showed VE 90% (95% CI, 86 to 94) against death at least 14 days after 2nd dose (confirmed VOC Delta) ChAdOx1 showed VE 91% (95% CI, 83 to	Serious	Retrospective cohort in Scotland; 114,706 participants; proxy for VOC Delta

		94) against death at least 14 days after 2nd dose (confirmed VOC Delta)		
120	Reis	BNT162b2 showed VE 59% (95% CI, 52 to 65) against infection 14 to 20 days after 1st dose (age 12 to 18) BNT162b2 showed VE 90% (95% CI, 88 to 92) against infection 7 to 21 days after 2nd dose (age 12 to 18)	Moderate	Case-control study in Israel; 94,354 vaccinated matched to 94,354 unvaccinated adolescents age 12 to 18; time and setting for VOC Delta
121	Nordstrom (2)	BNT162b2 showed VE 78% (95% CI, 78 to 79) against symptomatic infection at least 14 days after 2nd dose. mRNA-1273 showed VE 87% (95% CI, 84 to 88) against symptomatic infection at least 14 days after 2nd dose. ChAdOx1 showed VE 50% (95% CI, 41 to 58) against symptomatic infection at least 14 days after 2nd dose. ChAdOx1 followed by BNT162b2 showed VE 67% (95% CI, 59 to 73) against symptomatic infection at least 14 days after 2nd dose. ChAdOx1 followed by mRNA-1273 showed VE 79% (95% CI, 62 to 88) against symptomatic infection at least 14 days after 2nd dose.	Serious	Retrospective cohort study in Sweden; 721,787 participants; time and setting for VOC Delta (includes heterologous vaccines)
122	Skowronski (2)	BNT162b2 showed VE 79% (95% CI, 73 to 84) against infection at least 21 days after 1st dose (VOC Gamma) mRNA-1273 showed VE 85% (95% CI, 71 to 92) against infection at least 21 days after 1st dose (VOC Gamma) ChAdOx1 showed VE 60% (95% CI, 48 to 69) against infection at least 21 days after 1st dose (VOC Gamma)	Serious	Test-negative study in Canada; 68,074 participants; sample sequenced for VOC Alpha, Gamma and Delta (only VOC Gamma reported here)
123	Skowronski (3)	Delta BNT162b2 showed VE 89% (95% CI, 88 to 89) against infection at least 14 days after 2nd dose (Quebec- VOC Delta) mRNA-1273 showed VE 91% (95% CI, 90 to 92) against infection at least 14 days after 2nd dose (Quebec- VOC Delta) ChAdOx1 showed VE 73% (95% CI, 69 to 78) against infection at least 14 days after 2nd	Serious	Test-negative study in Canada; 380,532 British Columbia and 854,915 Quebec participants; sequenced for VOC Alpha, Gamma and Delta (selected data only reported here due to space constraints) (includes heterologous vaccines)

		dose (Quebec- VOC Delta) ChAdOx1 followed by mRNA vaccine showed VE 88% (95% CI, 85 to 89) against infection at least 14 days after 2nd dose (Quebec- VOC Delta) Gamma BNT162b2 showed VE 93% (95% CI, 89 to 95) against infection at least 14 days after 2nd dose (BC- VOC Gamma) mRNA-1273 showed VE 95% (95% CI, 85 to 99) against infection at least 14 days after 2nd dose (BC- VOC Gamma) ChAdOx1 showed VE 90% (95% CI, 61 to 98) against infection at least 14 days after 2nd dose (BC- VOC Gamma) ChAdOx1 followed by mRNA vaccine showed VE 96% (95% CI, 70 to 99) against infection at least 14 days after 2nd dose (BC- VOC Gamma) Time since vaccination (Delta) BNT162b2 showed VE 85% (95% CI, 84 to 86) against infection at 4 months after 2nd dose (Quebec – VOC Delta) mRNA-1273 showed VE 88% (95% CI, 86 to 90) against infection at 4 months after 2nd dose (Quebec – VOC Delta) ChAdOx1 showed VE 72% (95% CI, 66 to 77) against infection at 4 months after 2nd dose (Quebec – VOC Delta) ChAdOx1 followed by mRNA vaccine showed VE 86% (95% CI, 81 to 89) against infection at 4 months after 2nd dose (Quebec – VOC Delta) Time since vaccination and interval between doses (VOC Alpha to Delta) BNT162b2 showed VE 92% (95% CI, 91 to 93) at 14 to 27 days after 2nd dose (interval 7+ weeks) and VE 90% (95% CI, 88 to 91) at 4 months after 2nd dose (interval 7+ weeks) (Quebec) mRNA-1273 showed VE 92% (95% CI, 90 to		(results over varying time periods since vaccination reported)

		94) at 14 to 27 days after 2nd dose (interval 7+ weeks) and VE 91% (95% CI, 87 to 94) at 112+ days after 2nd dose (interval 7+ weeks) (Quebec) ChAdOx1 showed VE 85% (95% CI, 60 to 94) at 14 to 27 days after 2nd dose (interval 7+ weeks) and VE 72% (95% CI, 66 to 77) at 84 days after 2nd dose (interval 7+ weeks) (Quebec)		
124	Lin	BNT162b2 showed VE 94.9% (94.5 to 95.2) against symptomatic infection and VE 95.9% (95% CI, 92.9 to 97.6) against death at 60 days months after 2nd dose. BNT162b showed VE 70.1% (95% CI, 68.9 to 71.2) against symptomatic infection and VE 88.4% (95% CI, 83 to 92.1) against death at 210 days after 2nd dose) mRNA-1273 showed VE 96% (95.6 to 96.4) against symptomatic infection at 60 days; VE 96% (95% CI, 91.9 to 98) against death at 90 days after 2nd dose. mRNA-1273 showed VE 81.9% (95% CI, 81 to 82.7) against symptomatic infection and VE 93.7% (95% CI, 90.2 to 95.9) against death at 210 days after 2nd dose) Ad26.COV2.S showed VE 79% (77.1 to 80.7) against symptomatic infection at 30 days and VE 64.3% (95% CI, 62.3 to 66.1) at 150 days months after dose. Ad26.COV2.S showed VE 89.4% (95% CI, 52.3 to 97.6) against death at 120 days after dose)	Serious	Data-linkage study in North Carolina; 10,600,823 participants; time and setting for VOC Alpha to Delta (results over varying time periods since vaccination reported)
125	Barda	BNT162b2 (3 doses) showed VE 92% (82 to 97) against severe disease and VE 81% (95% CI, 59 to 97) against death at least 7 days after 3rd dose compared to 2 doses (given 5 months previously).	Serious	Data-linkage study of fully vaccinated (2 doses vs 3 doses) participants in Israel; 728,321 participants in each group; time and setting for VOC Delta
126	Andrews (2)	BNT162b2 (3 doses) showed VE 94% (95% CI, 93.4 to 94.6) against symptomatic infection at least 14 days after 3rd dose in age>50 (compared to unvaccinated) ChAdOx1 (2 doses followed by BNT162b2) showed VE 93.1% (95% CI, 91.7 to 94.3) against symptomatic infection at least 14 days	Moderate	Test-negative study of fully vaccinated participants (>140 days since 2nd dose) over age 50 in England; 271,747 participants; sequencing for VOC Delta

		after 3rd dose in age>50 (compared to unvaccinated)		
127	Starrfelt (2)	BNT162b2 showed VE 69.7% (95% CI, 68.6 to 70.8) against infection at least 7 days after 2nd dose (VOC Alpha to Delta) mRNA-1273 showed VE 78.2% (95% CI, 76.7 to 79.6) against infection at least 7 days after 2nd dose (VOC Alpha to Delta) ChAdOx1 showed VE 43.4% (95% CI, 4.4 to 66.5) against infection at least 7 days after 2nd dose (VOC Alpha to Delta) Heterologous mRNA showed VE 84.7% (95% CI, 83.1 to 86.1) against infection at least 7 days after 2nd dose (VOC Alpha to Delta) ChAdOx1 followed by mRNA showed VE 60.7% (95% CI, 57.5 to 63.6) against infection at least 7 days after 2nd dose (VOC Alpha to Delta)	Moderate	Population cohort study in Norway; 4,293,544 participants; time and setting for VOC Alpha to VOC Delta (includes heterologous vaccines)
128	Preio-Alhambra	ChAdOx1 followed by BNT162b2 showed HR 0.61 (95% CI, 0.52 to 0.71) against infection vs ChAdOx1 (homologous) – unreported number of days after 2nd dose	Serious	Retrospective cohort study in Spain; 28,650 participants aged 19 to 59 years; time and setting for VOC Delta (compared heterologous vaccines with homologous vaccines)
129	Ng	BNT162b2 or mRNA-1273 showed VE 61.6% (95% CI, 37.5 to 80.4) against transmission to fully vaccinated hh contacts and VE 100% (95% CI, not reported) against severe disease in fully vaccinated hh contacts	Serious	Retrospective cohort study of household contacts in Singapore; 753 contacts; index sequenced for VOC Delta
130	Desai	BBV152 showed VE 50% (95% CI, 33 to 62) against symptomatic infection at least 14 days after 2nd dose	Serious	Test-negative study of HCW in India; 1,068 matched pairs; time and setting for VOC Delta
131	Thiruvengadam(pub)	ChAdOx1showed VE 46.2% (95% CI, 31.6 to 57.7) against infection at least 21 days after 1st dose. ChAdOx1showed VE 63.1% (95% CI, 51.5 to 72.1) against infection at least 14 days after 2nd dose.	Serious	Test-negative study in India; 5,143 participants; sequencing for VOC Delta

132	Sharma	BNT162b2 showed VE 45.7% (95% CI, 37.9 to 52.5) against infection median of 30 days after 3rd dose compared to 2 doses (given at least 180 days previously) mRNA-1273 showed VE 46.6% (95% CI, 36.4 to 55.3) against infection median of 16 days after 3rd dose compared to 2 doses (given at least 180 days previously)	Serious	Case-control study of fully vaccinated (2 doses versus 3 doses) in veterans in USA; 129,130 pairs; time and setting for VOC Delta
133	Cohn (2)	BNT162b2 showed VE 43% (95% CI, 42 to 45) against infection after unclear number of days after 2nd dose (September 2021) mRNA-1273 showed VE 58% (95% CI, 57 to 59) after unclear number of days against infection after 2nd dose (September 2021) Ad26.COV2.S showed VE 13% (95% CI, 9 to 17) against infection after unclear number of days after dose (September 2021)	Serious	Retrospective cohort study of Veterans in the US; 780,225 Veterans; time and setting for VOC Delta (same population as Cohn but extended study time frame)
134	Arbel	BNT162b2 (3 doses) showed VE 90% (95% CI, 86 to 93) against death at 7 to 54 days after 3rd dose compared to 2 doses (given at least 5 months previously)	Moderate	Data-linkage study of fully vaccinated (>50 years) (2 doses versus 3 doses) in Israel; 843,208 participants; time and setting for VOC Delta
135	Bar-On (2)	BNT162b2 (3 doses) showed adjusted rate ratio of 12.3 (95% CI, 11.8 to 12.8) against infection and adjusted rate ratio of 17.9 (95% CI, 15.1 to 21.2) against severe disease and adjusted rate ratio of 14.7 (95% CI, 10 to 21.4) against death at least 12 days after 3rd dose compared to 2 doses (given at least 5 months previously) (age>60). BNT162b2 (3 doses) showed adjusted rate ratio of 9.0 (95% CI, 8.4 to 9.7) against infection at least 12 days after 3rd dose compared to 2 doses (given at least 5 months previously) (age 30-39).	Serious	Data-linkage study of fully vaccinated (>16 years) (2 doses versus 3 doses) in Israel; 4,696,865 participants; time and setting for VOC Delta (same population as Bar-On but extended end of study and additional ages and outcomes)
136	Andrews (3)	BNT162b2 (3 doses) showed VE 67.2% (95% CI, 66.5 to 67.8) against symptomatic infection at 2 to 4 weeks after 3rd dose; VE 55.0% (95% CI, 54.2 to 55.8) at 5 to 9 weeks after 3rd dose (VOC Omicron) BNT162b2 (2 doses) showed VE 48.7% (95% CI, 47.1 to 50.2) against symptomatic infection at 5 to 9 weeks after 2nd dose; VE 30.1% (95% CI, 28.7 to 31.5) against symptomatic infection at 10 to 14 weeks after 2nd dose (VOC Omicron)	Moderate	Test-negative study of fully vaccinated participants in England; 2,663,549 participants; sequencing for VOC Delta and Omicron (updated June 22, 2022 based on differences in published version)

		mRNA-1273 (3 doses) showed VE 66.3% (95% CI, 63.7 to 68.8)against symptomatic infection at 2 to 4 weeks after 3rd dose(VOC Omicron) mRNA-1273 (2 doses) showed VE 52.8% (95% CI, 48.2 to 57.1) against symptomatic infection at 5 to 9 weeks after 2nd dose; VE 35.6% (95% CI, 32.7 to 38.4) against symptomatic infection at 10 to 14 weeks after 2nd dose (VOC Omicron) ChAdOx1 (3 doses) showed VE 55.6% (95%CI, 44.4 to 64.6) against symptomatic infection at 2 to 4 weeks after 3rd dose; 46.7% (95% CI, 34.3 to 56.7) against symptomatic infection at 5 to 9 weeks after 3rd dose (VOC Omicron) ChAdOx1 (2 doses followed by 1 dose of BNT162b2) showed VE 62.4% (95% CI, 61.8 to 63) against symptomatic infection at 2 to 4 weeks after 3rd dose; VE 52.9% (95% CI, 52.1 to 53.7) against symptomatic infection at 5 to 9 weeks after 3rd dose (VOC Omicron) ChAdOx1 (2 doses followed by 1 dose of mRNA-1273) showed VE 70.1% (95% CI, 69.5 to 70.7)against symptomatic infection at 2 to 4 weeks; VE 60.9% (95% CI, 59.7 to 62.1) against symptomatic infection at 5 to 9 weeks after 3rd dose (VOC Omicron) ChAdOx1 (2 doses) showed VE 33.7% (95% CI, 25.0 to 41.5) against symptomatic infection at 5 to 9 weeks after 2nd dose; VE 28.6% (95% CI, 20.9 to 35.6) against symptomatic infection at 10 to 14 weeks after 2nd dose (VOC Omicron) Changes for VOC Delta listed below have NOT been transferred to Table 3a as of June 22, 2022 BNT162b2 (3 doses) showed VE 95.1% (95% CI, 94.8 to 95.4) against symptomatic infection at 2 to 4 weeks after 3rd dose; VE 91.8% (95% CI, 91.4 to 92.1) against symptomatic infection at 5 to 9 weeks after 3rd dose (VOC Delta) BNT162b2 (2 doses) showed VE 85.5% (95%		

