

Weekly COVID-19 Vaccine Updates

Number 45, 17 February 2022



Table of Contents

Introduction	3
COVID-19 Vaccine Specifications	4
COVID-19 Vaccine Efficacy	5
Vaccine Effectiveness Summary at-a-glance	6
Vaccine Efficacy/Effectiveness Against Omicron at-a-glance.....	7
Vaccine Efficacy/Effectiveness Against Delta at-a-glance	8
Vaccine Efficacy/Effectiveness and Immunogenicity of Boosters Against Delta at-a-glance	9
Vaccine Efficacy/Effectiveness in High-Risk Groups at-a-glance	10
Vaccine Efficacy/Effectiveness in Children	11
Maternal Vaccination	12
Vaccine Efficacy/Effectiveness Against Asymptomatic Infection at-a-glance	13
Mixed Dose Vaccine Safety and Immune Responses	14
Adverse Events Following Immunisation with WHO EUL Vaccines	15
Serious Adverse Events.....	16
Risk of Myo/Pericarditis in 12-17 Year Olds Following mRNA Vaccines	17
Who Can be Vaccinated Based on WHO SAGE Recommendations?	18
Vaccine Development Pipeline	19
WHO SAGE Emergency Use Listing and Prequalification Timeline	20
References.....	21
Acknowledgements.....	26
Appendix 1: COVID-19 Vaccine Effectiveness	27
Appendix 2: Vaccine Efficacy/Effectiveness Against Variants	29
Appendix 3: Vaccine Efficacy/Effectiveness and Immunogenicity of Boosters Against Delta	32
Appendix 4: Vaccine Efficacy/Effectiveness in High-Risk Groups	33
Appendix 5: Vaccine Efficacy/Effectiveness Against Transmission.....	34
Appendix 6: Risk of Rare Unusual Blood Clotting with Low Platelets (Thrombosis with Thrombocytopenia Syndrome – TTS)	35

Introduction

This document summarises the vaccine efficacy and effectiveness, the vaccine specifications, the vaccine development pipeline and the timeline for World Health Organization (WHO) review of the various COVID-19 vaccines in late phase development. This document is updated weekly.

- Vaccine efficacy refers to the performance of a vaccine in a controlled clinical trial (study) situation
- Vaccine effectiveness refers to the performance of a vaccine in a population under real-world conditions

Key messages











- COVID-19 vaccine efficacy results from different trials cannot be directly compared against each other. They must be interpreted in the context of study designs (including case definitions, clinical endpoints, access to testing), target populations, and COVID-19 epidemiologic conditions (in particular the variants circulating at the time of the study). All efficacy studies were conducted prior to Omicron predominance and most prior to Delta.
- All COVID-19 vaccines in late phase development report high vaccine efficacy against severe COVID-19 and favourable safety profiles
- Most vaccines have high effectiveness against infection, including with the Delta variant, but lower against Omicron
- The Pfizer/BioNTech vaccine has been authorised in children aged ≥5 years by the US FDA, EU EMA, Australian TGA and Health Canada; and in those ≥12 years by the UK MHRA and NZ Medsafe, The EMA, MHRA and TGA have authorised the Moderna vaccine in those ≥12 years.
- WHO SAGE recommends that boosters should be administered 4-6 months after the primary series in high-priority groups, including older adults and health workers.¹ ATAGI has recommended that immunocompromised persons in Australia receive a third dose as part of the primary series and booster doses of Pfizer/BioNTech be offered to all adults irrespective of the primary COVID-19 vaccine given.^{2,3} Boosters are recommended for all adults ≥18 years of age in the US and UK.^{4,5}
- Mixed vaccine schedules (i.e. delivering different types of vaccine for the first and second dose) generally provide good protection against infection and severe disease
- Seven intranasal vaccines are in development (6 live-attenuated viruses or virus-vectored vaccines; 1 protein subunit.⁶ These may be beneficial in preventing transmission
- A very rare clotting disorder with low platelets (Thrombosis with Thrombocytopenia Syndrome – TTS) has been associated with the AstraZeneca and Johnson & Johnson vaccines.⁷⁻⁹ The majority of cases fully recover with adequate treatment. The risk following the first dose of AstraZeneca vaccine has been estimated by the EMA as 1 in 100,000 and by the Australian Technical Advisory Group on Immunisation (ATAGI) as 1 in 50,000.^{10,11} Risk of TTS is much lower following the *second* dose of AstraZeneca vaccine: estimate in the UK is 1 in 1.5 million second doses.¹²
- The risk of TTS following the first dose of Johnson & Johnson vaccine has been estimated as 1 in 319,000 in the USA¹³
- The risk of myocarditis/pericarditis is increased following the second dose of Pfizer/BioNTech and Moderna vaccines, particularly in younger males, occurring in >1 in 20,000 males under 25 years of age.¹⁴ Highest rate in males 16-17 years of age following Pfizer/BioNTech vaccine but no clear difference in risk between Moderna and Pfizer/BioNTech.¹⁵ There is a small increase in risk of myocarditis in females <30 and males >50 years of age. Data from Ontario, Canada, and the UK suggest higher rates following Moderna than Pfizer/BioNTech vaccine. ATAGI in Australia continue to review the data.
- Appropriate communication on the benefit-risk profile of COVID-19 vaccines remains crucial to maintain confidence in immunisation programmes and to avoid vaccine hesitancy.

New updates

Key updates include (*also highlighted in yellow text in the document*):