		CI, 84.5 to 86.5) against symptomatic infection at 5 to 9 weeks after 2nd dose; VE against symptomatic infection after 2nd dose; VE 78.7% (95% CI, 78.0 to 79.4) against symptomatic infection at 10 to 14 weeks after 2nd dose (VOC Delta) mRNA-1273 (3 doses) showed VE 96.4% (95% CI, 91.4 to 98.5)against symptomatic infection at 2 to 4 weeks after 3rd dose(VOC Delta) mRNA-1273 (2 doses) showed VE 91.8% (95% CI, 89.6 to 93.6) against symptomatic infection at 5 to 9 weeks after 2nd dose; VE 84.1% (95% CI, 82.7 to 85.3) against symptomatic infection at 10 to 14 weeks after 2nd dose (VOC Delta) ChAdOx1 (3 doses) showed VE 82.3% (95% CI, 44.4 to 64.6) against symptomatic infection at 2 to 4 weeks after 3rd dose; 83.3% (95% CI, 69.7 to 90.8) against symptomatic infection at 5 to 9 weeks after 3rd dose (VOC Delta) ChAdOx1 (2 doses followed by 1 dose of BNT162b2) showed VE 95.4% (95% CI, 95.1 to 95.6) against symptomatic infection at 2 to 4 weeks after 3rd dose; VE 92.6% (95% CI, 92.2 to 92.9) against symptomatic infection at 5 to 9 weeks after 3rd dose (VOC Delta) ChAdOx1 (2 doses followed by 1 dose of mRNA-1273) showed VE 97.0% (95% CI, 96.7 to 97.3)against symptomatic infection at 2 to 4 weeks; VE 94.9% (95% CI, 93.8 to 95.9) against symptomatic infection at 5 to 9 weeks after 3rd dose (VOC Delta) ChAdOx1 (2 doses) showed VE 76.5% (95% CI, 70.3 to 81.5) against symptomatic infection at 5 to 9 weeks after 2nd dose; VE 69.2% (95% CI, 64.7 to 73.1) against symptomatic infection at 10 to 14 weeks after 2nd dose (VOC Delta)		
137	Hansen	BNT162b2 showed VE 55.2% (95% CI, 23.5 to 73.7) against infection up to 44 days after 2nd dose (VOC Omicron) BNT162b2 showed VE -76.5% (95% CI, -95.3 to -59.5) against infection up to 164 days	Serious	Retrospective cohort study in Denmark; 5,767 identified Omicron cases; sequenced for VOC Delta and Omicron

		after 2nd dose (VOC Omicron) BNT162b2 (3 doses) showed VE 54.6% (95% CI, 30.4 to 70.4) against infection up to 30 days after 3rd dose (VOC Omicron) mRNA-1273 showed VE 36.7% (95% CI, -69.9 to 76.4) against infection up to 44 days after 2nd dose (VOC Omicron) mRNA-1273 showed VE -39.3% (95% CI, -61.6 to -20) against infection up to 164 days after 2nd dose (VOC Omicron) BNT162b2 showed VE 86.7% (95% CI, 84.6 to 88.6) against infection up to 44 days after 2nd dose (VOC Delta) BNT162b2 showed VE 53.8% (95% CI, 52.9 to 54.6) against infection up to 164 days after 2nd dose (VOC Delta) BNT162b2 (3 doses) showed VE 81.2% (95% CI, 79.2 to 82.9) against infection up to 30 days after 3rd dose (VOC Delta) mRNA-1273 showed VE 88.2% (95% CI, 83.1 to 91.8) against infection up to 44 days after 2nd dose (VOC Delta) mRNA-1273 showed VE 65.0% (95% CI, 63.6 to 66.3) against infection up to 164 days after 2nd dose (VOC Delta) mRNA-1273 (3 doses) showed VE 82.8% (95% CI, 58.8 to 92.9) against infection up to 30 days after 3rd dose (VOC Delta)		(results over varying time periods since vaccination reported)
138	McLean	BNT162b2 showed VE 52% (95% CI, 20 to 71) against infection at least 14 days after 2nd dose (VOC Delta - June to Dec 2021) mRNA-1273 showed VE 59% (95% CI, 24 to 78) against infection at least 14 days after 2nd dose (VOC Delta - June to Dec 2021)	Serious	Prospective cohort in Wisconsin, USA; 1,518 participants; time and setting for VOC Delta
139	Berec	BNT162b2 (3 doses) showed VE 92% (95% CI, 91 to 92) against infection at least 7 days after 3rd dose. mRNA-1273 (3 doses) showed VE 94% (95% CI, 91 to 95) against infection at least 7 days after 3rd dose.	Serious	Population cohort in Czech Republic; 693,579 fully vaccinated participants; time and setting for VOC Delta (includes heterologous vaccines)

		ChAdOx1 (2 doses) followed by BNT162b2 showed VE 82% (95% CI, 68 to 90) against infection at least 7 days after 3rd dose ChAdOx1 (2 doses) followed by mRNA1273 showed VE 91% (95% CI, 63 to 98) against infection at least 7 days after 3rd dose		
140	Florea	mRNA-1273 showed VE 86.5% (95% CI, 84.8 to 88.0) against infection at least 14 days after 2nd dose	Serious	Prospective matched cohort study in California, USA; 1,854,008 participants; sequencing for VOC Delta
141	Kissling (2)	BNT162b2 showed VE 76% (95% CI, 72 to 81) against symptomatic infection at 30 -59 days after 2nd dose; VE 72% (95% CI, 61 to 80) at 60-89 days after 2nd dose and VE 65% (95% CI, 56 to 71) >90 days after 2nd dose (age 30-59) mRNA-1273 showed VE 91% (95% CI, 85 to 95) against symptomatic infection at 30 -59 days after 2nd dose; VE 90% (95% CI, 76 to 96) at 60-89 days after 2nd dose (age 30-59) ChAdOx1 showed VE 67% (95% CI, 57 to 75) against symptomatic infection at 30 -59 days after 2nd dose; VE 65% (95% CI, 48 to 76) at 60-89 days after 2nd dose (age 30-59) Ad26.COV2.S showed VE 50% (95% CI, 36 to 62) against symptomatic infection at 30 -59 days after dose; VE 52% (95% CI, 33 to 66) at 60-89 days after dose (age 30-59)	Serious	Test-negative study in 10 out of 14 I-MOVE countries; 14,282 participants; sample sequenced for VOC Delta (results over varying time periods since vaccination reported)
142	Katikireddi	ChAdOx1 showed VE 63.3% (95% CI, 61.3 to 65.3) against symptomatic infection at 8 to 9 weeks after 2nd dose; VE 48.7% (95% CI, 45.9 to 51.4) against symptomatic infection at 16 to 17 weeks after 2nd dose (VOC Delta) ChAdOx1 showed VE 79.0% (95% CI, 75.9 to 81.7) against severe disease (hospitalization or death) at 8 to 9 weeks after 2nd dose; VE 70.5% (95% CI, 67.0 to 73.7) against severe disease 16 to 17 weeks after 2nd dose (VOC Delta) ChAdOx1 showed VE 65.4% (95% CI, 64.6 to 66.2) against symptomatic infection at 8 to 9 weeks after 2nd dose; VE 58.7% (95% CI, 56.7 to 60.5) against symptomatic infection at 16 to 17 weeks after 2nd dose (VOC Gamma) ChAdOx1 showed VE 75.6% (95% CI, 73.4	Serious	Retrospective cohort in Scotland and Brazil; 1,972,454 fully vaccinated participants in Scotland (Delta); 42,558,839 fully vaccinated participants in Brazil (Gamma); time and setting for VOC Delta and VOC Gamma (results over varying time periods since vaccination reported)

		to 77.6) against severe disease (hospitalization or death) at 8 to 9 weeks after 2nd dose; VE 50.5% (95% CI, 43.4 to 56.6) against severe disease 16 to 17 weeks after 2nd dose (VOC Gamma)		
143	Abu-Raddad (4)	mRNA-1273 showed VE 90.6% (95% CI, 88.7 to 92.1) against infection at 60 days after 2nd dose; VE 80.7% (95% CI, 77 to 83.8) against infection at 120 days after 2nd dose mRNA-1273 showed VE 97.8% (95% CI, 83.7 to 99.7) against severe disease (hospitalization or death) at 60 days after 2nd dose; VE 91.5% (95% CI, 60.8 to 98.1) against infection at 120 days after 2nd dose	Serious	Test-negative study in Qatar; 1,781,505 participants; time and setting for VOC Beta to VOC Delta (same setting and methodology as Chemaitelly 3) (results over varying time periods since vaccination reported)
144	Machado	BNT162b2 (majority) or mRNA-1273 showed VE 68% (95% CI, 64 to 71) against symptomatic infection at 42-69 days after 2nd dose; VE 39% (95% CI, 29 to 48) against symptomatic infection at 98-148 days after 2nd dose ChAdOx1 showed VE 33% (95% CI, 23 to 42) against symptomatic infection at 42-69 days after 2nd dose; VE 34% (95% CI, 10 to 52) against symptomatic infection at 70-140 days after 2nd dose BNT162b2 (majority) or mRNA-1273 showed VE 95% (95% CI, 88 to 98) against death at 14-41 days after 2nd dose; VE 93% (95% CI, 87 to 96) against death at 70-148 days after 2nd dose ChAdOx1 showed VE 95% (95% CI, 90 to 97) against death at least 14 days after 2nd dose	Moderate	Retrospective cohort study of community-dwelling adults≥65 in Portugal; 2,117,002 participants; time and setting for VOC Alpha to VOC Delta (same population as Nunes) (results over varying time periods since vaccination reported)
145	Irizarry	BNT162b2 showed VE 57% (95% CI, 53 to 60) against infection at 144 days after 2nd dose; VE 86% (95% CI, 75 to 92) against death at 144 days after 2nd dose mRNA-1273 showed VE 73% (95% CI, 70 to 76) against infection at 144 days after 2nd dose; VE 93% (95% CI, 81 to 97) against death at 144 days after 2nd dose Ad26.COV2.S showed VE 36% (95% CI, 30 to 42) against infection at 144 days after 2nd dose; VE 72% (95% CI, 49 to 85) against death at 144 days after 2nd dose	Serious	Retrospective cohort study in Puerto Rico; 2,276,966 participants; time and setting for VOC Alpha to VOC Delta (same population as Robles-Fontan?) (results over varying time periods since vaccination reported)

146	Tartof (2)	BNT162b2 (3 doses) showed VE 88% (95% CI, 86 to 89) against infection at least 14 days after 3rd dose compared to unvaccinated (age>18) BNT162b2 (3 doses) showed VE 75% (95% CI, 71 to 78) against infection at least 14 days after 3rd dose compared to 2 doses (given at least 6 months previously) (age>18)	Moderate	Retrospective cohort study in California, USA; 3,133,075 participants; time and setting for VOC Alpha to VOC Delta
147	Buchan	BNT1652b2 or mRNA-1273 (2 doses) showed VE 6% (95% CI, -25 to 30) against infection at 7 to 59 days after 2nd dose; VE -13% (95% CI, -38 to 8) against infection at 60 to 119 days after 2nd dose; VE -38% (95% CI, -61 to -18) against infection at 120 to 179 days after 2nd dose; VE -16% (95% CI, -62 to 17) against infection at >240 days after 2nd dose (VOC Omicron) BNT162b2 (3 doses) showed VE 34% (95% CI, 16 to 49) against infection at 7 days after 3rd dose (VOC Omicron) mRNA-1273 (3 doses) showed VE 59% (95% CI, 16 to 80) against infection at 7 days after 3rd dose (VOC Omicron) BNT1652b2 or mRNA-1273 (2 doses) showed VE 84% (95% CI, 81 to 86) against infection at 7 to 59 days after 2nd dose; VE 81% (95% CI, 79 to 82) against infection at 60 to 119 days after 2nd dose; VE 80% (95% CI, 79 to 81) against infection at 120 to 179 days after 2nd dose; VE 71% (95% CI, 66 to 75) against infection at >240 days after 2nd dose (VOC Delta) BNT162b2 (3 doses) showed VE 93% (95% CI, 91 to 94) against infection at 7 days after 3rd dose (VOC Delta) mRNA-1273 (3 doses) showed VE 93% (95% CI, 90 to 96) against infection at 7 days after 3rd dose (VOC Delta)	Moderate	Test-negative study in Ontario, Canada; 484,188 fully vaccinated participants; sample sequenced for VOC Delta and VOC Omicron (results over varying time periods since vaccination reported)

148	Tseng	mRNA-1273 (2 doses) showed VE 30.4% (95% CI, 5.0 to 49.0) against infection at 14 to 90 days after 2nd dose; VE 15.2% (0 to 30.7) against infection at 91 to 180 days after 2nd dose; VE 0% (95% CI, 0 to 1.2) against infection at 181 to 270 days after 2nd dose (VOC Omicron) mRNA-1273 (3 doses) showed VE 63.6% 95% CI, 57.4 to 68.9) against infection at median of 35 days after 3rd dose (VOC Omicron) mRNA-1273 (2 doses) showed VE 82.8% (95% CI, 69.6 to 90.3) against infection at 14 to 90 days after 2nd dose; VE 63.6% (51.8 to 72.5) against infection at 91 to 180 days since 2nd dose; VE 61.4% (95% CI, 56.8 to 65.5) against infection at 181 to 270 days after 2nd dose; VE 52.9% (95% CI, 43.7 to 60.5) against infection at >270 days after 2nd dose (VOC Delta) mRNA-1273 (3 doses) showed VE 95.7% 95% CI, 94.2 to 96.8) against infection at median of 35 days after 3rd dose (VOC Delta)	Serious	Test-negative study in California, USA; 60,420 participants; sample sequenced for VOC Delta and VOC Omicron (results over varying time periods since vaccination reported)
149	Lyngse	BNT162b2* (cases) showed VET 10% (95% CI, 0 to 18) against transmission to vaccinated household contacts at least 7 days after 2nd dose BNT162b2* (cases) showed VET 31% (95% CI, 26 to 36) against transmission to unvaccinated household contacts at least 7 days after 2nd dose BNT162b2* (contacts) showed VES 46% (95% CI, 40 to 52) against susceptibility to infection from vaccinated case at least 7 days after 2nd dose BNT162b2* (contacts) showed VES 61% (95% CI, 59 to 63) against susceptibility to infection from unvaccinated household contacts at least 7 days after 2nd dose *vast majority	Serious	Household transmission study in Denmark; 24,693 index cases; sequencing for VOC Delta
150	Hitchings (3)	CoronaVac (2 doses) showed OR 1.59 (95% CI, 0.60 to 4.24) for infection comparing fully vaccinated ≥182 days vs fully vaccinated 14 to 41 days (age 40-64)	Serious	Test-negative study in Brazil; 37,929 matched fully vaccinated participants; time and setting for VOC Gamma and VOC Delta

		CoronaVac (2 doses) showed OR 3.32 (95% CI, 1.85 to 5.94) for infection comparing fully vaccinated ≥182 days vs fully vaccinated 14 to 41 days (age 80+)		
151	Abu-Raddad (5)	BNT162b2 (3 doses) showed VE 49.4% (95% CI, 47.1 to 51.6) 50.1% (95% CI, 47.3 to 52.8) against symptomatic infection; VE 100% (71.4 to 100) against hospitalization and death median of 249 days after 3rd dose compared to 2 doses mRNA-1273 (3 doses) showed VE 47.3% (95% CI, 40.7 to 53.3) 50.8% (95% CI, 43.4 to 57.3) against symptomatic infection median of 249 days after 3rd dose compared to 2 doses	Serious	Retrospective cohort studies in Qatar; 2,239,193 fully vaccinated participants; sample sequenced for VOC Omicron (updated June 22, 2022 based on differences in published version)
152	Zheutlin	BNT162b2 showed VE 84% (95% CI, 82 to 85) against infection ≥5 months after 2nd dose mRNA-1273 showed VE 88% (95% CI, 87 to 89) against infection ≥5 months after 2nd dose Ad26.COV2.S showed VE 74% (95% CI, 70 to 76) against infection ≥5 months after dose	Serious	Matched case-control in USA; 17,017,435 fully vaccinated participants; time and setting for VOC Alpha to VOC Delta (only Delta data shown here) (results over varying time periods since vaccination reported)
153	Cerqueira-Silva	BNT162b2 showed VE 64.8% (95% CI, 54.9 to 72.4) against symptomatic infection ≥14 days after 2nd dose ChAdOx1 showed VE 56% (95% CI, 51.4 to 60.2) ≥14 days after 2nd dose CoronaVac showed VE 39.4% (95% CI, 36.1 to 42.6) against symptomatic infection ≥14 days after 2nd dose Ad26.COV2.S showed VE 44% (95% CI, 31.5 to 54.2) against symptomatic infection ≥14 days after dose	Serious	Test-negative study in Brazil; 231,212 previously infected participants; time and setting for VOC Gamma to VOC Delta
154	Jara (2)	CoronaVac (3 doses) showed VE 78.8% (95% CI, 76.8 to 80.6) against symptomatic infection; VE 92.2% (95% CI, 88.7 to 94.6) against ICU admission; VE 86.7% (95% CI, 80.5 to 91.0) against death ≥14 days after 3rd dose BNT162b2 booster after CoronaVac (2 doses) showed VE 96.5% (95% CI, 96.2 to 96.7) against symptomatic infection; VE 96.2% (95% CI, 94.6 to 97.3) against ICU admission; VE 96.8% (95% CI, 93.9 to 98.3) against death ≥14 days after 3rd dose	Moderate	Prospective cohort in Chile; 11,174,257 fully vaccinated participants; time and setting for VOC Delta (includes heterologous vaccines)

		ChAdOx1 booster after CoronaVac (2 doses) showed VE 93.2% (95% CI, 92.9 to 93.6) against symptomatic infection; VE 98.9% (95% CI, 98.5 to 99.2) against ICU admission; VE 98.1% (95% CI, 97.3 to 98.6) against death ≥14 days after 3rd dose		
155	Tan	BNT162b2 (3 doses) showed VE 73% (95% CI, 71 to 74) against infection; VE 95% (95% CI, 92 to 97) against severe disease ≥12 days after 3rd dose compared to 2 doses mRNA-1273 (3 doses) showed VE 86% (95% CI, 81 to 90) against infection ≥12 days after 3rd dose compared to 2 doses of BNT162b2 BNT162b2 (2 doses) followed by mRNA-1273 showed VE 82% (95% CI, 77 to 86) against infection; VE 92% (95% CI, 44 to 99) against severe disease ≥12 days after 3rd dose compared to 2 doses of BNT162b2 mRNA-1273 (2 doses) followed by BNT162b2 showed VE 90% (95% CI, 73 to 96) against infection ≥12 days after 3rd dose compared to 2 doses of BNT162b2	Serious	Retrospective cohort study in Singapore; 73,209 fully vaccinated participants (age>60); time and setting for VOC Delta (includes heterologous vaccines)
156	Suah	BNT162b2 (2 dose vaccinated July to August) showed VE 90.8% (95% CI, 89.4 to 92.0) against infection; VE 83.8% (95% CI, 78.5 to 87.8) against ICU admission; VE 90.3% (95% CI, 88.1 to 92.2) against death in September (at least 14 days after 2nd dose) BNT162b2 (2 dose vaccinated April to June) showed VE 79.1% (95% CI, 75.8 to 81.9) against infection; VE 57.2% (95% CI, 43.4 to 67.6) against ICU admission ; VE 89.3% (95% CI, 85.9 to 91.9) against death in September (at least 14 days after 2nd dose) CoronaVac (2 dose vaccinated July to August) showed VE 74.4% (95% CI, 70.4 to 77.8) against infection; VE 46.1% (95% CI, 37.2 to 53.7) against ICU admission; VE 76.5% (95% CI, 72.9 to 79.6) against death in September (at least 14 days after 2nd dose) CoronaVac (2 dose vaccinated April to June) showed VE 30% (95% CI, 18.4 to 39.9) against infection; VE 30.2% (95% CI, 7.6 to 47.3) against ICU admission; VE 75.7% (95% CI, 67.0 to 82.1) against death in September	Serious	Retrospective cohort study in Malaysia; 9,927,350 fully vaccinated participants; time and setting for VOC Delta (results over varying time periods since vaccination reported)

		(at least 14 days after 2nd dose)		
157	Amodio	mRNA-1273 showed VE 69.2% (95% CI, 67.6 to 70.8) against infection; VE 85.2% (95% CI, 82.7 to 87.7) against severe disease at 6 months after 2nd dose mRNA-1273 showed VE 69.2% (95% CI, 67.6 to 70.8) against infection; VE 90.3% (95% CI, 86.2 to 94.4) against severe disease at 8 months after 2nd dose	Serious	Retrospective cohort study in Italy; 3,966,976 participants; time and setting for VOC Alpha to VOC Delta (only Delta data shown here) (results over varying time periods since vaccination reported)
158	Roberts	BNT162b2 showed VE 72.7% (95% CI, 65.4 to 78.5) against infection; VE 71.7% (95% CI, 45.1 to 85.6) against severe disease (21 days to <3 months after 2nd dose) (participants tested July–September 2021) BNT162b2 showed VE 73.8% (95% CI, 63.6 to 81.2) against infection; VE 68.3% (95% CI, 23.6 to 87.2) against severe disease (21 days to <3 months after 2nd dose) (participants tested October–December 2021) mRNA-1273 showed VE 79.0% (95% CI, 70.8 to 84.9) against infection; VE 74.5% (95% CI, 42.7 to 88.9) against severe disease (21 days to <3 months after 2nd dose) (participants tested July–September 2021) mRNA-1273 showed VE 83.1% (95% CI, 68.9 to 90.9) against infection; VE 93.4% (95% CI, 5.3 to 99.6) against severe disease (21 days to <3 months after 2nd dose) (participants tested October–December 2021)	Serious	Test-negative study in USA; 170,487 participants; time and setting for VOC Alpha to VOC Delta (only Delta data shown here)
159	Bar-On (3)	BNT162b2 (3 doses) showed a rate ratio (RR) of 1.9 (95% CI, 1.8 to 1.9) for infection; RR 4.0 (95% CI, 2.3 to 7.0) for severe disease compared to 4 doses	Serious	Data-linkage study of 4 doses (>60 years) (3 doses versus 4 doses) in Israel; 1,138,681 participants; time and setting for VOC Omicron
160	Willett	BNT162b2 (3 doses) showed VE 43.2% (95% CI, 38.1 to 47.8) against infection (VOC Omicron) mRNA-1273 (3 doses) showed VE 46.3% (95% CI, 41.3 to 51.0) against infection (VOC Omicron) BNT162b2 (2 doses) showed VE 26% (95% CI, x to x) against infection (VOC Omicron) mRNA-1273 (2 doses) showed VE 23.7%	Serious	Test-negative study in Scotland; 1,200,000 participants; sample sequenced for VOC Omicron and VOC Delta

		(95% CI, x to x) against infection (VOC Omicron) BNT162b2 (3 doses) showed VE 85.9% (95% CI, 84.2 to 87.4) against infection (VOC Delta) mRNA-1273 (3 doses) showed VE 86.5% (95% CI, 84.8 to 88.0) against infection (VOC Delta) BNT162b2 (2 doses) showed VE 83.5% (95% CI, x to x) against infection (VOC Delta) mRNA-1273 (2 doses) showed VE 87.8% (95% CI, x to x) against infection (VOC Delta)		
161	Jalali	BNT162b2 or mRNA-1273 (3 doses) showed VES 47% (95% CI, 17 to 64) against transmission at least 7 days after 3rd dose (VOC Omicron) BNT162b2 or mRNA-1273 (2 doses) showed VES 16% (95% CI, 0 to 37) against transmission at least 7 days after 2nd dose (VOC Omicron) BNT162b2 or mRNA-1273 (3 doses) showed VES 62% (95% CI, 38 to 78) against transmission at least 7 days after 3rd dose (VOC Delta) BNT162b2 or mRNA-1273 (2 doses) showed VES 46% (95% CI, 28 to 58) against transmission at least 7 days after 2nd dose (VOC Delta)	Serious	Retrospective cohort study in Norway; 979 primary cases and 1,888 household contacts; sample sequenced for VOC Omicron and VOC Delta
162	Chemaitelly (4)	BNT162b2 (3 doses) showed VE 56.6% (95% CI, 50.8 to 61.7) against symptomatic infection at 28 to 35 days; VE 43.7% (95% CI, 32.9 to 52.7) against symptomatic infection 70 to 77 days after 3rd dose BNT162b2 (3 doses) showed VE 90.6% (95% CI, 77.8 to 96) against severe, critical, or fatal disease at 7 to 42 days; VE 90.8% (95% CI, 81.5 to 95.5) against severe, critical, or fatal disease at 49 days+ after 3rd dose mRNA-1273 (3 doses) showed VE 54.6% (95% CI, 41.1 to 65.0) against symptomatic infection at 28 to 35 days; VE 38.6% (95% CI, 19.4 to 53.1) against symptomatic	Serious	Test negative study in Qatar; 2,193,013 participants; proxy for VOC Omicron (results over varying time periods since vaccination reported)

		infection at least 42 days after 3rd dose mRNA-1273 (3 doses) showed VE 80.8% (95% CI, -51.9 to 97.6) against severe, critical, or fatal disease at 7 to 42 days after 3rd dose BNT162b2 (2 doses) showed VE 61.9% (95% CI, 49.9 to 71.1) against symptomatic infection at 30 days; VE 45.9% (95% CI, 33.8 to 55.8) against symptomatic infection at 60 days; VE 36.3% (95% CI, 25.1 to 45.8) against symptomatic infection at 90 days after 2nd dose mRNA-1273 (2 doses) showed VE 44.8% (95% CI, 16.0 to 63.8) against symptomatic infection at 28 to 35 days after 2nd dose		
163	Fabiani (2)	BNT162b2 showed VE 82% (95% CI, 80.5 to 83.5) against infection at 21 to 30 days after 2nd dose; VE 67.3% (95% CI, 65.2 to 69.3) against infection at 44 to 98 days after 2nd dose compared to non-immune period after 1st dose BNT162b2 showed VE 96.3% (95% CI, 95 to 97.3) against severe disease at 21 to 30 days after 2nd dose; VE 91.1% (95% CI, 90 to 92) against severe disease at 44 to 98 days after 2nd dose compared to non-immune period after 1st dose	Serious	Retrospective cohort study in Italy; 33,250,344 partially vaccinated participants; time and setting for VOC Delta (results over varying time periods since vaccination reported)
164	Sritipsukho	CoronaVac (2 doses) + BNT162b2 showed VE 98% (95% CI, 87 to 100) against infection at least 7 days after 3rd dose CoronaVac (2 doses) + ChAdOx1 showed VE 86% (95% CI, 74 to 93) against infection at least 7 days after 3rd dose ChAdOx1 (2 doses) showed VE 83% (95% CI, 70 to 90) against infection at least 7 days after 2nd dose CoronaVac (1 dose) + ChAdOx1 showed VE 74% (95% CI, 43 to 88) against infection at least 7 days after 2nd dose CoronaVac (2 doses) showed VE 60% (95% CI, 49 to 69) against infection at least 7 days after 2nd dose	Serious	Test-negative study in Thailand; 3,353 participants; time and setting for VOC Delta (includes heterologous vaccines)

165	Cerqueira-Silva(2)	CoronaVac (2 doses) + BNT162b2 showed VE 92.7% (95% CI, 91 to 94) against infection at 14 to 30 days after 3rd dose CoronaVac (2 doses) + BNT162b2 showed VE 97.3% (95% CI, 96.1 to 98.1) against severe disease (hospitalization or death) at 14 to 30 days after 3rd dose	Serious	Test-negative study in Brazil; 7,314,318 participants; time and setting for VOC Gamma and Delta (only booster data shown here because it is most likely to represent Delta) (results over varying time periods since vaccination reported) (includes heterologous vaccines)
166	Grima	BNT162b2 or mRNA-1273 or ChAdOx1 (3 doses) showed OR 0.60 (95% CI, 0.33 to 1.10) against transfer to ICU; OR 0.70 (95% CI, 0.27 to 1.80) against death unreported number of days after 3rd dose (VOC Omicron) BNT162b2 or mRNA-1273 or ChAdOx1 (3 doses) showed OR 0.38 (95% CI, 0.16 to 0.92) against transfer to ICU; OR 0.80 (95% CI, 0.35 to 1.81) against death unreported number of days after 3rd dose (VOC Delta)	Serious	Time-matched cohort in Canada; 20,064 participants hospitalized due to COVID; sequenced for variants (only VOC Omicron and VOC Delta reported here) (results not reported according to vaccine brand)
167	Monge(2)	BNT162b2 (2 doses) followed by an mRNA vaccine showed VE 49.7% (95% CI, 48.3 to 51.1) against infection at least 7 days after 3rd dose mRNA-1273 (2 doses) followed by an mRNA vaccine showed VE 55.3% (95% CI, 52.3 to 58.2) against infection at least 7 days after 3rd dose ChAdOx1 (2 doses) followed by an mRNA vaccine showed VE 58.6% (95% CI, 55.5 to 61.6) against infection at least 7 days after 3rd dose Ad26.COV2.S followed by an mRNA vaccine showed VE 48.0% (95% CI, 42.5 to 53.7) against infection at least 7 days after 3rd dose	Serious	Retrospective cohort study in Spain; 6,222,318 fully vaccinated participants >40 years; time and setting for VOC Omicron (results over varying time periods since vaccination reported) (includes heterologous vaccines)
168	Patalon (2)	BNT162b2 (3 doses) showed VE 35.7% (95% CI, 29.8 to 41.2) against infection up to 90 days after 3rd dose (Nov 2021 compared to Aug 2021)	Moderate	Test-negative study in Israel; 109,633 fully vaccinated participants; time and setting for VOC Omicron

169	Smid	BNT162b2 (3 doses) showed VE 58% (95% CI, 57 to 58) against infection up to 60 days after 3rd dose (VOC Omicron) BNT162b2 (2 doses) showed VE 49% (95% CI, 48 to 50) against infection up to 60 days after 2nd dose (VOC Omicron) mRNA-1273 (3 doses) showed VE 61% (95% CI, 60 to 62) against infection up to 60 days after 3rd dose (VOC Omicron) mRNA-1273 (2 doses) showed VE 48% (95% CI, 44 to 52) against infection up to 60 days after 2nd dose (VOC Omicron) ChAdOx1 (2 doses) showed VE 51% (95% CI, 23 to 69) against infection up to 120 days after 2nd dose (VOC Omicron) Ad26.COV2.S (1 dose) showed VE 47% (95% CI, 45 to 49) against infection up to 60 days after 2nd dose (VOC Omicron) BNT162b2 (3 doses) showed VE 90% (95% CI, 89 to 90) against infection up to 60 days after 3rd dose (VOC Delta) BNT162b2 (2 doses) showed VE 82% (95% CI, 80 to 83) against infection up to 60 days after 2nd dose (VOC Delta) mRNA-1273 (3 doses) showed VE 92% (95% CI, 91 to 93) against infection up to 60 days after 3rd dose (VOC Delta) mRNA-1273 (2 doses) showed VE 71% (95% CI, 64 to 76) against infection up to 60 days after 2nd dose (VOC Delta) ChAdOx1 (2 doses) showed VE 65% (95% CI, 57 to 71) against infection up to 120 days after 2nd dose (VOC Delta) Ad26.COV2.S (1 dose) showed VE 60% (95% CI, 57 to 62) against infection up to 60 days after 2nd dose (VOC Delta)	Serious	Retrospective cohort study in Czech Republic; 4,874,253 participants (for the outcomes reported here); sample sequenced for VOC Omicron and VOC Delta
170	Norddahl	BNT162b2 (3 doses) showed relative effectiveness 47% (95% CI, 36 to 56) against infection unknown number of days after 3rd dose relative to 2 doses of BNT162b2 (VOC Omicron)	Serious	Retrospective population cohort study in Iceland; 278,026 at least partly vaccinated participants; sequenced for VOC