- Efficacy of a single dose of Johnson & Johnson against symptomatic infection and severe disease in USA, Brazil, Peru, South Africa (Page 5):
 - Symptomatic infection: 55.9% (51.0-60.5)
 - Severe disease: 73.3% (63.9-80.5)
 - Death: 84.5% (47.3-97.1)
- Pooled effectiveness of Pfizer/BioNTech and Moderna against hospitalisation over time in Delta and Omicron predominant periods in USA (Page 23):
 - Delta
 - 2 doses
 - <2 months: 94% (92-96)
 - ≥5 months: 82% (82-83)
 - 3 doses
 - <2 months: 96% (95-97)
 - ≥4 months: 76% (14-93)
 - Omicron
 - 2 doses
 - <2 months: 71% (51-83)
 - ≥5 months: 54% (48-59)
 - 3 doses
 - <2 months: 91% (88-93)
 - ≥4 months: 78% (67-85)
- Effectiveness of Pfizer/BioNTech and Moderna against symptomatic infection and hospitalisation with Omicron over time in Qatar (Pages 6, 7, 27 and 29):
 - Pfizer/BioNTech
 - Symptomatic infection:
 - Single dose: 26.1% (5.8-42.0)
 - 2 doses (first month): 61.9% (49.9-71.1)
 - 2 doses (seventh month): 9.6% (2.4-16.3)
 - 3 doses (4-5 weeks): 56.6% (50.8-61.7)
 - 3 doses (≥12 weeks): 37.6% (28.8-45.4)
 - Hospitalisation:
 - 2 doses (1-6 months): 73.7% (46.8-87.0)
 - 2 doses (≥7 months): 80.7% (71.3-87.0)
 - 3 doses (1-6 weeks): 90.6% (77.8-96.0)
 - 3 doses (≥7 months): 90.8% (81.5-95.5)
 - Moderna
 - Symptomatic infection:
 - Single dose: -1.6% (-56.8-34.1)
 - 2 doses (1-3 months): 44.8% (16.0-63.8)
 - 2 doses (≥7 months): -9.3% (-16.3-2.8)
 - 3 doses (4-5 weeks): 54.6% (41.1-65.0)
 - 3 doses (≥6 weeks): 38.6% (19.4-53.1)
 - Hospitalisation:
 - 2 doses (1-3 months): 76.9% (19.2-93.4)
 - 2 doses (≥7 months): 64.0% (39.1-78.7)
- Effectiveness of AstraZeneca and mRNA vaccines against infection, hospitalisation, and death with Omicron in the UK (effectiveness was similar between Omicron variants BA.1 and BA.2) (updated 10 Feb 2022):
 - Infection:
 - AstraZeneca 2 doses: (2-4 weeks): 45-50%
 - AstraZeneca 2 doses: No effect beyond 20 weeks
 - Pfizer/BioNTech or Moderna 2 doses (2-4 weeks): 65-70%
 - Pfizer/BioNTech or Moderna 2 doses (20 weeks): ~10%
 - Pfizer/BioNTech or Moderna booster (2-4 weeks): 60-75%
 - Pfizer/BioNTech or Moderna booster (≥15 weeks): 25-40%
 - Hospitalisation:
 - AstraZeneca or Pfizer/BioNTech 2 doses (≥25 weeks): 25-35%
 - Pfizer/BioNTech booster after any primary series (2 weeks): ~90%
 - Pfizer/BioNTech booster after any primary series (10-14 weeks): ~75%
 - Moderna booster after any primary series (<9 weeks): 90-95%
 - Death:
 - AstraZeneca, Pfizer/BioNTech or Moderna 2 doses (≥25 weeks): 59% (4-82)
 - Pfizer/BioNTech or Moderna booster (≥2 weeks): 95% (90-98)
- Following JCVI advice, vaccination will be offered to 5-11 year olds in the UK
- Pfizer/BioNTech in pregnancy not associated with adverse neonatal and early infant outcomes in Israel (Page 12):
 - Following a cohort of 24,288 newborns, no difference in preterm birth, congenital anomalies, hospitalisation, or death between those with vaccinated and unvaccinated mothers

COVID-19 Vaccine Specifications

	ASTRAZENECA	GAMALEYA	JOHNSON & JOHNSON	MODERNA	NOVAVAX	PFIZER/ BIONTECH	SINOVAC	SINOPHARM	BHARAT BIOTECH	CLOVER
VACCINE TYPE	Viral vector (chimpanzee adenovirus ChAdOx1)	Viral vector (recombinant adenovirus types 5 and 26)	Viral vector (recombinant adenovirus type 26)	mRNA	Protein subunit	mRNA	Inactivated virus	Inactivated virus	Inactivated virus	Protein
Available Through COVAX	✓	-	✓	-	✓	✓	-	-	-	-
Doses Required	 4-12 weeks apart	 3 weeks apart	 2 doses with 2-6 month interval also recommended	 4 weeks apart*	 3 weeks apart	 3-4 weeks apart*	 2-4 weeks apart*	 3-4 weeks apart*	 3 weeks apart	 3 weeks apart
Third dose/ boosters	As part of primary series for those with immunocomp.	-	-	As part of primary series for those with immunocomp. USA: at least 6 months after primary series in at-risk groups and ≥65 years	As part of primary series for those with immunocomp.	As part of primary series for those with immunocomp. USA: at least 6 months after primary series in at-risk groups and ≥65 years	As part of primary series for ≥60 years	As part of primary series for ≥60 years	-	-
Shipping, Storage & Presentation	Normal cold chain requirements (2-8°C); 10-dose vials	-18,5°C (liquid form); 2-8°C (dry form)	Shipped at -20°C; 2-8°C for up to 3 months; 5-dose vials	-25°C to -15°C; 10-dose vials	2-8°C; 10-dose vials	-80°C to -60°C; 2-8°C for up to 1 month; 6-dose vials	2-8°C; Single-dose vials	2-8°C; Single-dose vials/ pre-filled syringes	2-8°C; 10-dose or 20-dose vials	2-8°C
Approval by a Stringent Regulatory Authority (SRA)	WHO EUL, EMA, TGA, MHRA	Under review by WHO SAGE	WHO EUL, EMA, FDA, MHRA	WHO EUL, EMA, FDA, TGA	WHO EUL, EMA, TGA	WHO EUL, EMA, FDA, TGA, MHRA	WHO EUL	WHO EUL	WHO EUL	-

WHO EUL: WHO Emergency Use Listing
 EMA: European Medicines Agency
 FDA: Food and Drug Administration (US)
 TGA: Therapeutic Goods Administration (Australia)
 MHRA: Medicines and Healthcare Products Regulatory Agency (UK)

COVID-19 Vaccine Efficacy

All studies conducted prior to Omicron predominance and most prior to Delta. Efficacy is dependent on variants circulating at the time of the study so it is difficult to directly compare efficacy between vaccines.

VACCINE	VACCINE EFFICACY			
	SYMPTOMATIC INFECTION	MODERATE-SEVERE	SEVERE	HOSPITALISATION/DEATH
AstraZeneca	UK: 66.7% (57.4-74.0) ¹⁶ USA, Chile, Peru: 76% ¹⁷ (not peer-reviewed) Single dose in UK (22-90 days post-vaccination): 76.0% (59.3 to 85.9) ¹⁶ Efficacy with different interval between doses in UK: 12+ weeks: 82.4% (2.7-91.7) <6 weeks: 54.9% (32.7-69.7) ¹⁶	-	Severe/critical and hospitalisation in USA, Chile, Peru: 100% ¹⁷ (not peer-reviewed) UK: 100% (15 cases in the placebo group) ¹⁶	Hospitalisation in UK: 100% (9 cases in placebo group) ¹⁶
Bharat Biotech	India: 77.8% (65.2-86.4) ¹⁸	-	India: 93.4% (57.1-99.8) ¹⁸	-
Clover	Philippines, Colombia, Brazil, South Africa and Belgium: Overall: 67.2% (54.3-76.8); Delta: 78.7% (57.3-90.4) ¹⁹	Philippines, Colombia, Brazil, South Africa and Belgium: Overall: 83.7% (55.9-95.4); Delta: 81.7% (35.9-96.6) ¹⁹	-	Hospitalisation in Philippines, Colombia, Brazil, South Africa and Belgium: 100% (42.7-100) ¹⁹
Gamaleya	Russia: 91.6% (85.6-95.2) ²⁰ Single dose (Sputnik Light) in Argentina: 78.6% ²¹	Moderate-severe: 100% (20 cases in the placebo group) ²⁰	-	-
Johnson & Johnson	USA: 93.2% (91.0-94.8) ²² USA, Brazil, Peru, South Africa: 55.9% (51.0-60.5) ²³	Moderate to severe/critical: All sites: 66.1% (55.0-74.8) USA: 72.0% (58.2-81.7) Latin America: 61.0% (46.9-71.8) South Africa: 64.0% (41.2-78.7) ^{24,25} South Africa: 67-71% ²⁶	85.4% (54.2-96.9) ²⁵ USA: 98.2% (92.8-99.6) ²² USA, Brazil, Peru, South Africa: 73.3% (63.9-80.5) ²³	100% (5 deaths in placebo group) ²⁵ Death in South Africa: 96% ²⁶ USA, Brazil, Peru, South Africa: Death: 84.5% (47.3-97.1) ²³
Moderna	USA: 94.1% (89.3-96.8) ²⁷ USA: >90% ²⁸ Efficacy in USA: 12-17 years: Symptomatic: 92.7% (67.8-99.2) Infection: 69.8% (49.9-82.1) Asymptomatic infection: 59.5% (28.4-77.3) ²⁹	-	USA: 100% (30 cases in placebo group) ²⁷ US: >95% ²⁸	USA: 100% (1 death in placebo group) ²⁷
Novavax	UK: 89.7% (80.2-94.6) ³⁰ US and Mexico: 90.4% (82.9-94.6) ³¹	US and Mexico: 100% (87.0-100) ³¹	-	-
Pfizer/BioNTech	Argentina, Brazil, Germany, South Africa, Turkey and the USA: 94.6% (89.9-97.3) ³² Infection over 6 months: 91.3% (89.0-93.2) ³³ Single dose: 100%	-	Argentina, Brazil, Germany, South Africa, Turkey and the USA: 88.9% (20.1-99.7) ³² Severe disease: 96.7% (80.3-99.9) ³³	-
Sinopharm	UAE, Bahrain, Egypt and Jordan: 78.1% (64.9-86.3) ³⁴	-	-	Hospitalisation in UAE, Bahrain, Egypt and Jordan: 78.7% (26.0-93.9) ³⁴
Sinovac	Brazil: 50.7% (35.9-62.0) Chile: 67% (65-69) Indonesia: 65% (20-85) ³⁴ Turkey: 83.5% (65.4-92.1) ³⁵	Requiring medical assistance in Brazil: 83.7% (58.0-93.7) Moderate-severe: 100% (56.4-100.0) ³⁶	-	Hospitalisation: Brazil: 100% (56-100) Chile: 85% (83-97) Turkey: 100% (20-100) ³⁴
CanSino Biologics	Pakistan, Mexico, Argentina, Russia and Chile: 57.5% (39.7-70.0) ³⁷	-	-	-

Vaccine Effectiveness Summary at-a-glance

Detailed summary available in Appendix 1.

VACCINE	ANY INFECTION	SYMPTOMATIC INFECTION	HOSPITALISATION/ SEVERE DISEASE	DEATH	EFFECTIVENESS 4 to <6 MONTHS	EFFECTIVENESS ≥6 MONTHS
AstraZeneca	45-73% ³⁸⁻⁴⁴ Single dose 30-67% ^{38,40,43,45}	-39-78% ^{41,48-53*} Single dose: 38-68% ^{46,52,54,55} Moderate-Severe: 82%; Single dose: 79% ⁴³	84-100% ^{41,44,47-49,52,53,56-59} Single dose: 49-94% ^{52,54,59,60}	90-100% ^{44,47,48,53,61}	Infection: 44-45% ^{50,52,53} Hospitalisation or death: 42-80% ^{52,53} Death: 85% ⁵³	Infection: 42% ⁵⁰
Bharat Biotech	-	50% ⁶²	-	-	-	-
Johnson & Johnson	50-88% ^{41,63-66}	54% ⁴¹	71-91% ^{26,41,56,64,67}	-	-	Infection: 13% ⁶⁸ Death: <65 years: 73%; ≥65 years: 52% ⁶⁸
Moderna	37-92% ^{41,65,69-73} Single dose: 20-72% ^{45,74}	45-95% ^{41,48,70,71,75,76} Single dose: 0-72% ⁷⁵⁻⁷⁷	77-98% ^{41,48,56,67,69-72,74,76} Single dose: 69-96% ^{45,74}	98% ⁷⁰	-	Infection: 0-58% ^{68,71,76} Hospitalisation: 64% ⁷⁶ Hospitalisation and death: 56% ⁷¹ Death: <65 years: 82%; ≥65 years: 76% ⁶⁸
Pfizer/BioNTech	55-95% ^{38,39,41,42,54,65,69,73,78-85} Single dose: 36-57% ^{38,40,45}	-18-97% ^{41,46-48,50,51,53,54,75,76,81,85-88*} Single dose: 26-61% ^{46,75-77,88}	74-99% ^{41,47,48,53,54,56,59,67,69,76,78,81,83,85,86,89-92} Single dose: 85-94% ^{59,60}	90-100% ^{47,48,53,61,78,81,85,89,90}	Infection: 47-65% ^{50,53,83} Hospitalisation: 92% ⁵³ Death 92% ⁵³	Infection: 10-64% ^{50,68,76,88} Death: <65 years: 84%; ≥65 years: 70% ⁶⁸ Hospitalisation: 68-81% ^{76,92}
Sinopharm	-	90% ³⁴	-	-	-	-
Sinovac	53-60% ^{44,89}	59% ⁴⁷	73-91% ^{44,47,89}	74-95% ^{44,47,89}	-	-

* Low/negative values are against the Omicron variant

Vaccine Efficacy/Effectiveness Against Omicron at-a-glance

Detailed summary available in Appendix 2.

VACCINE	VACCINE EFFECTIVENESS (AFTER 2 DOSES) UNLESS OTHERWISE STATED		
	ANY INFECTION	SYMPTOMATIC INFECTION	HOSPITALISATION AND DEATH
AstraZeneca	-	No protective effect beyond 15 weeks ⁵⁰ -39-50% ^{51,93}	~55% ⁹³ ≥25 weeks: 25-35% ⁹³
Johnson & Johnson	Strong antibody response ⁹⁴	-	Booster: Hospitalisation: 85% (54-95) ⁹⁵
Moderna	30-37% ^{73,74} Single dose: 20% ⁷⁴ Booster: 64% ⁷⁴	45% ⁷⁶ ≥7 months: 0% ⁷⁶ Booster: 55% ⁷⁶ Booster ≥6 weeks: 39% ⁷⁶ Single dose: 0% ⁷⁶	77% ⁷⁶ ≥7 months: 64% ⁷⁶ Booster: Hospitalisation: 90-95% ⁹³
Pfizer/BioNTech	55% ⁷³ Booster: 55% ⁷³	-18-88% ^{50,51,76,96} ≥15 weeks: 34-37% ⁵⁰ No effect beyond 6 months ⁷⁶ Booster: 54-76% ^{50,51,76} Booster ≥12 weeks: 38% ⁷⁶ Single dose: 26-34% ^{50,76}	Hospitalisation: 70-74% ^{76,92,96} Hospitalisation >6 months: 68-81% ^{76,92} Booster: Hospitalisation: 89-91% ^{76,92,93} Booster: Hospitalisation 10-14 weeks: 75% ⁹³ Booster: Hospitalisation ≥7 months: 91% ⁷⁶

Vaccine Efficacy/Effectiveness Against Delta at-a-glance

Detailed summary and vaccine efficacy/effectiveness against other variants available in Appendix 2.