		BNT162b2 (2 doses) followed by mRNA-1273 showed relative VE 50% (95% CI, 34 to 62) against infection unknown number of days after 3rd dose relative to 2 doses of BNT162b2 (VOC Omicron) mRNA-1273 (3 doses) showed relative VE 9% (95% CI, -21 to 32) against infection unknown number of days after 3rd dose relative to 2 doses of BNT162b2 (VOC Omicron) mRNA-1273 (2 doses) followed BNT162b2 showed relative VE 27% (95% CI, 9 to 61) against infection unknown number of days after 3rd dose relative to 2 doses of BNT162b2 (VOC Omicron) ChAdOx1 (2 doses) followed by BNT162b2 showed relative VE 30% (95% CI, 14 to 43) against infection unknown number of days after 3rd dose relative to 2 doses of BNT162b2 (VOC Omicron) ChAdOx1 (2 doses) followed by mRNA-1273 showed relative VE 7% (95% CI, -16 to 25) against infection unknown number of days after 3rd dose relative to 2 doses of BNT162b2 (VOC Omicron) Ad26.COV2 followed by BNT162b2 showed relative VE 5% (95% CI, -7 to 15) against infection unknown number of days after 2nd dose relative to 2 doses of BNT162b2 (VOC Omicron) Ad26.COV2 followed by mRNA-1273 showed relative VE -70% (95% CI, -50 to -80) against infection unknown number of days after 2nd dose relative to 2 doses of BNT162b2 (VOC Omicron)		Omicron and VOC Delta (only Omicron data shown here) (includes heterologous vaccines)
171	Rane	BNT162b2 (2 doses) showed VE 76% (95% CI, 74 to 78) against symptomatic infection unknown number of days after 2nd dose mRNA-1273 (2 doses) showed VE 83% (95% CI, 81 to 84) against symptomatic infection unknown number of days after 2nd dose Ad26.COV2.S showed VE 29% (95% CI, 26 to 32) against symptomatic infection	Serious	Test-negative study in New York; 1,058,493 participants; time and setting for VOC Alpha to VOC Delta (results for VOC Delta shown here)

		unknown number of days after dose		
172	Wu	BBIBP-CorV showed VES 39.4% (-20.4 to 69.5) against symptomatic infection from 14 to 90 days after 2nd dose CoronaVac showed VES 45.5% (-6 to 72) against symptomatic infection from 14 to 90 days after 2nd dose	Serious	Outbreak cohort in China; 1,462 close-contacts of index case; sequenced for VOC Delta (results over varying time periods since vaccination reported)
173	Gazit (3)	BNT162b2 (single dose) after previously infected showed VE 82% (95% CI, 80 to 85) against re-infection compared to previously infected and unvaccinated	Serious	Series of retrospective multiple nested emulated target trials in Israel; 107,413 previously infected participants; time and setting from VOC Alpha to VOC Delta (unable to separate results reported but <1% Alpha so predominantly Delta)
174	Korves	BNT162b2 or mRNA-1273 (3 doses) showed relative VE 56% (95% CI, 39 to 67) against infection at 14 to 16 days after 3rd dose compared to 2 doses of an mRNA vaccine (VOC Omicron) BNT162b2 or mRNA-1273 (3 doses) showed relative VE 70% (95% CI, 42 to 84) against infection at 14 to 16 days after 3rd dose compared to 2 doses of an mRNA vaccine (VOC Delta)	Moderate	Self-controlled risk interval analysis in USA; 259 fully vaccinated participants; time and setting for VOC Omicron and VOC Delta
175	Chemaitelly (5)	BNT162b2 (3 doses) showed VE 49.5% (95% CI, 44.3 to 54.1) against symptomatic infection up to 30 days after 3rd dose; VE 90.9% (95% CI, 78.6 to 96.1) against severe, critical or fatal disease 7 to 42 days after 3rd dose (VOC Omicron – any subtype) BNT162b2 (3 doses) showed VE 59.9% (95% CI, 51.2 to 67.0) against symptomatic infection up to 30 days after 3rd dose (VOC Omicron BA.1) BNT162b2 (3 doses) showed VE 43.7% (95% CI, 36.5 to 50.0) against symptomatic infection up to 30 days after 3rd dose (VOC Omicron BA.2) BNT162b2 (2 doses) showed VE 47.8% (95% CI, 40.8 to 53.9) against symptomatic infection up to 30 to 90 days after 2nd dose (VOC Omicron – any subtype)	Serious	Test-negative study in Qatar; 134,619 participants; sample sequenced for VOC Omicron (overlaps with population in ref #162) (results over varying time periods since vaccination reported)

		BNT162b2 (2 doses) showed VE 46.6% (95% CI, 33.4 to 57.2) against symptomatic infection up to 30 to 90 days after 2nd dose (VOC Omicron BA.1) BNT162b2 (2 doses) showed VE 51.7% (95% CI, 43.2 to 58.9) against symptomatic infection up to 30 to 90 days after 2nd dose (VOC Omicron BA.2) mRNA-1273 (3 doses) showed VE 43.6% (95% CI, 33.2 to 52.4) against symptomatic infection up to 30 days after 3rd dose; VE 81.8% (95% CI, -49.5 to 97.8) against severe, critical or fatal disease 7 to 42 days after 3rd dose (VOC Omicron – any subtype) mRNA-1273 (3 doses) showed VE 51.5% (95% CI, 32.3 to 65.2) against symptomatic infection up to 30 days after 3rd dose (VOC Omicron BA.1) mRNA-1273 (3 doses) showed VE 39.4% (95% CI, 24.8 to 51.2) against symptomatic infection up to 30 days after 3rd dose (VOC Omicron BA.2) mRNA-1273 (2 doses) showed VE 43.2% (95% CI, 15.0 to 62.1) against symptomatic infection up to 30 to 90 days after 2nd dose (VOC Omicron – any subtype) mRNA-1273 (2 doses) showed VE 71.0% (95% CI, 24.0 to 89.0) against symptomatic infection up to 30 to 90 days after 2nd dose (VOC Omicron BA.1) mRNA-1273 (2 doses) showed VE 35.9% (95% CI, -5.9 to 61.2) against symptomatic infection up to 30 to 90 days after 2nd dose (VOC Omicron BA.2)		
176	Altarawneh	BNT162b2 (3 doses) plus prior infection showed VE 76.3% (95% CI, 71.7 to 80.1) against symptomatic infection median 42 days after 3rd dose (VOC Omicron – any subtype) BNT162b2 (3 doses) plus prior infection showed VE 74.4% (95% CI, 63.4 to 82.2) against symptomatic infection median 42 days after 3rd dose (VOC Omicron BA.1) BNT162b2 (3 doses) plus prior infection	Serious	Series of test-negative studies in Qatar; 49,071 (BNT162b2) and 25,598 (mRNA-1273) previously infected participants; sample sequenced for VOC Omicron (study population overlaps with population for ref# 175 so only hybrid data of

		showed VE 77.3% (95% CI, 72.4 to 81.4) against symptomatic infection median 43 days after 3rd dose (VOC Omicron BA.2) BNT162b2 (2 doses) plus prior infection showed VE 51.7% (95% CI, 43.5 to 58.7) against symptomatic infection median 268 days after 2nd dose (VOC Omicron BA.1) BNT162b2 (2 doses) plus prior infection showed VE 55.1% (95% CI, 50.9 to 58.9) against symptomatic infection median 268 days after 2nd dose (VOC Omicron BA.2) mRNA-1273 (3 doses) plus prior infection showed VE 79.4% (95% CI, 66.1 to 87.5) against symptomatic infection unknown median days after 3rd dose (VOC Omicron – any subtype) mRNA-1273 (3 doses) plus prior infection showed VE 77.2% (95% CI, 38.5 to 91.5) against symptomatic infection unknown median days after 3rd dose (VOC Omicron BA.1) mRNA-1273 (3 doses) plus prior infection showed VE 69.8% (95% CI, 50.1 to 81.7) against symptomatic infection unknown median days after 3rd dose (VOC Omicron BA.2) mRNA-1273 (2 doses) plus prior infection showed VE 44.3 (95% CI, 30.4 to 55.4) against symptomatic infection unknown median after 2nd dose (VOC Omicron BA.1) mRNA-1273 (2 doses) plus prior infection showed VE 47.9% (95% CI, 40.8 to 54.1) against symptomatic infection unknown median after 2nd dose (VOC Omicron BA.2)		vaccinated plus prior infection reported here)
177	Kirsebom	BNT162b2, mRNA-1273 or ChAdOx1 primary series followed by BNT162b2 or mRNA-1273 booster showed VE 70.2% (95% CI, 69.5 to 71.0) against symptomatic infection 14 to 30 days after 3rd dose; VE 66.2% (95% CI, 65.5 to 66.9) against symptomatic infection 35 to 63 days after 3rd dose (VOC Omicron BA.1) BNT162b2, mRNA-1273 or ChAdOx1 primary series followed by BNT162b2 or	Moderate	Test-negative study in UK; 626,148 participants; sequenced or proxy for VOC Omicron (results not reported separately by manufacturer; BNT162b2, mRNA-1273 or ChAdOx1 primary series followed by BNT162b2 or mRNA-1273 booster)

		mRNA-1273 booster showed VE 74.2% (95% CI, 72.4 to 75.8) against symptomatic infection 14 to 30 days after 3rd dose; VE 68.1% (95% CI, 66.7 to 69.5) against symptomatic infection 35 to 63 days after 3rd dose (VOC Omicron BA.2)		
178	Gazit (4)	BNT162b2 (4 doses) showed relative effectiveness 63% (95% CI, 60 to 65.8) against infection 21 to 27 days after 4th dose; relative VE 56% (95% CI, 53.4 to 58.5) against infection 35 to 41 days after 4th dose; relative VE 27.1% (95% CI, 4.2 to 44.5) against infection 63 to 69 days after 4th dose compared to 3 doses BNT162b2 (4 doses) showed relative VE 82.5% (95% CI, 70.5 to 89.6) against severe disease 7 to 27 days after 4th dose; relative VE 70.3% (95% CI, 37.4 to 85.9) against severe disease 28 to 48 days after 4th dose; relative VE 87.1% (95% CI, 0 to 98.4) against severe disease 49 to 69 days after 4th dose compared to 3 doses	Serious	Test-negative study in Israel; 97,499 fully vaccinated participants age 60+ (69,623 three doses; 27,876 four doses); time and setting for VOC Omicron
179	Rearte	ChAdOx1 showed VE 39.9% (95% CI 39 to 41) against infection up to 126 days after 1st dose; VE 68.5% (95% CI, 67 to 71) against infection up to 126 days after 2nd dose ChAdOx1 showed VE 71.8% (95% CI 71 to 73) against death up to 126 days after 1st dose; VE 80.1% (95% CI, 78 to 82) against death up to 126 days after 2nd dose rAd26-rAd5 showed VE 39.5% (95% CI 39 to 40) against infection up to 126 days after 1st dose; VE 64% (95% CI, 63 to 65) against infection up to 126 days after 2nd dose rAd26-rAd5 showed VE 68.8% (95% CI 68 to 70) against death up to 126 days after 1st dose; VE 80.7% (95% CI, 79 to 82) against death up to 126 days after 2nd dose BBIBP-CorV showed VE 22.6% (95% CI 20 to 25) against infection up to 126 days after 1st dose; VE 43.6% (95% CI, 42 to 45) against infection up to 126 days after 2nd dose BBIBP-CorV showed VE 61.8% (95% CI 59 to 64) against death up to 126 days after 1st dose; VE 73.4% (95% CI, 71 to 75) against death up to 126 days after 2nd dose	Serious	Test-negative study in Argentina; 1,282,928 participants age 60+; time and setting for VOC Gamma (predominantly)

180	Butt (4)	BNT162b2 (3 doses) showed relative effectiveness 84% (95% CI, 78 to 88) against symptomatic infection up to 40 days after 3rd dose compared to 2 doses mRNA-1273 (3 doses) showed relative VE 87% (95% CI, 83 to 90) against symptomatic infection up to 40 days after 3rd dose compared to 2 doses	Serious	Retrospective cohort in US; 791,372 fully vaccinated participants; time and setting for VOC Delta
181	Castillo (2)	BNT162b2 (majority) showed VE 78.6% (95% CI, 77.4 to 79.9) against symptomatic infection 15 to 30 days after 2nd dose; VE 74% (95% CI, 73.1 to 74.8) against symptomatic infection 30 to 60 days after 2nd dose; VE 68.6% (95% CI, 67.6 to 69.5) against symptomatic infection 60 to 90 days after 2nd dose (VOC Delta) BNT162b2 (majority) showed VE 84.2% (95% CI, 78.2 to 90.3) against symptomatic infection 15 to 30 days after 2nd dose; VE 68% (95% CI, 59.1 to 76.9) against symptomatic infection 30 to 60 days after 2nd dose; VE 61.2% (95% CI, 45.7 to 76.8) against symptomatic infection 60 to 90 days after 2nd dose (VOC Beta/Gamma)	Serious	Test-negative study in France; 1,296,351 participants age 50+; sequenced for VOC Alpha, Beta/Gamma and Delta (only Beta/Gamma and Delta results reported here) (mixture of vaccine brands used but >75% BNT162b2 so reported under this brand only in this synopsis) (results over varying time periods since vaccination reported)
182	McMenamin	BNT162b2 (3 doses) showed VE 71.6% (95% CI, 43.5 to 85.7) against mild/moderate infection; VE 99.2% (95% CI, 96.7 to 99.8) against severe or fatal disease; VE 98.9% (95% CI, 95.3 to 99.7) against death median 35 days after 3rd dose CoronaVac (3 doses) showed VE 50.7% (95% CI, 12.9 to 72.1) against mild/moderate infection; VE 98.5% (95% CI, 95.3 to 99.6) against severe or fatal disease; VE 98.7% (95% CI, 94.4 to 99.7) median 35 days after 3rd dose	Serious	Ecological study in Hong Kong; 14,861 cases; sample sequenced for VOC Omicron BA.2
183	Arbel (2)	BNT162b2 (4 doses) showed relative effectiveness 78% (95% CI, 72 to 83) against death 7 to 40 days after 4th dose compared to 3 doses	Moderate	Retrospective cohort study in Israel; 563,465 fully vaccinated plus boosted participants ages 60 to 100; time and setting for VOC Omicron
184	Wang (2)	BNT162b2 or mRNA-1273 (3 doses) showed VE 65% (95% CI, 63 to 66) against infection; VE 85% (95% CI, 60 to 94) against death 14-179 days after 3rd dose (VOC Omicron)	Serious	Test-negative study in US; 249,070 participants; time and setting for VOC Delta and VOC Omicron

		BNT162b2 or mRNA-1273 (2 doses) showed VE 26% (95% CI, 22 to 30) against infection; VE 60% (95% CI, 49 to 68) against death 14-179 days (VOC Omicron) BNT162b2 or mRNA-1273 (3 doses) showed VE 91% (95% CI, 90 to 92) against infection; VE 76% (95% CI, 46 to 89) against death 14-179 days after 3rd dose (VOC Delta) BNT162b2 or mRNA-1273 (2 doses) showed VE 70% (95% CI, 68 to 72) against infection; VE 58% (95% CI, 49 to 66) against death 14-179 days vaccination (VOC Delta)		
185	Horne	BNT162b2 (2 doses) showed VE 73% (95% CI, 69 to 77) against infection 3-6 weeks following the second dose ChAdOx1 (2 doses) showed VE 21% (95% CI, 18 to 24) against infection 3-6 weeks following the second dose	Moderate	Retrospective cohort study in the UK; 7,168,969 participants aged 40-64 years; time and setting for VOC Delta
186	Starrfelt (3)	BNT162b2 (3 doses) showed VE 75.3% (95% CI, 72.5 to 77.8) against infection at >1 week compared to no vaccination BNT162b2 (2 doses) showed VE 77.7% (95% CI, 76.8 to 78.5) against infection at 2-9 weeks compared to no vaccination mRNA-1273 (3 doses) showed VE 84.9% (95% CI, 71.8 to 91.9) against infection at >1 week compared to no vaccination mRNA-1273 (2 doses) showed VE 86.6% (95% CI, 85.6 to 87.6) against infection at 2-9 weeks compared to no vaccination mRNA-1273 (2 doses), followed by BNT162b2 booster showed VE 87.1% (95% CI, 80.1 to 91.6) against infection at >1 week compared to no vaccination BNT162b2 (2 doses), followed by mRNA-1273 booster showed VE 68.2% (95% CI, 57.6 to 76.1) against infection at >1 week compared to no vaccination	Serious	Retrospective cohort study in Norway; 4,301,995 participants, time and setting for VOC Delta