VACCINE	VACCINE EFFECTIVENESS UNLESS OTHERWISE STATED				
	ANY INFECTION	SYMPTOMATIC INFECTION	HOSPITALISATION AND DEATH	EFFECTIVENESS 4 to <6 MONTHS	EFFECTIVENESS ≥6 MONTHS
AstraZeneca	60-67% ^{38-40,43} Single dose 30-67% ^{38,40,43,45}	25-76% ⁴⁸⁻⁵³ Moderate-Severe: 82%; Single dose: 38-79% ^{43,52}	84-95% ^{48,49,52,53,58,59,61} Single dose: 49-88% ^{45,52,59}	Infection: 44-45% ^{50,52,53} Hospitalisation: 64-80% ^{52,53} Death: 82% ⁵³	Infection: 42% ⁵⁰
Bharat Biotech	Efficacy: 65% ¹⁸	50% ⁶²	-	-	-
Clover	-	Efficacy: 79% ¹⁹	Efficacy (moderate-severe): Delta: 82% ¹⁹	-	-
Johnson & Johnson	78% ⁶⁴	-	71-85% ^{26,64}	-	Infection: 13% ⁶⁸ Death: <65 years: 73%; ≥65 years: 52% ⁶⁸
Moderna	76-88% ^{69,72,73} Single dose: 60-72% ^{45,74}	95% ⁴⁸	81-98% ^{48,69,72,74} Single dose: 69-96% ^{45,74}	-	Infection: 22-58% ^{68,71} Death: <65 years: 82%; ≥65 years: 76% ⁶⁸ 56% ⁷¹
Pfizer/BioNTech	39-93% ^{38,39,69,73,82,83} Single dose: 36-57% ^{38,40,45}	56-90% ^{48,50,51,53} Single dose: 33% ⁵¹	75-100% ^{48,53,59,61,69,82,83,92} Single dose: 78-94% ^{45,59}	Infection: 53-66% ^{50,53,83} Hospitalisation: 92% ⁵³ Death: 92% ⁵³	Infection: 43-64% ^{48,50,68} Death: <65 years: 84%; ≥65 years: 70% ⁶⁸ Hospitalisation: 74% ⁹²

Vaccine Efficacy/Effectiveness and Immunogenicity of Boosters Against Delta at-a-glance

Booster refers to an additional dose administered at least 5 months after completion of the primary series.

Booster efficacy/effectiveness reported relative to primary series (not unvaccinated) unless otherwise specified.

Detailed summary available in Appendix 3.

VACCINE	IMMUNOGENICITY	BOOSTER VACCINE EFFECTIVENESS (UNLESS OTHERWISE STATED)			
		ANY INFECTION	SYMPTOMATIC INFECTION	HOSPITALISATION	DEATH
Johnson & Johnson	Strong antibody response ⁹⁴	-	-	-	-
Moderna	Strong antibody response ⁹⁴	83-96%* ^{73,74}	87% ⁹⁷ 95%* ⁹⁷	-	-
Pfizer/BioNTech	Strong antibody response ⁹⁴	81%* ⁷³	Efficacy: 84-95% ^{98,99} 86% ⁹⁷ 89-94%* ^{50,51,97} After AZ primary series: 90-94%* ^{50,51,97}	93-99% ^{92,97,100} ≥3 months: 65% ⁹²	81-99% ^{97,100,101}
Sinopharm	Strong antibody response but stronger with a Sinopharm recombinant protein vaccine booster ¹⁰²	90% ³⁴	-	-	-
Sinovac	Strong antibody response ¹⁰³	-	79% ¹⁰⁴	86% ¹⁰⁴	87% ¹⁰⁴

*Relative to unvaccinated

Vaccine Efficacy/Effectiveness in High-Risk Groups at-a-glance

Detailed summary available in Appendix 4.

VACCINE	VACCINE EFFICACY/EFFECTIVENESS			
	DIABETES	OBESITY	AT RISK FOR SEVERE COVID-19	ELDERLY*
AstraZeneca	-	-	Efficacy against symptomatic infection: 76% ¹⁷ Effectiveness of single dose against: Symptomatic infection: 60% ⁴⁶ Effectiveness against: Symptomatic infection: 80% ⁴⁶ Hospitalisation: 63% ⁵⁷	Efficacy against infection: 85% ¹⁷ Effectiveness of single dose against: Symptomatic infection: 53-61% ^{46,54} Hospitalisation: 80% ¹⁰⁵ Death: 83% ⁷⁷ Effectiveness against: Symptomatic infection: 39-81% ^{44,46,48,49,53,106} Hospitalisation: 37-94% ^{44,49,53,106,107} Death: 65-94% ^{44,53,61,77}
Bharat Biotech	-	-	Efficacy against infection: 66% ¹⁸	Efficacy against symptomatic infection: 68% ¹⁸
Gamaleya	-	-	-	Symptomatic infection: 92% ²⁰
Johnson & Johnson	Efficacy: 23% ²⁴	Efficacy: 66% ²⁴	Efficacy: 59% ²⁴	Efficacy 66% ²⁴
Moderna	-	-	Efficacy against symptomatic infection: 84-91% ²⁷ Effectiveness against hospitalisation: 84% (80-87) ⁵⁶	Efficacy against symptomatic infection: 86% ²⁷ Effectiveness against infection: pre-Omicron: 75-97% ^{70,72,74} ; Omicron: 57% ⁷⁴
Novavax			Efficacy against infection: 91% ³¹	
Pfizer/BioNTech	Effectiveness against infection: 82% ⁸⁴ 89% ⁹⁰	Effectiveness against infection: 90% ⁹⁰	Efficacy against symptomatic infection: 95% ³² Effectiveness of single dose against symptomatic infection: 56% ⁴⁶ Effectiveness against: Infection: 71-90% ^{78,90} Symptomatic infection: 89% ⁴⁶ Hospitalisation: 72-81% ⁷⁸	Efficacy against symptomatic infection: 95-100% ^{32,33} Effectiveness of single dose against: Infection: 76% ⁵⁴ Symptomatic infection: 40-80% ^{46,53,75} Hospitalisation: 71-91% ^{53,105,107} Death: 77-92% ^{53,77} Effectiveness against: Infection: 70-89% ^{78,84,90,108} Symptomatic infection: 61-93% ^{46,48,75,106} Hospitalisation: 43-93% ¹⁰⁶⁻¹⁰⁸ Death: 87-98% ^{61,77}
Sinopharm	-	81% ³⁴	-	Effectiveness against symptomatic infection 91% ³⁴
Sinovac	-	Infection: 75% ³⁴	Infection: 49% ³⁴	Infection: 28% ⁴⁴ Hospitalisation: 32% ⁴⁴ Death: 34% ⁴⁴

*Estimates in those ≥60 years to ≥90 years

Vaccine Efficacy/Effectiveness in Children

Most studies conducted during Delta predominance.

VACCINE	VACCINE EFFICACY, EFFECTIVENESS AND OTHER OUTCOMES		COUNTRIES VACCINATING CHILDREN BY AGE GROUP
	<12 years	12-18 years	
Moderna	Well tolerated and produced strong antibody response in 6-11 year olds in USA (Moderna press release) ¹⁰⁹	Efficacy: Symptomatic infection in USA, 12-15 years: 96% ¹¹⁰	≥12 years: Authorised by EMA, MHRA, TGA ≥12 years: France, Italy, Japan, Australia, Canada, Guinea, Philippines ≥3 years: Colombia
Novavax	7-12 years trial underway in India	Study in 12-18 years has started recruitment	-
Pfizer/BioNTech	5-11 years: Antibody response and safety profile for reactogenicity similar to 16-25 year-olds ¹¹¹ Efficacy: Symptomatic infection in 5-11 year olds in USA during Delta predominance: 90.9% (88.3-98.3) ¹¹² <5 years: Evaluation of a 3 dose schedule underway due to low immunogenicity of 2 doses ¹¹³ UK JCVI: estimated impact of single dose in 5-11 years with underlying health conditions: Prevented per million first doses: 105 PICU admissions; 1265 hospital admissions; 16 PIMS-TS cases ¹¹⁴ Effectiveness: Hospitalisation in USA in the week beginning 20 December 2021: 5-11 years: 76% ¹¹⁵	Efficacy: Symptomatic infection in USA, 12-15 years: 100% ¹¹⁶ ; Up to 4 months after second dose: 100% (87.5-100) ¹¹⁷ Efficacy: Symptomatic infection in Israel, 12-15 years: 100% ¹¹⁸ Effectiveness in Israel 12-18 years: Any infection: 90% (88-92); Symptomatic infection: 93% (88-97) ¹¹⁹ Effectiveness against hospitalisation in USA: 12-18 years: 93% (83-97) ¹²⁰ Effectiveness: Symptomatic infection 12-15 years: Single dose 2 weeks: 75.4% (73.9-76.9); Single dose 8-9 weeks: 46.8% (14.9-66.7); 16-17 years: Single dose 2 weeks: 75.9% (74.3-77.4); Single dose 8-9 weeks: 34.3 (30.7 to 37.7); 2 doses 2-9 weeks: 94.6% (92.8-95.9); Hospitalisation: 16-17 years: Single dose: 84.5% (64.6-93.2) ¹²¹ USA: Effectiveness: MIS-C: 91% (78-97) ¹²² USA: Effectiveness: 2 doses: Hospitalisation: 94% (90-96); ICU admission: 98% (93-99); Single dose: Hospitalisation: 97% (86-100) ¹²³ Effectiveness: Hospitalisation in USA in the week beginning 20 December 2021: 12-17 years: 81% ¹¹⁵	≥5 years: Authorised by FDA, EMA, TGA ≥5 years: USA, Israel, Canada, Oman, Saudi Arabia, Bahrain, UAE, Costa Rica, UK ≥12 years: Authorised by EMA, MHRA TGA, Medsafe ≥12 years: USA, Canada, UK Israel, France, Spain, Italy, Netherlands, Germany, South Africa, Singapore, Japan, Australia, Estonia, Denmark, Greece, Ireland, Lithuania, Sweden, Finland, Norway, Switzerland, Jordan, Morocco, Egypt, Guinea, Namibia, South Korea, Philippines, Brazil 12-15 years single dose: South Africa 12-17 years single dose: Hong Kong ≥3 years: Colombia
Sinovac	Phase I/II studies complete in 3-17 year olds in China ¹²⁴ ; Phase 3 studies underway in Chile, Kenya, Malaysia, the Philippines, and South Africa	-	≥12 years: Indonesia ≥6 years: Chile, El Salvador, Ecuador Indonesia ≥3 years: China, Colombia, Hong Kong
Sinopharm	Phase I/II studies in 3-17 year olds in China	-	≥12 years: Morocco ≥3 years: China, UAE, Venezuela, Argentina, Bahrain
AstraZeneca	Trials suspended when evidence emerged of the higher risk of TTS in younger adults compared to older adults	-	≥3 years: Colombia
Bharat Biotech	Phase 2/3 trial in 2-18 year olds	-	-

Maternal Vaccination

VACCINE	VACCINE EFFICACY/EFFECTIVENESS IN PREGNANT WOMEN	OTHER OUTCOMES
AstraZeneca	-	In four clinical trials in the UK, Brazil and South Africa, fertility was unaffected by vaccination and there was no increased risk of miscarriage and no instances of stillbirth in women vaccinated before pregnancy ¹²⁵
Moderna	-	<p>Following maternal vaccination with mRNA vaccines, 100% of neonates (n=36) had protective antibodies at birth¹²⁶</p> <p>Comparison in USA of 35,691 participants who received an mRNA vaccine in pregnancy and nonpregnant women (v-safe registry and VAERS): Injection-site pain more frequent in pregnancy; headache, myalgia, chills, and fever less frequent. Adverse pregnancy and neonatal outcomes similar in pregnant women to studies conducted before the Covid-19 pandemic¹²⁷</p> <p>Durability of anti-spike antibodies in infants after maternal Pfizer or Moderna: 98% of infants had antibodies at 2 months of age; higher antibody levels than in infants of those previously infected; 57% of infants of vaccinated mothers had antibodies at 6 months of age compared to 8% of infants of infected mothers¹²⁸</p>
Novavax	-	-
Pfizer/BioNTech	<p>Effectiveness in Israel: Any infection: 96% (89-100); Symptomatic infection: 97% (91-100); Hospitalisation: 89% (43-100)¹²⁹</p> <p>Effectiveness in Israel: Any infection: 78% (57-89)¹³⁰</p>	<p>Following maternal vaccination with mRNA vaccines, 100% of neonates (n=36) had protective antibodies at birth¹²⁶</p> <p>NIH-funded MOMI-VAX study will assess antibody responses in 750 pregnant women and 250 women vaccinated with any US-licensed vaccine within 2 months of birth, and their infants¹³¹</p> <p>Comparison in USA of 35,691 participants who received an mRNA vaccine in pregnancy and nonpregnant women (v-safe registry and VAERS): Injection-site pain more frequent in pregnancy; headache, myalgia, chills, and fever less frequent. Adverse pregnancy and neonatal outcomes similar in pregnant women to studies conducted before the Covid-19 pandemic¹²⁷</p> <p>Durability of anti-spike antibodies in infants after maternal Pfizer or Moderna: 98% of infants had antibodies at 2 months of age; higher antibody levels than in infants of those previously infected; 57% of infants of vaccinated mothers had antibodies at 6 months of age compared to 8% of infants of infected mothers¹²⁸</p> <p>Infants of vaccinated and unvaccinated mothers in Israel: No difference in preterm birth, congenital anomalies, hospitalisation, or death¹³²</p>
Sinopharm	-	-
Sinovac	-	-

Vaccine Efficacy/Effectiveness Against Asymptomatic Infection at-a-glance

Some of these studies assessed multiple variants, including Delta but none analysed the Delta variant alone.
Detailed summary of vaccine efficacy/effectiveness against transmission available in Appendix 5.