187	Hansen (2)	BNT162b2 (2 doses) showed VE 37.0% (95% CI, 35.6 to 38.3) against infection at 14-30 days following the second dose compared to no vaccination BNT162b2 (3 doses) showed VE 47.9% (95% CI, 47.4 to 48.3) against infection at 14-30 days following the third dose compared to no vaccination mRNA-1273 (2 doses) showed VE 37.9% (95% CI, 34.4 to 41.2) against infection at 14-30 days following the second dose compared to no vaccination mRNA-1273 (3 doses) showed VE 47.7% (95% CI, 47.0 to 48.3) against infection at 14-30 days following the third dose compared to no vaccination	Serious	Retrospective cohort study in Denmark; 3,090,833 participants, time and setting for VOC Omicron
188	Tenforde (4)	BNT162b2 or mRNA-1273 (3 doses) showed VE 95% (95% CI, 91 to 97) against infection >14 days after 3rd dose compared to no vaccination (VOC Delta) BNT162b2 or mRNA-1273 (3 doses) showed VE 94% (95% CI, 88 to 97) against infection >14 days after 3rd dose compared to no vaccination (VOC Omicron)	Serious	Case-control study in US; 7544 participants; time and setting for VOC Delta and VOC Omicron
189	Ranzani (4)	CoronaVac (3 doses) showed VE 15.0% (95% CI, 12.0 to 18.0) against symptomatic infection; VE 71.3% (95% CI, 60.3 to 79.2) against severe disease at 8-59 days after booster dose compared to no vaccination CoronaVac (2 doses), followed by BNT162b2 booster showed VE 56.8% (95% CI, 56.3 to 57.4) against symptomatic infection; VE 85.5% (95% CI, 83.3 to 87.0) against severe disease at 8-59 days after booster dose compared to no vaccination	Serious	Test-negative study in Brazil; 2,679,972 participants; time and setting for VOC Omicron
190	Magen	BNT162b2 (4 doses) showed relative effectiveness 45% (95% CI, 44 to 47) against confirmed infection 7-30 days after 4th dose; relative VE 55% (95% CI, 53 to 58) against symptomatic infection 7 to 30 days after 4th dose; relative VE 62% (95% CI, 50 to 74) against severe infection 7-30 days after 4th dose; relative VE 74% (95% CI, 50 to 90) against death 7-30 days after 4th dose compared with 3 doses.	Serious	Data-linkage study in Israel; 182,122 matched pairs of fully vaccinated and boosted participants; time and setting for VOC Omicron

		BNT162b2 (4 doses) showed relative effectiveness 52% (95% CI, 49 to 54) against confirmed infection 14-30 days after 4th dose; relative VE 61% (95% CI, 58 to 64) against symptomatic infection 14-30 days after 4th dose; relative VE 64% (95% CI, 48 to 77) against severe infection 14-30 days after 4th dose; relative VE 76% (95% CI, 48 to 91) against death 14-30 days after 4th dose compared with 3 doses.		
191	Cerqueira-Silva (3)	BNT162b2 (3 doses) showed VE 70% (95% CI, 68.4 to 71.6) against symptomatic infection 2-9 weeks after 3rd dose; VE 95.7% (95% CI, 90.6 to 98) against severe disease 2-9 weeks after 3rd dose in individuals with hybrid immunity (prior infection) compared to no vaccination and no prior infection BNT162b2 (2 doses) showed VE 66.5% (95% CI, 65.5 to 67.5) against symptomatic infection 2-9 weeks after 2nd dose; VE 90.9% (95% CI, 84 to 94.8) against severe disease 2-9 weeks after 2nd dose in individuals with hybrid immunity (prior infection) compared to no vaccination and no prior infection ChAdOx-1 (3 doses) showed VE 72.9% (95% CI, 72.2 to 73.5) against symptomatic infection 2-9 weeks after 3rd dose; VE 97.5% (95% CI, 96.6 to 98.1) against severe disease 2-9 weeks after 3rd dose in individuals with hybrid immunity (prior infection) compared to no vaccination and no prior infection ChAdOx-1 (2 doses) showed VE 49% (95% CI, 46.6 to 51.3) against symptomatic infection 2-9 weeks after 2nd dose; VE 90.2% (95% CI, 77.4 to 95.8) against severe disease 2-9 weeks after 2nd dose in individuals with hybrid immunity (prior infection) compared to no vaccination and no prior infection Ad26.COV2.S (2 doses) showed VE 47.2% (95% CI, 45.2 to 49.2) against symptomatic infection 2-9 weeks after 2nd dose; VE 97.5% (95% CI, 91.3 to 99.3) against severe disease 2-9 weeks after 2nd dose in individuals with hybrid immunity (prior infection) compared to no vaccination and no prior infection	Serious	Test-negative study in Brazil; 918,219 tests; time and setting for VOC Omicron (updated on June 22, 2022 to matched study design which includes municipality of residence)

		CoronaVac (3 doses) showed VE 74% (95% CI, 73.1 to 74.8) against symptomatic infection 2-9 weeks after 3rd dose; VE 95.9% (95% CI, 94.1 to 97.1) against severe disease 2-9 weeks after 3rd dose in individuals with hybrid immunity (prior infection) compared to no vaccination and no prior infection CoronaVac (2 doses) showed VE 49.3% (95% CI, 46.5 to 52) against symptomatic infection 2-9 weeks after 2nd dose; VE 78.4% (95% CI, 48.2 to 91) against severe disease 2-9 weeks after 2nd dose in individuals with hybrid immunity (prior infection) compared to no vaccination and no prior infection		
192	Dale	BNT162b2 or mRNA-1273 (2 doses) showed VE 63% (95% CI, -9 to 88) against infection >14 days after 2nd dose; VE 80% (95% CI, 15 to 95) against symptomatic infection >14 days after 2nd dose; VE 88% (95% CI, -10 to 99) against death >14 days after 2nd dose compared to no vaccination	Serious	Outbreak in a single short-term rehabilitation unit in the USA; 161 residents (analysis excluding immunocompromised residents); time and setting (partial sequencing) for VOC Delta
193	Kim (2)	BNT162b2 or mRNA-1273 (3 doses) showed VE 62% (95% CI, 48 to 72) against symptomatic infection >7 days after 3rd dose compared to no vaccination (VOC Omicron) BNT162b2 or mRNA-1273 (2 doses) showed VE 45% (95% CI, 14 to 66) against symptomatic infection 14-149 days after 2nd dose compared to no vaccination (VOC Omicron) BNT162b2 or mRNA-1273 (3 doses) showed VE 96% (95% CI, 93 to 98) against symptomatic infection >7 days after 3rd dose compared to no vaccination (VOC Delta) BNT162b2 or mRNA-1273 (2 doses) showed VE 89% (95% CI, 78 to 94) against symptomatic infection 14-149 days after 2nd dose compared to no vaccination (VOC Delta)	Serious	Test-negative study in the US; 3847 participants; time and setting for VOC Delta and VOC Omicron
194	Nasreen (2)	BNT162b2 or mRNA-1273 (2 doses) showed VE 99% (95% CI, 97 to 99) against severe disease at least 7 days after 2nd dose compared to no vaccination	Serious	Test-negative study in Canada; 2,508,296 participants; sequenced for VOC Delta

195	Petrie	BNT162b2 (majority) or mRNA-1273 (3 doses) showed relative effectiveness 70% (95% CI, 51 to 81) against symptomatic infection* median 33 days after 3rd dose relative to 2 doses of BNT162b2 or mRNA-1273	Serious	Prospective cohort in USA; 884 fully vaccinated participants; time and setting for VOC Omicron *from sensitivity analysis that excluded prior infection
196	Gram (2)	BNT162b2 or mRNA-1273 (3 doses) showed VE 57.6% (95% CI, 55.8 to 59.4) against infection 14 to 30 days; VE 55.3% (95% CI, 53.6 to 56.9) against infection 31 to 60 days; VE 58.3% (95% CI, 56.5 to 60.0) against infection 61 to 90 days after the 3rd dose (VOC Omicron age 60+) BNT162b2 or mRNA-1273 (2 doses) showed VE 39.9% (95% CI, 26.4 to 50.9) against infection 14 to 30 days; VE 39.2% (27.8 to 48.8) against infection 31 to 60 days; VE 26.4% (95% CI, 10.4 to 39.6) against infection 61 to 90 days after 2nd dose (VOC Omicron age 60+)	Serious	Population cohort study in Denmark (age 12+); 530,635 participants over age 60; sample sequenced for VOC Omicron
197	Bjork (2)	BNT162b2 (majority) (3 doses) showed VE 94% (95% CI, 76 to 98) against severe disease unknown number of days^ after 3rd dose (VOC Omicron BA.1 age 65+) BNT162b2 (majority) (2 doses) showed VE 84% (95% CI, 37 to 96) against severe disease unknown number of days after 2nd dose (VOC Omicron BA.1 age 65+) BNT162b2 (majority) (3 doses*) showed VE 82% (95% CI, 56 to 93) against severe disease unknown number of days after 3rd dose (VOC Omicron BA.2 age 65+) BNT162b2 (majority) (2 doses) showed VE 43% (95% CI, 0 to 79) against severe disease unknown number of days after 3rd dose (VOC Omicron BA.2 age 65+)	Serious	Continuous density case-control study in Sweden; 1,419 BA.1 and 3,388 BA.2 participants; sequenced for VOC Omicron (by subtype); transition period not reported here *9 BA.2 participants had 4 doses ^majority less than 3 months but a smaller proportion >6 months
198	Carazo (2)	BNT162b2 or mRNA-1273 (3 doses) + non-Omicron infection showed VE 83% (95% CI, 81 to 84) against reinfection up to 60 days after 3rd dose BNT162b2 or mRNA-1273 (2 doses) + non-Omicron infection showed VE 82% (95% CI, 80 to 84) against reinfection up to 60 days after 3rd dose; VE 67% (95% CI, 65 to 68)	Serious	Test-negative study in Canada; 39,217 previously infected participants; sample sequenced for VOC Omicron

		against reinfection up to 150 days after 2nd dose BNT162b2 or mRNA-1273 (1 dose) + non-Omicron infection showed VE 81% (95% CI, 74 to 86) against reinfection up to 60 days after dose; VE 64% (95% CI, 60 to 67) against reinfection up to 150 days after dose		
199	Castillo (3)	BNT162b2 (majority) (3 doses) showed VE 67% (95% CI, 67 to 68) against symptomatic infection 15 to 30 days after 3rd dose; VE 59% (95% CI, 59 to 60) against symptomatic infection 30 to 60 days after 3rd dose; VE 58% (95% CI, 57 to 59) against symptomatic infection 60 to 90 days after 3rd dose BNT162b2 (majority) (3 doses) showed VE 82% (95% CI, 72 to 92) against death 15 to 30 days after 3rd dose; VE 85% (95% CI, 79 to 90) against death 30 to 60 days after 3rd dose; VE 86% (95% CI, 80 to 92) against death 60 to 90 days after 3rd dose BNT162b2 (majority) (2 doses) showed VE 32% (95% CI, 30 to 34) against symptomatic infection 30 to 60 days after 2nd dose; VE 27% (95% CI, 26 to 29) against symptomatic infection 60 to 90 days after 2nd dose; VE 26% (95% CI, 24 to 27) against symptomatic infection 90 to 120 days after 2nd dose BNT162b2 (majority) (2 doses) showed VE 62% (95% CI, 33 to 90) against death 30 to 60 days after 2nd dose; VE 88% (95% CI, 71 to 105) against death 60 to 90 days after 2nd dose; VE 57% (95% CI, 35 to 78) against death 90 to 120 days after 2nd dose	Serious	Test-negative study in France; 2,701,992 participants; sequenced for VOC Omicron
200	Cerqueira-Silva (4)	BNT162b2 (3 doses) showed VE 36.9% (95% CI, 36.2 to 37.6) against symptomatic disease 14 to 63 days after 3rd dose; VE 74.5% (95% CI, 71.4 to 77.2) against severe disease (hospitalization or death) 14 to 63 days after 3rd dose (Brazil) ChAdOx1 (2 doses) + BNT162b2 booster showed VE 15.9% (95% CI, 14.3 to 17.4) against symptomatic disease 14 to 63 days after 3rd dose; VE 66.7% (95% CI, 61 to 71.6) against severe disease (hospitalization or death) 14 to 63 days after 3rd dose (Brazil)	Serious	Test-negative study in Brazil and Scotland; 4,219,703 and 370,556 participants, respectively; time and setting for VOC Omicron

		BNT162b2 (2 doses) + mRNA booster showed VE 43.7% (95% CI, 37.3 to 49.5) against symptomatic disease 14 to 63 days after 3rd dose; VE 68.8% (95% CI, -87 to 94.8) against severe disease (hospitalization or death) 14 to 63 days after 3rd dose (Scotland) ChAdOx1 (2 doses) + mRNA booster showed VE 18.1% (95% CI, -6.7 to 37.2) against symptomatic disease 14 to 63 days after 3rd dose (Scotland)		
201	Kirsebom (2)	BNT162b2 (3 doses) showed VE 68.5% (95% CI, 65.7 to 71.2) against symptomatic infection 14 to 34 days after 3rd dose; 54.1% (95% CI, 50.5 to 57.5) against symptomatic infection 35 to 69 days after 3rd dose; VE 40.1% (95% CI, 35.2 to 44.5) against symptomatic infection 70 to 104 days after 3rd dose ChAdOx1 (3 doses) showed VE 51.6% (95% CI, 20.8 to 70.4) against symptomatic infection 14 to 34 days after 3rd dose; 44.5% (95% CI, 22.4 to 60.2) against symptomatic infection 35 to 69 days after 3rd dose; VE -27.2% (95% CI, -131.6 to 30.1) against symptomatic infection 70 to 104 days after 3rd dose	Serious	Test-negative study in England; 43,171 ChAOx1 boosted and 13,038,908 BNT162b2 boosted; sequencing or proxy for VOC Omicron (only 65+ reported here)
202	Suah (2)	BNT162b2 (3 doses) showed relative effectiveness 51.1% (95% CI, 50.3 to 51.9) against infection up to 90 days post 3rd dose compared to BNT162b2 (2 doses) ChAdOx1 (3 doses) showed relative VE 30.1% (95% CI, 28.4 to 31.8) against infection up to 90 days post 3rd dose compared to BNT162b2 (2 doses) CoronaVac (3 doses) showed relative VE 33.4% (95% CI, 31.9 to 34.9) against infection up to 90 days post 3rd dose compared to BNT162b2 (2 doses) ChAdOx1 (2 doses) + BNT162b2 showed relative VE 53.0% (95% CI, 51.6 to 54.3) against infection up to 90 days post 3rd dose compared to BNT162b2 (2 doses) CoronaVac (2 doses) + BNT162b2 showed relative VE 47.6% (95% CI, 46.9 to 48.3) against infection up to 90 days post 3rd dose compared to BNT162b2 (2 doses)	Serious	Test-negative study in Malaysia; 955,829 fully vaccinated participants; time and setting for VOC Omicron and VOC Delta (only VOC Omicron results reported here)