VACCINE	VACCINE EFFECTIVENESS UNLESS OTHERWISE STATED
AstraZeneca	Efficacy: 54% ¹⁶
Bharat Biotech	Efficacy: 64 ¹⁸
Johnson & Johnson	Efficacy: 60% ²⁴
Moderna	73% ⁷⁰
Pfizer/BioNTech	65-92% ^{71,85-87,133,134}

Mixed Dose Vaccine Safety and Immune Responses

Mixed vaccine schedules (i.e. delivering different types of vaccine for the first and second dose) could be particularly useful to facilitate better protection against variants of concern and enable vaccination programs to continue if a particular vaccine is unavailable.

SCHEDULE	SAFETY	IMMUNE RESPONSES OR EFFECTIVENESS	COUNTRIES USING SCHEDULE
AZ-PF	Spain: Similar side effects to those receiving 2 doses of the same vaccine; no safety concerns (not peer reviewed) ¹³⁵ UK: Greater systemic side effects (mild-moderate symptoms) following the booster dose than with 2 doses of the same vaccine; no safety concerns ¹³⁶ Germany: greater reactogenicity with first dose of AstraZeneca than with the Pfizer/BioNTech booster ¹³⁷ Increased reactogenicity (54.4%; 49.4-59.5) vs AstraZeneca-AstraZeneca (33.5%; 28.0-39.2) ¹³⁸ Total adverse event reporting in Korea: 0.28% (vs AZ-AZ: 0.22%; and PF-PF: 0.31%)	Spain: ≥8 week dose interval: Stronger immune response following Pfizer/BioNTech than after 2 doses of AstraZeneca vaccine (not peer reviewed) ¹³⁵ Spain: 8-12 week dose interval: robust antibody response ¹³⁹ UK: 4 week dose interval: stronger antibody and cellular response than after 2 doses of AstraZeneca vaccine ¹⁴⁰ Germany: 9-12 week dose interval: Significantly stronger immune response following Pfizer/BioNTech booster than AstraZeneca, and slightly stronger than after 2 doses of Pfizer/BioNTech (not peer reviewed) ¹⁴¹ Germany: 4-fold greater immune response than 2 doses of AstraZeneca ¹⁴² South Korea: 6-fold greater neutralising antibody response than 2 doses of AstraZeneca Germany: Higher neutralising antibody response against wild-type, Alpha, Beta, Gamma and Delta variants than AZ-AZ ¹⁴³	Canada, Denmark, Finland, France, Germany, Sweden, Norway, Spain and South Korea ¹⁴⁴
PF-AZ	UK: Greater systemic side effects (mild-moderate symptoms) following the booster dose than with 2 doses of the same vaccine; no safety concerns ¹³⁶ Greater reactogenicity with first of homologous and heterologous prime-boost immunisation with BNT162b2 and ChAdOx1-nCoV19: a prospective cohort study increased reactogenicity (55.2%; 46.1-64.1) vs Pfizer/BioNTech-Pfizer/BioNTech (33.3%; 23.4-44.5) ¹³⁸	UK: 4 week dose interval: weaker antibody response than after 2 doses of Pfizer/BioNTech vaccine (but stronger than after 2 doses of AstraZeneca vaccine) ¹⁴⁰	-
AZ-mRNA (PF or MO)	-	Effectiveness in Canada: Infection: 90% (89-91); 87% (85-89); Hospitalisation: 99% (98-100); 98% (95-99) ¹⁴⁹	-
Primary series of PF, J&J or MO followed by PF, J&J or MO booster	Reactogenicity for all combinations similar to primary series ⁹⁴	Homologous boosters increased neutralising antibody titres 4.2 to 20-fold; Heterologous boosters increased neutralising antibody titres 6 to 76-fold ⁹⁴	-
AZ, MO and PF	-	Canada: Trial underway mixing and matching all three vaccines with study arms assessing 4 week and 16 week dose intervals ¹⁴⁵ Denmark: Vaccine effectiveness against infection: AZ-PF or AZ-MO: 88% (83-92) ¹⁴⁶	AstraZeneca followed by either Moderna or Pfizer/BioNTech: Denmark, Finland, France, Germany, Sweden, Norway and Spain ¹⁴⁴
Sinovac primary series	-	Chile: Symptomatic infection: Sinovac booster: 78.8% (76.8-80.6); PF booster: 96.5% (96.2-96.7); AZ booster: 93.2% (92.9-93.6); Hospitalisation: Sinovac: 86.3% (83.7-88.5); PF: 96.1% (95.3-96.9); AZ: 97.7 (97.3-98.0); Death: Sinovac: 86.7% (80.5-91.0); PF: 96.8% (93.9-98.3); AZ: 98.1% (97.3-98.6) ¹⁰⁴	Sinovac-AZ: Thailand

Adverse Events Following Immunisation with WHO EUL Vaccines

Adverse events following immunisation (AEFIs) are any reactions occurring after immunisation. They can be either expected or unexpected. The vaccine may not actually cause the AEFI; it may occur coincidentally as millions of people are being vaccinated so some people may get sick after vaccination but this does not necessarily mean that it is due to the vaccine. Special investigations determine whether they are due to the vaccine. Adverse events of special interest (AESIs) are of scientific and medical concern that are found through active surveillance, that have the potential to be causally associated with a vaccine and that need to be carefully monitored and confirmed by further special studies.

For all injectable vaccines, appropriate medical treatment and supervision should always be readily available in case of an anaphylactic event following administration.

	ASTRAZENECA	MODERNA	PFIZER/BIONTECH	JOHNSON & JOHNSON	SINOPHARM	SINOVAC	CLOVER	BHARAT BIOTECH
Adverse events following immunisation (AEFIs)*	<p>Very common (more than 1 in 10 people): headache, nausea, muscle pain, joint pain, injection site tenderness/ pain/ warmth/ itch, fatigue, malaise, fever, chills</p> <p>Common (between 1 in 10 and 1 in 100 people): injection site swelling/ redness¹⁴⁷</p>	<p>Injection site pain (92%)/ swelling (15%)/ redness (10%), fatigue (70%), headache (65%), muscle pain (62%), joint pain (46%), fever (16%), chills (45%), nausea/vomiting (23%), axillary swelling/tenderness (20%)¹⁴⁸</p>	<p>Very common: headache, muscle pain, joint pain, injection site pain/ swelling, fatigue, fever, chills;</p> <p>Common: nausea, injection site redness¹⁴⁷</p> <p>Uncommon (between 1 in 100 and 1 in 1000 people): lymphadenopathy, insomnia, pain in extremity of vaccinated arm, malaise, injection site itch;</p> <p>Rare: (between 1 in 1000 and 1 in 10,000): acute peripheral facial paralysis¹⁴⁹</p>	<p>Injection site pain/ redness/ swelling, headache, fatigue, muscle pain, nausea, fever¹⁵⁰</p>	<p>Injection site pain (16%)/ itch (1%)/ swelling (2%)/ redness (1%), fever (4%), fatigue (3%), nausea (1%), headache (1%), diarrhoea (1%), muscle pain (<1%), itch (non-injection site) (1%)¹⁵¹</p>	<p>Fatigue (8.3%), fever (3.3%), diarrhoea (0.8%), nausea (1.7%), headache (2.5%), muscle pain (1.7%), injection site pain (10.0%)/ redness (0%)/ swelling (0%)¹⁵²</p>	<p>Very common: Injection site pain, fatigue, headache</p> <p>Common: Injection site erythema, myalgia, arthralgia, loss of appetite, nausea, chills</p> <p>Uncommon: Injection site swelling, fever¹⁹</p>	<p>Common: Injection site pain/redness/ itching, headache, fever, malaise, fatigue, body ache</p>
Adverse events of special interest (AESIs)	<p>Thrombosis with thrombocytopenia syndrome (TTS) (see page 13 for estimated risk);</p> <p>EMA PRAC: Guillain-Barre syndrome (GBS)¹⁵³</p> <p>Australia: Guillain-Barre syndrome: 52 cases (10.4 per million doses)¹⁵⁴</p> <p>Australia: Immune thrombocytopenia (ITP)</p>	<p>Myopericarditis (most common in younger males)</p> <p>USA VAERS: myocarditis cases per million second doses: 18-24 year males 38.5, females: 5.3; 25-29 year males: 17.2, females: 5.7¹⁵⁵</p> <p>ITP**¹⁵⁶</p>	<p>Myopericarditis (most common in younger males)</p> <p>USA VAERS: myocarditis cases per million second doses: 12-15 year males: 39.9, females: 3.9; 16-17 year males: 69.1, females: 7.9;</p> <p>18-24 year males: 36.8, females: 2.5; 25-29 year males 10.8, females: 1.2¹⁵⁵</p> <p>>1 in 20,000 males under 25 years of age¹⁴</p> <p>Israel: 1 to 5 cases of myocarditis per 100,000 persons^{157,158}</p> <p>ITP**¹⁵⁶</p>	<p>TTS (see page 14 for estimated risk)</p> <p>USA: Guillain-Barre Syndrome: 100 preliminary reports of GBS following 12.5 million doses of vaccine administered (mostly males >50 years)¹⁵⁹</p>	-	-	-	-

*Details for AstraZeneca, Moderna, Pfizer/BioNTech and Johnson & Johnson from product information sheets in SRA countries, based on data from clinical trials; Sinopharm, Sinovac and Bharat Biotech details from published clinical trials

**The ITP cases are mostly without the thrombotic events characteristic of TTS

Serious Adverse Events

Caution is required when comparing safety profiles as definitions and reporting systems vary in trials and in particular phase IV studies. Risk of TTS in PICs available in Appendix 6.