		CoronaVac (2 doses) + ChAdOx1 showed relative VE 49.0% (95% CI, 46.7 to 51.3) against infection up to 90 days post 3rd dose compared to BNT162b2 (2 doses)		
203	Amir	BNT162b2 (4 doses) showed rate ratio of 9.2 (95% CI, 7.9 to 10.7) against severe disease up to 60 days after 4th dose compared to BNT162b2 (2 doses) BNT162b2 (3 doses) showed rate ratio of 2.3 (95% CI, 1.6 to 3.4) against severe disease up to 30 days after 3rd dose; rate ratio of 2.9 (95% CI, 1.8 to 4.7) against severe disease 30 to 60 days after 3rd dose; rate ratio 3.1 (95% CI, 2.2 to 4.6) against severe disease 60 to 90 days after 3rd dose compared to BNT162b2 (2 doses)	Serious	Retrospective cohort in Israel; 1,178,704 fully vaccinated participants; time and setting for VOC Omicron
204	Lind	BNT162b2 or mRNA-1273 (3 doses) showed VE 38.1% (95% CI, 18.6 to 52.9) against infection up to 14 days after 3rd dose in participants without prior infection; VE 36.3% (95% CI, -71.8 to 76.4) against infection up to 14 days after 3rd dose in previously infected participants BNT162b2 or mRNA-1273 (2 doses) showed VE 28.5% (95% CI, 20 to 36.2) against infection up to 149 days after 2nd dose in participants without prior infection; VE 36.1% (95% CI, 7.1 to 56.1) against infection up to 149 days after 2nd dose in previously infected participants BNT162b2 or mRNA-1273 (3 doses) showed relative effectiveness 54% (95% CI, 48 to 60) against infection 14 to 59 days after 3rd dose compared to 2 doses; relative effectiveness 47% (95% CI, 37 to 56) against infection 60 to 89 days after 3rd dose compared to 2 doses	Moderate	Test-negative study in USA; 130,073 participants; proxy for VOC Omicron BA.1
205	Rennert	BNT162b2 (3 doses) showed VE 42.8% (95% CI, 22.7 to 57.6) against infection median of 1.31 months after 3rd dose (students: 18 to 24); 74.3% (95% CI, 42.1 to 88.6) against infection median of 2.03 months after 3rd dose (employees: 18 to 64) BNT162b2 (2 doses) showed VE 2.1% (95% CI, -21.2 to 21.0) against infection median of 4.3 months after 2nd dose (students: 18 to 24); 30.1% (95% CI, -24.5 to 60.8) against	Serious	Propensity-matched retrospective cohort in USA; 1,944 students and 658 employees; time and setting for VOC Omicron

		infection median of 4.5 months after 2nd dose (employees: 18 to 64) mRNA-1273 (3 doses) showed VE 48.5% (95% CI, 25.0 to 64.7) against infection median of 1.31 months after 3rd dose (students: 18 to 24); 60.4% (95% CI, 32.4 to 76.8) against infection median of 2.03 months after 3rd dose (employees: 18 to 64) mRNA-1273 (2 doses) showed VE 17.3% (95% CI, -10.8 to 38.3) against infection median of 4.3 months after 2nd dose (students: 18 to 24); 14.4% (95% CI, -64.2 to 55.4) against infection median of 4.5 months after 2nd dose (employees: 18 to 64)		
206	Braeye (2)	ChAdOx1 (2 doses) or Ad26.COV2.S (1 dose) followed by BNT162b2 or mRNA-1273 showed VE 52% (95% CI, 52 to 53) against symptomatic infection up to 100 days after booster dose; VE 25% (95% CI, 24 to 27) against symptomatic infection at 100 to 150 days after booster dose ChAdOx1 (2 doses) or Ad26.COV2.S (1 dose) showed VE 37% (95% CI, 34 to 40) against symptomatic infection up to 50 days after last dose	Serious	Test-negative study from Belgium; 1,433,135 participants; time and setting for VOC Delta and VOC Omicron (only Omicron data shown here)
207	Butt (5)	BNT162b2 (3 doses) showed relative VE 11% (95% CI, 7 to 14) against infection up to 120 days after 3rd dose; relative VE 88% (95% CI, 68 to 96) against severe disease or death up to 120 days after 3rd dose relative to 2 doses of BNT162b2 mRNA-1273 (3 doses) showed relative VE 27% (95% CI, 24 to 30) against infection up to 120 days after 3rd dose; relative VE 72% (95% CI, 24 to 90) against severe disease or death up to 120 days after 3rd dose relative to 2 doses of mRNA-1273	Serious	Retrospective cohort study of veterans (median age 71) in the US; 925,900 fully vaccinated participants; time and setting for VOC Omicron
208	Accorsi	BNT162b2 (3 doses) showed VE 66.8% (95% CI, 66 to 67.6) against symptomatic infection 14 day to 30 days after 3rd dose; VE 59.6% (95% CI, 58.9 to 60.3) against symptomatic infection 60 to 120 days after 3rd dose mRNA-1273 (3 doses) showed VE 71.3% (95% CI, 70.4 to 72.1) against symptomatic infection 14 day to 30 days after 3rd dose; VE 66.8% (95% CI, 66.1 to 67.5) against	Serious	Test-negative study in US; 512,928 participants; time and setting for VOC Omicron (includes heterologous vaccines)

		symptomatic infection 60 to 120 days after 3rd dose Ad26.COV2.S (2 doses) showed VE 28% (95% CI, 18.3 to 36.5) against symptomatic infection 14 to 30 days after 2nd dose; VE 29.3% (95% CI, 23.2 to 34.9) against symptomatic infection 60 to 120 days after 2nd dose Ad26.COV2.S followed by BNT162b2 showed VE 58.9% (95% CI, 54.6 to 62.8) against symptomatic infection 14 to 30 days after 2nd dose; VE 51.5% (95% CI, 48.3 to 54.5) against symptomatic infection 60 to 120 days after 2nd dose Ad26.COV2.S followed by mRNA-1273 showed VE 63.7% (95% CI, 59.7 to 67.3) against symptomatic infection 14 to 30 days after 2nd dose; VE 56.7% (95% CI, 53.9 to 59.3) against symptomatic infection 60 to 120 days after 2nd dose Ad26.COV2.S showed VE 17.9% (95% CI, 4.3 to 29.5) against symptomatic infection 14 to 30 days after dose; VE 8.4% (95% CI, 1.5 to 14.8) against symptomatic infection 60 120 days after dose		
209	Nielsen	BNT162b2 (84%) (2 doses) showed VE 60% (95% CI, 58 to 62) against reinfection 14 to 43 days after 2nd dose; VE 43% (95% CI, 39 to 46) against reinfection 44 to 73 days after 2nd dose; VE 34% (95% CI, 32 to 37) against reinfection 104 to 133 days after 2nd dose compared to previously infected and unvaccinated	Serious	Population cohort study in Denmark; 245,530 previously infected participants; time and setting for VOC Omicron (results for VOC Alpha and VOC Delta not reported here)
210	Ioannou (2)	BNT162b2 (3 doses) showed relative VE 39% (95% CI, 36.4 to 41.6) against infection; relative VE 79.1% (95% CI, 71.2 to 84.9) against death mean of 80 days after 3rd dose relative to 2 doses of BNT162b2 mRNA-1273 (3 doses) showed relative VE 44.6% (95% CI, 42.5 to 46.6) against infection; relative VE 75.2% (95% CI, 62.9 to 83.5) against death mean of 80 days after 3rd dose relative to 2 doses of mRNA-1273 mRNA vaccine (3 doses) showed relative VE 36.4% (95% CI, 33.3 to 39.4) against infection; relative VE 78.1% (95% CI, 67.5 to	Moderate	Target emulation trial in US; 486,616 fully vaccinated predominantly male (>87%) participants; time and setting for VOC Omicron

		85.3) against death mean 80 days after 3rd dose when primary series completed 5 to 9 months ago relative to 2 doses of mRNA vaccine mRNA vaccine (3 doses) showed relative VE 46.5% (95% CI, 44.1 to 48.7) against infection; relative VE 81.6% (95% CI, 67.8 to 89.4) against death mean 80 days after 3rd dose when primary series completed >9 months ago relative to 2 doses of mRNA vaccine		
211	Liu (2)	BNT162b2 (3 doses) showed relative VE 49.4% (95% CI, 30.8 to 63.0) against severe disease (hospitalization or death) mean 49 days after 3rd dose relative to 2 doses of BNT162b2 (age 50-69) ChAdOx1 (2 doses) followed by BNT162b2 (85%) showed relative VE 52.9% (95% CI, 36.9 to 64.8) against severe disease (hospitalization or death) mean 49 days after 3rd dose relative to 2 doses of BNT162b2 (age 50-69)	Serious	Retrospective cohort study in Australia; 2,056,123 fully vaccinated participants over age 40; time and setting for VOC Omicron
212	Chariyalertsak	CoronaVac/Sinopharm/ChAdOx1 (2 doses) followed by BNT162b2 showed VE 31% (95% CI, 15 to 44) against infection median 53 days since 3rd dose (too many combinations to include in Tables) CoronaVac/Sinopharm/ChAdOx1 (2 doses) followed by mRNA-1273 showed VE 31% (95% CI, 13 to 45) against infection median 53 days since 3rd dose (too many combinations to include in Tables) CoronaVac/Sinopharm/ChAdOx1 (2 doses) followed by ChAdOx1 showed VE 26% (95% CI, 8 to 40) against infection median 53 days since 3rd dose (too many combinations to include in Tables)	Serious	Test-negative study in Thailand; 36,170 participants; time and setting for VOC Omicron (VOC Delta also reported but not captured in this LES)
213	Cerqueira-Silva(5)	CoronaVac (2 doses) followed by BNT162b2 showed VE 63.6% (95% CI, 62.8 to 64.3) against symptomatic infection 14 to 30 days after 3rd dose; VE 48.5% (95% CI, 47.8 to 49.3) against symptomatic infection 31 to 60 days after 3rd dose; VE 32.5% (95% CI, 31.7 to 33.3) against symptomatic infection 61 to 90 days after 3rd dose. CoronaVac (2 doses) followed by BNT162b2 showed VE 89.4% (95% CI, 87.8 to 90.7) against severe disease 14 to 30 days after 3rd dose; VE 89.6% (95% CI, 88.8 to 90.4)	Serious	Test-negative study in Brazil; 2,471,576 participants; time and setting for VOC Omicron

		against severe disease 31 to 60 days after 3rd dose; VE 89.3% (95% CI, 88.8 to 89.8) against severe disease 61 to 90 days after 3rd dose.		
214	Hansen(3)	BNT162b2 or mRNA-1273 (3 doses) plus prior omicron infection showed VE 93.6% (95% CI, 92.1 to 94.8); VE 46.9% (95% CI, 27 to 61.3) plus prior delta infection; VE 65.4% (95% CI, 49.8 to 76.2) plus prior alpha infection against infection by BA.5 unknown number of days after 3rd dose BNT162b2 or mRNA-1273 (3 doses) plus prior omicron infection showed VE 96.3% (95% CI, 95.8 to 96.7); VE 77.2% (95% CI, 72.2 to 81.3) plus prior delta infection; VE 74.5% (95% CI, 68.7 to 79.2) plus prior alpha infection against infection by BA.2 unknown number of days after 3rd dose	Serious	Test-negative study in Denmark; 169,178 previously infected participants; sample sequenced for VOC Omicron subvariants
215	Arashiro(2)	BNT162b2 or mRNA-1273 (3 doses) showed VE 74% (95% CI, 62 to 83) against symptomatic infection at least 14 days after 3rd dose BNT162b2 or mRNA-1273 (2 doses) showed VE 56% (95% CI, 37 to 70) against symptomatic infection 14 to 90 days after 2nd dose	Serious	Test-negative study in Japan; 5,795 participants; time and setting for VOC Delta and VOC Omicron (only Omicron data reported here)
216	Risk	BNT162b2 (3 doses) showed VE 35% (95% CI, 29 to 41) against infection mean of 90 days after 3rd dose. mRNA1273 (3 doses) showed VE 57% (95% CI, 51 to 62) against infection mean of 90 days after 3rd dose.	Serious	Retrospective cohort study in USA; 162,805 immunocompetent participants; time and setting for VOC Omicron (also reported findings in immunosuppressed participants)
217	Yan	BNT162b2 (3 doses) showed VE 90.5% (95% CI, 72.6 to 96.7) against severe disease mean of 66 days after 3rd dose; VE 98.1% (95% CI, 92.3 to 99.5) against death mean of 53 days after 3rd dose (age 51 to 64) CoronaVac (3 doses) showed VE 84.6% (95% CI, 62 to 93.7) against severe disease mean of 66 days after 3rd dose; VE 97% (95% CI, 90.3 to 99.1) against death mean of 53 days after 3rd dose (age 51 to 64) CoronaVac (2 doses) plus BNT162b2 showed VE 91.7% (95% CI, 37.5 to 98.9) against	Serious	Case-control study in Hong Kong; 98,461 participants; time and setting for VOC Omicron BA.2 (additional age groups also reported) (includes heterologous vaccines)

		severe disease mean of 66 days after 3rd dose. (age 51 to 64)		
218	Ng (2)	3rd dose of BNT162b2 showed relative effectiveness of 31.7% (95% CI, 30 to 33.4) against infection; relative effectiveness of 85.2% (95% CI, 80.2 to 88.9) against severe disease at 15 to 60 days after 3rd dose relative to mRNA vaccine (2 doses) 3rd dose of mRNA-1273 showed relative effectiveness of 41.3% (95% CI, 39.4 to 43.1) against infection; relative effectiveness of 97.5% (95% CI, 89.7 to 99.4) against severe disease at 15 to 60 days after 3rd dose relative to mRNA vaccine (2 doses) BNT162b2 (2 doses) followed by mRNA-1273 showed relative effectiveness of 34.9% (95% CI, 33 to 36.8) against infection; relative effectiveness of 87.3% (95% CI, 72.8 to 94.1) against severe disease at 15 to 60 days after 3rd dose relative to mRNA vaccine (2 doses) mRNA-1273 (2 doses) followed by BNT162b2 showed relative effectiveness of 35.6% (95% CI, 32.8 to 38.3) against infection at 15 to 60 days after 3rd dose relative to mRNA vaccine (2 doses)	Serious	Retrospective cohort study in Singapore; fully vaccinated 2,441,581 participants(age 30+); time and setting for VOC Omicron
219	Tsang	BNT162b2 (3 doses) showed VE 41.4% (95% CI, 23.2 to 55.2) against infection less than 90 days since 3rd dose BNT162b2 (2 doses) showed VE 27.6% (95% CI, -6.3 to 50.7) against infection less than 90 days since 2nd dose CoronaVac (3 doses) showed VE 32.4% (95% CI, 9 to 49.8) against infection less than 90 days since 3rd dose CoronaVac (2 doses) showed VE 22.7% (95% CI, -15.2 to 48.2) against infection less than 90 days since 2nd dose CoronaVac (2 doses) followed by BNT162b2 showed VE 31.3% (95% CI, -1.0 to 53.3) against infection less than 90 days after 3rd dose	Serious	Prospective cohort study in Hong Kong; 8,636 participants; time and setting for VOC Omicron BA.2

220	Gram (3)	mRNA vaccine (3 doses) showed VE 57.7% (95% CI, 55.9 to 59.5) against infection 14 to 30 days after 3rd dose; VE 54.4% (95% CI, 52.7 to 56) against infection 31 to 60 days after 3rd dose; VE 57.9% (95% CI, 56.1 to 59.6) against infection 61 to 90 days after 3rd dose (age 60+) mRNA vaccine (2 doses) showed VE 39.9% (95% CI, 26.3 to 50.9) against infection 14 to 30 days after 2nd dose; VE 39.0% (95% CI, 27.6 to 48.7) against infection 31 to 60 days after 2nd dose; VE 25.5% (95% CI, 9 to 38.6) against infection 61 to 90 days after 2nd dose; VE 24% (95% CI, 11.4 to 34.8) against infection 91 to 120 days after 2nd dose	Serious	Population cohort study in Denmark; 2,863,386 participants sequenced for VOC Omicron (VOC Alpha and Delta also reported)

Section 2: excluded studies	
Author	**Reason for exclusion**
Abu-Raddad (3)	Vaccine effectiveness not reported
Adams	Clinical outcomes of interest for this LES not reported
Agrawal	Results not reported for variants of interest for this LES (Only reported Delta variant)
Akhrass	Delayed exclusion – Clinical outcomes of interest for this LES not reported
Al Kaabi	Results not reported for variants of interest for this LES (Only reported non-Omicron variants)
Albahrani	Prevalence of variants unknown and suspected to be <50%
Alencar	Critical risk of bias
Alhamlan	Vaccine effectiveness not reported
Alharbi	Prevalence of variants unknown and suspected to be <50%
Ali	Prevalence of variants unknown and suspected to be <50%
Alkhafaji	Prevalence of variants unknown and suspected to be <50%
Allahgholipour	Results not reported for variants of interest for this LES (Only reported Delta variant)
Allen	Serious risk of bias
Allen(2)	Results not reported according to vaccine type/brand
Almadhi	Results not reported for variants of interest for this LES (Only reported Alpha variant)
Almufty	Prevalence of variants unknown and suspected to be <50%
Al-Qahtani	Delayed exclusion – critical risk of bias
Andeweg	Vaccine effectiveness not reported
Andeweg (2)	Results not reported according to vaccine type/brand
Andrejko (3)	Results not reported for variants of interest for this LES (Only reported Delta variant)
Apisarnthanarak	Vaccine effectiveness not reported
Arashiro	Vaccine effectiveness not reported
Araujo	Clinical outcomes of interest for this LES not reported
Auvigne	Clinical outcomes of interest for this LES not reported
Ayass	Clinical outcomes of interest for this LES not reported
Baden	Critical risk of bias
Bahremand	Clinical outcomes of interest for this LES not reported
Bailly	Delayed exclusion – critical risk of bias
Bajema	Clinical outcomes of interest for this LES not reported
Bajema (2)	Clinical outcomes of interest for this LES not reported
Bal	Vaccine effectiveness not reported
Barchuk	Clinical outcomes of interest for this LES not reported
Barchuk (2)	Clinical outcomes of interest for this LES not reported
Belayachi	Results not reported by variant
Bello-Chavolla	Results not reported according to VOC
Bergwerk	Vaccine effectiveness not reported
Bernal (2)	Delayed exclusion – critical risk of bias
Bhatnagar (published)	Results not reported for variants of interest for this LES (Only reported Delta variant)
Bhattacharya	Delayed exclusion – critical risk of bias

Bianchi	Delayed exclusion – critical risk of bias
Bjork	Prevalence of variants unknown and suspected to be <50%
Blaiszik	Clinical outcomes of interest for this LES not reported
Blaiszik	Clinical outcomes of interest for this LES not reported
Borobia	Clinical outcomes of interest for this LES not reported
Bosch	Clinical outcomes of interest for this LES not reported
Branda	Results not reported according to vaccine type/brand
Britton	Prevalence of variants unknown and suspected to be <50%
Britton (2)	Critical risk of bias
Brown	Vaccine effectiveness not reported
Brunelli	Prevalence of variants unknown and suspected to be <50%
Bruxvoort	Prevalence of variants unknown and suspected to be <50%
Butt	Critical risk of bias
Butt (2)	Delayed exclusion – critical risk of bias
Butt (3)	Prevalence of variants unknown and suspected to be <50%
Cabezas	Prevalence of variants unknown and suspected to be <50%
Caillard	Clinical outcomes of interest for this LES not reported
Cardona	Vaccine effectiveness not reported
Cavanaugh	Delayed exclusion – VOI not VOC
Chadeau-Hyams(2)	Results not reported according to vaccine type/brand
Chaguza	Vaccine effectiveness not reported
Charles Pon Ruban	Vaccine effectiveness not reported
Charmet	Serious risk of bias
Chau	Vaccine effectiveness not reported
Chemaitelly (6)	Results not reported according to time post 2nd dose or VOC
Christensen	Vaccine effectiveness not reported
Chung (2)	Results not reported according to vaccine type/brand
Clemens	Prevalence of variants unknown and suspected to be <50%
Cohen	Vaccine effectiveness not reported
Cohen(2)	Vaccine effectiveness not reported
Collie	Clinical outcomes of interest for this LES not reported
Corchado-Garcia	Prevalence of variants unknown and suspected to be <50%
Corrao	Results not reported according to vaccine type/brand
Cura-Bilbao	Results not reported for variants of interest for this LES (Only reported Alpha variant)
Dash	Critical risk of bias
Davies	Results not reported according to vaccine type/brand
Davies (2)	Vaccine effectiveness not reported
de Gier Brechje	Prevalence of variants unknown and suspected to be <50%
De Jesus	Clinical outcomes of interest for this LES not reported
De Lemos	Results not reported according to vaccine type/brand
Dickerman	Results reported comparison of two vaccines (no unvaccinated or early vaccinated groups)
Dolzhikova	Critical risk of bias

Domi	Prevalence of variants unknown and suspected to be <50%
Drawz	Critical risk of bias
Eick-Cost	Results not reported for variants of interest for this LES (Only reported Delta variant)
El Sahly	Prevalence of variants unknown and suspected to be <50%
Ella	Prevalence of variants unknown and suspected to be <50%
Elliot	Delayed exclusion – critical risk of bias
El-Sahly	Prevalence of variants unknown and suspected to be <50%
Emani	Results not reported according to vaccine type/brand
Epaulard	Clinical outcomes of interest for this LES not reported
Falsey	Prevalence of variants unknown and suspected to be <50%
Fang	Modelling study
Fano	Results not reported for variants of interest for this LES (Only reported Delta variant)
Farah	Clinical outcomes of interest for this LES not reported
Farinholt	Vaccine effectiveness not reported
Ferdinands	Clinical outcomes of interest for this LES not reported
Fisher	Prevalence of variants unknown and suspected to be <50%
Fisman (2)	Results not reported according to vaccine type/brand
Flacco	Results not reported according to vaccine type/brand
Frenck	Prevalence of variants unknown and suspected to be <50%
Furer	Delayed exclusion – critical risk of bias
Gardner	Modelling study
Geisen	Clinical outcomes of interest for this LES not reported
Gharpure	Vaccine effectiveness not reported
Ghosh	Delayed exclusion – critical risk of bias
Gils	Clinical outcomes of interest for this LES not reported
Goga	Vaccine effectiveness not reported
Gorgels	Prevalence of variants unknown and suspected to be <50%
Grannis	Clinical outcomes of interest for this LES not reported
Gray	Prevalence of variants unknown and suspected to be <50%
Gray (2)	Clinical outcomes of interest for this LES not reported
Griffin	Vaccine effectiveness not reported
Guijarro	Prevalence of variants unknown and suspected to be <50%
Gupta	Prevalence of variants unknown and suspected to be <50%
Gupta	Vaccine effectiveness not reported
Haas (2)	Modelling study
Hacisuleyman	Critical risk of bias
Hansen (4)	Results not reported according to vaccine type/brand
Hardt	Results not reported for variants of interest for this LES (Only reported Alpha variant)
Harris	Modelling study
Herlihy	Delayed exclusion – critical risk of bias
Hetemaki	Vaccine effectiveness not reported
Hippisley-Cox (2)	Results not reported according to vaccine type/brand
Hitchings (3)	Vaccine effectiveness not reported

Hitchings(2)	Delayed exclusion – critical risk of bias
Hollinghurst	Serious risk of bias
Hulme (2)	Reported vaccine effectiveness of one vaccine brand vs another without unvaccinated control
Hyams	Delayed exclusion - Clinical outcomes of interest for this LES not reported
Hyams (2)	Vaccine effectiveness not reported
Iliaki	Prevalence of variants unknown and suspected to be <50%
Iliaki	Prevalence of variants unknown and suspected to be <50%
Ioannou	Results not reported for variants of interest for this LES (Only reported Alpha variant)
Ismail	Delayed exclusion - Clinical outcomes of interest for this LES not reported
Jacobson	Critical risk of bias
Jassat	Results not reported according to vaccine type/brand
John	Prevalence of variants unknown and suspected to be <50%
Johnson	Results not reported according to vaccine type/brand
Jones	Critical risk of bias
Jucker	Results not reported according to vaccine type/brand
Kaabi	Prevalence of variants unknown and suspected to be <50%
Kahn	Results not reported according to vaccine type/brand
Kale	Delayed exclusion – critical risk of bias
Kaur	Delayed exclusion – critical risk of bias
Keegan	Critical risk of bias
Kemlin	Vaccine effectiveness not reported
Kemp	Modelling study
Kerr	Results not reported for variants of interest for this LES (Only reported Delta variant)
Khan	Prevalence of variants unknown and suspected to be <50%
Khawaja	Critical risk of bias
Kirsebom (3)	Clinical outcomes of interest for this LES not reported
Kislaya	Vaccine effectiveness not reported
Kislaya (2)	Results reported comparison of two variants
Kislaya (3)	Results not reported according to vaccine type/brand
Kissling (3)	Results not reported for variants of interest for this LES (Only reported Delta variant)
Kojima	Prevalence of variants unknown and suspected to be <50%
Kshirsagar	Vaccine effectiveness not reported
Kustin	Delayed exclusion - only included infected population
Lamprini	Clinical outcomes of interest for this LES not reported
Lan	Results not reported according to vaccine type/brand
Lauring	Clinical outcomes of interest for this LES not reported
Lee	Clinical outcomes of interest for this LES not reported
Lefèvre	Critical risk of bias
León	Results not reported according to vaccine type/brand
Leung	Clinical outcomes of interest for this LES not reported
Levin-Rector	Only included previously infected
Lewis	Clinical outcomes of interest for this LES not reported

Lewis (2)	Results not reported for variants of interest for this LES (Only reported Delta variant)
Lewnard	Clinical outcomes of interest for this LES not reported
Lewnard (2)	Results not reported according to vaccine type/brand
Li	Phase 1 trial
Li (2)	Clinical outcomes of interest for this LES not reported
Li (3)	Delayed exclusion – critical risk of bias
Li (4)	Critical risk of bias
Li (5)	Results not reported according to vaccine type/brand
Lin	Results not reported for variants of interest for this LES (Only reported Delta variant)
Lind (2)	Results not reported for variants of interest for this LES (Only reported Alpha and Delta variants)
Ling	Prevalence of variants unknown and suspected to be <50%
Link-Gelles	Clinical outcomes of interest for this LES not reported
Linsenmeyer	Vaccine effectiveness not reported
Lippi	Results not reported according to vaccine type/brand
Lippi (2)	Critical risk of bias
Liu	Vaccine effectiveness not reported
Loconsole	Vaccine effectiveness not reported
López-Muñoz	Results not reported according to vaccine type/brand
Luo	Vaccine effectiveness not reported
Lyngse (2)	Results not reported according to vaccine type/brand
Lytras	For Waning LES
Ma	Critical risk of bias
Maeda	Critical risk of bias
Mallow	Results not reported according to time frame: cannot separate Alpha from Delta
Marco	Delayed exclusion – critical risk of bias
Marquis	Vaccine effectiveness not reported
Martelucci	Results not reported according to vaccine type/brand (during the Omicron timeframe)
Mattar	Prevalence of variants unknown and suspected to be <50%
Mattiuzzi	Results not reported according to vaccine type/brand
Matveeva	Results not reported for variants of interest for this LES (Only reported Delta variant)
Maurya	Prevalence of variants unknown and suspected to be <50%
Mayr	Results not reported for variants of interest for this LES (Only reported Alpha and Delta variants)
Mazagatos	Critical risk of bias
Mazagatos (2)	Results not reported for variants of interest for this LES (Only reported Alpha and Delta variants)
McEvoy	Prevalence of variants unknown and suspected to be <50%
McKeigue(2)	Results not reported according to vaccine type/brand
Medic	Results not reported according to vaccine type/brand
Medic	Results not reported according to vaccine type/brand
Menni	Serious risk of bias
Mielke	Clinical outcomes of interest for this LES not reported
Mirahmadizadeh	Prevalence of variants unknown and suspected to be <50%

Mizrahi	Modelling study
Molani	Clinical outcomes of interest for this LES not reported
Monge	Prevalence of variants unknown and suspected to be <50%
Mor	Prevalence of variants unknown and suspected to be <50%
Moustsen-Helms	Prevalence of variants unknown and suspected to be <50%
Munitz	Clinical outcomes of interest for this LES not reported
Munro	Clinical outcomes of interest for this LES not reported
Murali	Results not reported for variants of interest for this LES (Only reported Delta variant)
Murison	Results not reported according to vaccine type/brand
Musser	Vaccine effectiveness not reported
Mutnal	Vaccine effectiveness not reported
Nabirova	Results not reported for variants of interest for this LES (Only reported Delta variant)
Nadig	Critical risk of bias
Nanduri	Critical risk of bias
Natarajan	Clinical outcomes of interest for this LES not reported
Nguyen	Results not reported according to vaccine type/brand
Nguyen (2)	Vaccine reported is not approved by health Canada (Nanocovax vaccine)
Niessen	Clinical outcomes of interest for this LES not reported
Nordstrom (3)	Results not reported according to VOC
Nordstrom (4)	Results not reported according to VOC
Nyberg	Clinical outcomes of interest for this LES not reported
Oduwole	Clinical outcomes of interest for this LES not reported
Ogawa	Vaccine effectiveness not reported
Olmedo	Clinical outcomes of interest for this LES not reported
Olson	Clinical outcomes of interest for this LES not reported
Open-SAFELY	Vaccine effectiveness not reported
Ostropolets	Not reported separately according to variant
Palacios	Prevalence of variants unknown and suspected to be <50%
Pardo-Seco	Results not reported for variants of interest for this LES (Only reported Alpha variant)
Paredes	Clinical outcomes of interest for this LES not reported
Paris	Prevalence of variants unknown and suspected to be <50%
Paternina-Caicedo	Results not reported for variants of interest for this LES (Only reported Mu variant of interest)
Pattni	Modelling study
Pawlowski	Critical risk of bias
Peralta-Santos	Clinical outcomes of interest for this LES not reported
Perrella	Vaccine effectiveness not reported
Perry	Clinical outcomes of interest for this LES not reported
Perry	Results not reported according to vaccine type/brand
Peter	Vaccine effectiveness not reported
Peter	Vaccine effectiveness not reported
Pilishvili	Prevalence of variants unknown and suspected to be <50%
Piltch-Loeb	Prevalence of variants unknown and suspected to be <50%

Plumb	Clinical outcomes of interest for this LES not reported
Plumb	Clinical outcomes of interest for this LES not reported
Polinski	Delayed exclusion – critical risk of bias
Poukka	Critical risk of bias
Pulliam	Modelling study
Raches Ella	Phase 1 trial
Rana	Critical risk of bias
Regev-Yochay	Prevalence of variants unknown and suspected to be <50%
Reynolds	Results not reported according to vaccine type/brand
Richardson	Results not reported for variants of interest for this LES (Only reported Delta variant)
Riemersma	Clinical outcomes of interest for this LES not reported
Riley	Critical risk of bias
Rivelli	Clinical outcomes of interest for this LES not reported
Robinson	Clinical outcomes of interest for this LES not reported
Rosero-Bixby	Clinical outcomes of interest for this LES not reported
Rovida	Critical risk of bias
Rudolph	Prevalence of variants unknown and suspected to be <50%
Salmeron Rios	Prevalence of variants unknown and suspected to be <50%
Sansone	Critical risk of bias
Satwik	Delayed exclusion – critical risk of bias
Scobie	Delayed exclusion – critical risk of bias
Self	Clinical outcomes of interest for this LES not reported
Sharma	Prevalence of variants unknown and suspected to be <50%
Sheikh (3)	Results not reported according to vaccine type/brand
Shimabukuro	Clinical outcomes of interest for this LES not reported
Shrotri	Delayed exclusion – critical risk of bias
Simon	Prevalence of variants unknown and suspected to be <50%
Şimşek-Yavuz	Clinical outcomes of interest for this LES not reported
Smoliga	Critical risk of bias
Starrfelt	Serious risk of bias
Stephenson	Results not reported for variants of interest for this LES (Only reported Alpha variant)
Stoliaroff-Pepin	Clinical outcomes of interest for this LES not reported
Stowe (2)	Clinical outcomes of interest for this LES not reported
Sun	Results not reported according to vaccine type/brand
Suri	Vaccine effectiveness not reported
Suryatma	Results not reported for variants of interest for this LES (Only reported Alpha variant)
Swift	Prevalence of variants unknown and suspected to be <50%
Tande	Prevalence of variants unknown and suspected to be <50%
Tang (2)	Results not reported for variants of interest for this LES (Only reported Delta variant)
Tanriover	Prevalence of variants unknown and suspected to be <50%
Taquet	Modelling study
Tartof (3)	Clinical outcomes of interest for this LES not reported
Tartof (4)	Clinical outcomes of interest for this LES not reported

Tenforde	Clinical outcomes of interest for this LES not reported
Tenforde (2)	Clinical outcomes of interest for this LES not reported
Tenforde (3)	Clinical outcomes of interest for this LES not reported
Thangaraj	Critical risk of bias
Thiruvengadam	Critical risk of bias
Thompson (1)	Prevalence of variants unknown and suspected to be <50%
Thompson (2)	Prevalence of variants unknown and suspected to be <50%
thompson (4)	Clinical outcomes of interest for this LES not reported
Tobolowsky	Clinical outcomes of interest for this LES not reported
Tonnaro	Results not reported for variants of interest for this LES (Only reported Alpha and Delta variants)
Tsundue	Results not reported for variants of interest for this LES (Only reported Delta variant)
Turtle	Vaccine effectiveness not reported
Ulloa	Vaccine effectiveness not reported
Uschner	Critical risk of bias
Vahidy	Prevalence of variants unknown and suspected to be <50%
Vasileiou	Clinical outcomes of interest for this LES not reported
Veerapu	Results not reported for variants of interest for this LES (Only reported Delta variant)
Veneti	Clinical outcomes of interest for this LES not reported
Victor	Critical risk of bias
Vo	Clinical outcomes of interest for this LES not reported
Voko	Results not reported for variants of interest for this LES (Only reported Delta variant)
Volkov	Modelling study
Voysey	Prevalence of variants unknown and suspected to be <50%
Waldhorn	Serious risk of bias
Wang	Clinical outcomes of interest for this LES not reported
Ward	Results not reported according to vaccine type/brand
Waxman	Clinical outcomes of interest for this LES not reported
Westerhof	Results not reported according to vaccine type/brand
Wickert	Critical risk of bias
Wijtvliet	Clinical outcomes of interest for this LES not reported
Williams (2)	Critical risk of bias
Wolff	Vaccine effectiveness not reported
Woolley	Results not reported according to vaccine type/brand
Wright	Results not reported according to vaccine type/brand
Xiang	Clinical outcomes of interest for this LES not reported
Young-Xu	Prevalence of variants unknown and suspected to be <50%
Young-Xu (4)	Critical risk of bias
Zacay	Delayed exclusion – critical risk of bias
Zeng	Modelling study
Zhang	Results not reported for variants of interest for this LES (Only reported Alpha variant)
Zheutlin	Results not reported for variants of interest for this LES (Only reported Alpha variant)
Zhong	Clinical outcomes of interest for this LES not reported

Appendix 2: Glossary

AZ: AstraZeneca

Alpha: variant of concern B.1.1.7

Beta: variant of concern B.1.351

Delta: variant of concern B.1.617.2

Gamma: variant of concern P.1

Epsilon: variant of concern B.1.427/B.1.429

HCW: Healthcare workers

LTC: Long-term care

LTCF: Long-term care facility

MOD: Moderna

Obs: observational study

Omicron: variant of concern B.1.1.529

OR: odds ratio

PF: Pfizer

RME: range of mean estimates across 2 or more studies

VE (Vaccine effectiveness): measure of how well a vaccine protects people from getting the outcome of interest in real-world practice (For example: VE of 92% against infection means that 92% of people will be protected from becoming infected with COVID and 8% of people will still be at risk of becoming infected with COVID)

VES: vaccine effectiveness against susceptibility (vaccinated contact)

VET: vaccine effectiveness against transmission (vaccinated index case)

VOC: variant of concern

VOI: variant of interest

Appendix 3: Data-extraction template

Vaccine product	
Source	First author of study
Link	DOI or Pubmed ID
Date published	in format YYYY/MM/DD or preprint
Country	
Funding	public or industry
Study details	
Study type	RCT/cohort/data-linkage/test-negative/case-control/other
Surveillance	routine screening Y or N
Population(s)	general public/LTC/Households/HCW/Other
Control group	not vaccinated, <7day vaccinated internal control, none, other
Total (N)	number of all study participants
Female	number or %
LTC	number or %
HCW	number or %
Households	number or %
>80	number or %
>70	number or %
>60	number or %
Outcomes	outcomes separated by VOC type
Outcomes	confirmed infection/asymptomatic/mild symptomatic/severe symptoms/hospitalized/ICU/death
1st Dose VE	VE with 95% CI
Days post 1st dose	days post 1st dose when VE provided
2nd Dose VE	VE with 95% CI
Days post 2nd dose	days post 2nd dose when VE provided
Rates per X person-days/years	vaccinated vs control
HR	vaccinated vs control
RR	vaccinated vs control
Adjusted	Regression, stratification, matching and associated variables
Transmission	infection rates in unvaccinated contacts of vaccinated individuals
Critical appraisal	See Appendix 5

Appendix 4: Process for assigning Variant of Concern to studies

A Variant of Concern is considered to be the dominant (≥50%) strain in a study if any of the following conditions apply:
i) the authors make a statement about prevalence of VOC during the study time frame
ii) time and setting of the study is consistent with a VOC being dominant according to the following open tracking sources:

Nextstrain. Real-time tracking of pathogen evolution. https://nextstrain.org/
Outbreak Info. https://outbreak.info/location-reports

Appendix 5: Research question and critical appraisal process (revised 06 Oct 2021)

Review question:

Participants	People at risk of COVID-19 (usually without but sometimes with previous COVID-19 infection)
Intervention	COVID-19 Vaccine
Comparator	Unvaccinated people (*)
Outcomes	PCR-diagnosis of COVID-19 infection (**); symptomatic disease; hospital/ICU admission; death; transmission

(*) before-after studies, where the infection rate in the first 2 weeks after the vaccination are used as control are (**)
(**) commonly performed and may be appraised confirmation of specific variant, or reasonable evidence the variant was the dominant circulating strain

Critical Appraisal Process

We appraise the quality of the individual studies using an adapted version of ROBINS-I. This tool classifies the Risk of Bias of a study as **Low, Moderate, Serious, Critical, or No Information**. Low Risk of Bias indicates High Quality, and Critical Risk of Bias indicates Very Low (insufficient) Quality. ROBINS-I appraises 7 bias domains and judges each study against an ideal reference randomized controlled trial. To improve the utility of ROBINS-I for assessing studies reporting vaccine effectiveness, we have focused on study characteristics that introduce bias as reported in the vaccine literature. (WHO. Evaluation of COVID-19 vaccine effectiveness. Interim Guidance. 17 March 2021). Studies rated as "critical" risk of bias will not be included in the Summary statements on Page 1-2 (exception: if limited data available for an outcome for a VOC). An overall judgement of "serious" or "critical" is given when the study is judged to be at critical risk of bias in at least one domain. Three of more serious risk of bias domains is given an overall risk of bias of critical.

VE Study Characteristics that may introduce bias	Description
Study design ROBINS-I: Bias in selection of participants into study	In cohort studies, people who get vaccinated may differ in health-seeking behaviour from people who do not get vaccinated; using a test-negative study design minimizes this type of bias Examples and typical judgement: • test-negative design with a clearly defined symptomatic study population (low) • test-negative design (mixed or unclear study population) or case-control or cohort design or data-linkage with no concerns (moderate) • cross-sectional design or case-control (concerns about whether controls had same access to vaccines/risk of exposure to COVID or unclear) or cohort design (concerns that exposed and non-exposed were not drawn from the same population) (serious)
Method for confirming vaccination ROBINS-I: Bias in classification of interventions	Questionnaires are prone to recollection bias; Population databases developed for purpose of tracking COVID vaccines minimize this type of bias Examples and typical judgement: • database linkage study (low) • Questionnaire with confirmation by an additional method (e.g. registry) of at least a subset of study population (moderate)

	• Questionnaire without confirmation by an additional method (serious) • Estimating vaccination status based on surveillance data alone (critical)
Databases used for retrieval of COVID test results, participant prognostic factors, and clinical outcomes ROBINS-I: Bias in classification of interventions	Databases developed for collecting data on COVID are less prone to bias due to missing information and misclassification Examples and typical judgement: • database for non-COVID purpose but with individual level data (moderate) • database for non-COVID purpose without individual level data (serious) • no or unclear description of database type (critical)
Assignment of infection start date ROBINS-I: Bias in classification of interventions	Using date of symptom onset (if within 10 days of testing) as infection start date reduces risk of misclassification bias (e.g., vaccinated participant who is reported as COVID+ may have been infected prior to receiving the vaccine or during non-immune period) and sensitivity of assays decreases over time Examples and typical judgement: • using a PCR positive test that was part of an ongoing standardized monitoring system (e.g., within a health network) (low) • using sample date without interview or documented confirmation of symptoms ≤ 10 days (relevant for symptomatic disease only) (serious)
Verification of symptoms ROBINS-I: Bias in classification of interventions	Prospective, standardized collection of symptoms from patients reduces risk of missing information bias; testing within 10 days after symptom onset reduces risk of false-negative COVID test Examples and typical judgement: • using sample date without patient report/ documented confirmation of symptoms ≤ 10 days (relevant for symptomatic disease only) (serious) • if symptomatic COVID is not an outcome (no information)
Accounting for non-immune period (first 14 days after first vaccine dose) ROBINS-I: Bias due to confounding	Reported absence of vaccine effect during non-immune period reduces risk of residual confounding bias Example/common case: • presence of an effect during non-immune period or result not reported (moderate) • unclear that non-immune period was considered (serious)
Inclusion of participants with prior COVID infection ROBINS-I: Bias due to confounding	Exclusion (or separate analysis) of participants with prior COVID infection reduces concern about differences in infectivity as well as risk-taking and health-seeking behaviour Examples and typical judgement: • inclusion of prior infection status as a covariate in the models (moderate) • previously infected not excluded or analyzed separately (serious)

Accounting for calendar time ROBINS-I: Bias due to confounding (time-varying confounding)	Accounting for calendar time reduces bias due to differences in vaccine accessibility and risk of exposure over time Examples and typical judgement: • use of time-varying statistics without explicit mention of adjustment for calendar time (moderate) • not taken into account but short-time frame (e.g. ≤2 months) (serious) • not taken into account and time frame >2 months (critical)
Adjustment for prognostic factors ROBINS-I: Bias due to confounding	Adjustment for prognostic factors for COVID infection, severity of disease, and vaccination, such as age, gender, race, ethnicity, socioeconomic factors, occupation (HCW, LTC), and chronic medical conditions Examples and typical judgement: • no or insufficient adjustment for occupation (or number of tests as a surrogate for exposure risk) -exception age>65 or LTCF resident (moderate) • no or insufficient adjustment for socioeconomic factors (or neighborhood or income as a surrogate), race, ethnicity (serious) • no or insufficient adjustment for age (any study population) or chronic medical conditions (LTC)(critical)
Testing frequency ROBINS-I: Bias in measurement of outcomes	Similar frequency of testing between groups reduces risk of bias introduced by detecting asymptomatic infection in one group but not in another (e.g. when only one group undergoes surveillance screening) Examples and typical judgement: • no systematic screening but consistent methods for detection in one group vs. the other, e.g., within health networks (moderate) • screening performed for a subset of both study groups (serious) • screening performed routinely in one study group but not in the other (critical)

Appendix 6: Detailed description of the narrative summary statement

We include studies with the following clinical outcomes: prevention of infection, severe disease (as defined by the study investigators), death, and prevention of transmission. These outcomes were selected because they are less susceptible to bias. If data are not available for these specific outcomes, but are available for symptomatic infection and/or hospitalization, data for these additional outcomes are provided temporarily. Studies reporting only antibody responses are excluded.

We aim at providing a lay language, standardized summary statement for each combination of vaccine and VOC for which we found evidence.

Where more than one study was found, we will provide a summary statement with a **range of the estimates across the studies**.

Where a single study provided data, we will provide the **estimate plus 95% confidence interval** for that study. As additional studies are added, the estimate plus confidence interval will be replaced by a range as described above.

In the summaries, "reach threshold" will be applied to mean estimates or range of mean estimates that are greater than or equal to 70% with lower limit of 95% CI at 50% or higher for infection and 90% with lower limit of 95% CI at 70% for severe disease (revised June 22, 2022 due to updated WHO criteria)

Section 3: Special Groups (after 5 November 2021)	
Author	**Special Group**
Arriola	Healthcare workers
Ashmawy	Healthcare workers
Baum (2)	Elderly >70 years
Bedston	Elderly >75 years
Bekker	Healthcare workers
Bieber	patients with autoimmune rheumatic diseases
Botton	Elderly >75 years
Breznik	Nursing home residents
Bukatko	Homeless shelter residents
Butt (2)	Veterans (on Hemodialysis)
Can	Healthcare workers
Canetti	Healthcare workers
Carazo (3)	Healthcare workers
Cheng	Chronic kidney disease patients
Chin (2)	Prisoners and prison staff
Cohen (3)	Healthcare workers
Dujmovic	Nursing Home residents
El Adam	Healthcare workers
Embi	Immunocompromised
Filon	Healthcare workers
Gaio	Healthcare workers
Goldhaber-Fiebert	Prison residents and staff
Goldin	LTCF
Gray (3)	Healthcare workers
Gray (4)	Healthcare workers
Grebe	blood donors
Grewal	LTCF
Grewal (2)	LTCF
Guedalia	Pregnant Women
Hall (2)	Healthcare workers
Hatfield	Nursing home residents
Helmsdal	Healthcare workers
Hertz	Healthcare workers
Iskander	Coast guard personnel
Kaur (2)	Healthcare workers
Kawasuji	Healthcare workers
Kim (3)	Healthcare workers
Krutikov	LTCF
Kwon	Organ Transplant Recipients
Lustig	Healthcare workers

Malhotra	Healthcare workers
Manteghinejad	Cancer patients only
Marra	Healthcare workers
McConeghy	LTCF
Mohr	Healthcare workers
Muhsen	Healthcare workers
Muhsen	LTCF residents
Nunes (2)	Healthcare workers
Oliver	Maintenance dialysis patients
Paixao	Pregnant women
Paranthaman	LTCF
Petráš	Healthcare workers
Piekos	Pregnant women
Pinto-Álvarez	Solid organ transplant recipients
Quach	Healthcare workers
Regev-Yochay (2)	Healthcare workers
Richterman	Healthcare workers
Salvatore	Prison staff and prisoners
Sharma	Veterans (elderly population)
Shen	immunosuppressed patients
Shrestha (3)	Healthcare workers
Shrotri (2)	LTCF
Simwanza	Prisoners
Smith	Renal patients only
Spensley	End-stage Kidney disease patients
Spitzer	Healthcare workers
Stirrup	LTCF
Subbarao	LTCF
Sultan	Healthcare workers
Tai	special population (NBA)
Tan (2)	Prison residents
Tanir	Healthcare workers
Wan	Patients with diabetes mellitus
Yassi (2)	Healthcare workers
Yoon	Frontline workers
Young-Xu (3)	Male Veterans