VACCINE	VACCINE SAFETY
AstraZeneca	<p>108 SAEs in 12,282 (0.9%) vaccine recipients and 127 in 11,962 (1.1%) placebo recipients; 7 deaths all considered unrelated to vaccination (2 vaccine, 5 placebo)¹⁶⁰ US Phase III study: No serious safety concerns involving 32,449 participants¹⁷ (not peer-reviewed) EMA investigation: possible link between the AstraZeneca vaccine and Thrombosis with Thrombocytopenia Syndrome (TTS) Blood clots affected the brain (central venous sinus thrombosis, CVST) and abdomen (splanchnic vein thrombosis) There have been reports of 169 cases of CVST and 53 cases of splanchnic vein thrombosis in ~34 million vaccinated people in Europe The EMA confirmed the overall benefits of the vaccine in preventing COVID-19 outweigh the risks of side effects⁹ UK: Risk factors for death in patients with TTS following the AstraZeneca vaccine: baseline platelet count; and intracranial haemorrhage¹⁶⁰ TTS reported to occur in ~1 in 50,000 vaccinated adults in Australia¹¹ Several countries introduced age recommendations for the vaccine: >60 years in Germany and Australia; >55 years in France and Canada; >40 years in the UK¹⁶¹⁻¹⁶³ EMA has started a review of reports of capillary leak syndrome following 5 cases of this very rare disorder post vaccination¹⁶⁴ WHO GACVS reports Guillain Barre Syndrome (GBS) rates following adenovirus vector vaccines: EU/EEA: 4.4; AUS: 9.7; KOR: 0.4; PHL: <1¹⁶⁵ Guillain-Barre Syndrome in England: IRR 15-21 days: 2.90 (2.15-3.92); Scotland: IRR 1-28 days: 2.32 (1.08-5.02); following SARS-CoV-2 infection: IRR 1-28 days: 5.25 (3.00-9.18); Bell's Palsy in England: IRR 15-21 days: 1.29 (1.08-1.56); IRR 1-28 days: 1.07 (0.94-1.21)¹⁶⁶ Immune thrombocytopenia (ITP) in Victoria, Australia: 8 cases per million doses (17 cases; 15 after second dose) (Expected background rate: 20-49 years: 1.9; ≥50 years: 4.1)¹⁶⁷</p>
Gamaleya	<p>45 SAEs in 16,427 (0.3%) vaccine recipients and 23 in 5,435 (0.4%) placebo recipients; 4 deaths all considered unrelated to vaccination (3 vaccine, 1 placebo)²⁰</p>
Johnson & Johnson	<p>83 SAEs in 21,895 (0.4%) vaccine recipients and 96 in 21,888 placebo recipients (0.4%); 19 deaths all considered unrelated to vaccination (3 vaccine, 16 placebo)²⁴ EMA investigation of 8 reports of TTS. Most cases occurred in women <60 years of age but specific risk factors have not been confirmed⁹ USA: Cases of TTS per million doses: Overall: 3.1; Female: 5.2; Male: 1.5¹⁶⁸ Deaths: 5 (4 female, 1 male) Guillain-Barre Syndrome: 100 preliminary reports of GBS following 12.5 million doses of vaccine administered in USA (mostly males >50 years)¹⁵⁹ WHO GACVS reports Guillain Barre Syndrome (GBS) rates following adenovirus vector vaccines: USA: 7.8; KOR: 0.9; EU/EEA: AZ: 2.1¹⁶⁵</p>
Moderna	<p>153 SAEs in 15,166 (1.0%) placebo recipients and 147 in 15,185 (1.0%) vaccine recipients; 5 deaths considered unrelated to vaccine (2 vaccine, 3 placebo)²⁷ Anaphylaxis reported in the US at a rate of 2.5 per million doses¹⁶⁸ No obvious safety signals among pregnant women who received mRNA COVID-19 vaccines in USA¹²⁷ USA: Myo/pericarditis reported in 40.6 males and 4.2 females aged 12-29 years per million second doses of mRNA vaccine; and 2.4 males and 1.0 females aged 30+¹⁶⁹ USA VAERS: myocarditis cases per million second doses: 18-24 year old males: 38.5, females: 5.3; 25-29 year old males: 17.2, females: 5.7¹⁵⁵ Ontario, Canada: Myo/pericarditis cases per million second doses in those aged 18-24 years: Males 198.6; Females 59.6¹⁷⁰ Overall rates in the UK per million second doses: Myocarditis: 28.3; Pericarditis: 17.2¹⁷¹ EMA PRAC: French study: 57 extra cases of myocarditis per million 16-24-year-old males compared to unexposed; Nordic study: 190 extra cases of myocarditis per million 16-24-year-old males¹⁷² Myo/pericarditis in Ontario, Canada: Rates in males 18-24 years 5.1 (1.9-15.5) times higher following Moderna second dose than Pfizer/BioNTech; Rates higher with shorter dose interval (i.e. ≤30 days)¹⁷³ Myocarditis excess cases in people <40 years in the UK: First dose: 8 (4-9) per million; Second dose: 15 (12-16)¹⁷⁴ Myo/pericarditis in Australia: 25 (18-33)¹⁷⁵ Australia: Myo/pericarditis following boosters: 4 cases¹⁷⁶</p>
Novavax	<p>SAEs at low levels and similar between vaccine and placebo groups¹⁷⁷</p>
Pfizer/BioNTech	<p>SAEs and deaths were low and comparable between vaccine and placebo groups (total 37,586 participants)³² Anaphylaxis reported in the US at a rate of 4.7 per million doses¹⁶⁸ No obvious safety signals among pregnant women who received mRNA COVID-19 vaccines in USA¹²⁷ Brazil: SAEs: 5.4/100,000 doses USA: Myo/pericarditis reported in 40.6 males and 4.2 females aged 12-29 years per million second doses of mRNA vaccine; and 2.4 males and 1.0 females aged 30+¹⁶⁹ USA VAERS: myocarditis cases per million second doses: 12-15 year males: 39.9, females: 3.9; 16-17 year males: 69.1, females: 7.9; 18-24 year males: 36.8, females: 2.5; 25-29 year males 10.8, females: 1.2¹⁵⁵ Ontario, Canada: Myo/pericarditis cases per million second doses in those aged 18-24 years: Males 35.5; females 39.9¹⁷⁰ Overall rates in the UK per million second doses: Myocarditis 7.4; Pericarditis 5.6¹⁷¹ Israel: Myo/pericarditis: 106.9 (69.3-144.6) cases per million in those aged 16-29¹⁷⁸; 137.3 (81.1-194.6) cases per million people aged 16-19¹⁷⁹ Haemorrhagic stroke in England: IRR 15-21 days: 1.38 (1.12-1.71) (not replicated in Scotland data)¹⁶⁵ Israel: Myo/pericarditis: 16-19 year old males: Second dose: 161 cases per million; Third dose: 52 cases per million¹⁸⁰ EMA PRAC: French study: 26 extra cases of myocarditis per million 12-29-year-old males compared to unexposed; Nordic study: 130 extra cases of myocarditis per million 12-29-year-old males¹⁷² Hong Kong: Myo/pericarditis in 12-17 year-olds: After first dose: 34 (11-95) cases per million; Second dose: 212 (138-323); Males, first dose: 56 (24-125); Males, second dose: 373 (270-513)¹⁸¹ Myo/pericarditis in Ontario, Canada: Rates higher with shorter dose interval (i.e. ≤30 days)¹⁷³ Myocarditis excess cases in people <40 years in the UK: First dose: 2 (1-3) per million; Second dose: 3 (2-4)¹⁷⁴ Myo/pericarditis in Australia: 16 (15-17)¹⁷⁵ USA: Myocarditis 5-11 years: 11 confirmed cases following ~8 million doses administered¹⁸² Australia: Myo/pericarditis following boosters: 14 cases¹⁷⁶ France: MIS-C following vaccination in 12-17 year olds: 1.1 cases per million doses (post-SARS-CoV-2 MIS-C in the same age group in the same population was 113 per million doses)¹⁸³ USA: MIS-C following vaccination in 12-20 year olds: 21 cases (1 case per million persons vaccinated)¹⁸⁴</p>
Sinovac	<p>Brazil: SAEs: 79.7/100,000 doses Safety in Chile 6-11 years: Adverse events following 0.011% of doses administered (most common: vomiting, itching, injection site pain and erythema)¹⁸⁵</p>

Risk of Myo/Pericarditis in 12-17 Year Olds Following mRNA Vaccines

Estimated number of myo/pericarditis cases that potentially might occur in Pacific Island Countries if all 12-17 year olds received the Pfizer/BioNTech or Moderna vaccine, based on official country population estimates and incidence myo/pericarditis (highest and lowest estimates) in other settings. Nearly all myo/pericarditis cases related to mRNA vaccination are mild and managed conservatively.

COUNTRY	TOTAL POPULATION	ESTIMATED POPULATION AGED 12-17 YEARS*	POTENTIAL NUMBER OF MYO/PERICARDITIS CASES IF ALL 12-17 YEAR OLDS RECEIVED THE PFIZER/BIONTECH VACCINE**	POTENTIAL NUMBER OF MYO/PERICARDITIS CASES IF ALL 12-17 YEAR OLDS RECEIVED THE MODERNA VACCINE ***
American Samoa	55,519	7,217	0.3-1.5	0.1-1.4
Cook Islands	15,300	1,989	<1	<1
Federated States of Micronesia	102,300	13,299	0.5-2.8	0.3-2.6
Fiji	867,000	112,710	4.2-23.9	2.3-22.0
French Polynesia	275,918	35,869	1.3-7.6	0.7-7.0
Guam	159,358	20,717	0.8-4.4	0.4-4.1
Kiribati	113,400	14,742	0.6-3.1	0.3-2.9
Marshall Islands	54,900	7,137	0.3-1.5	0.1-1.4
Nauru	10,900	1,417	<1	<1
New Caledonia	271,407	35,283	1.3-7.5	0.7-6.9
Niue	1,611	209	<1	<1
Northern Mariana Islands	53,883	7,005	0.3-1.5	0.1-1.4
Palau	18,000	2,340	<1	<1
Papua New Guinea	7,744,700	1,006,811	37.7-213.4	20.8-196.8
Samoa	195,979	25,477	1.0-5.4	0.5-5.0
Solomon Islands	642,000	83,460	3.1-17.7	1.7-16.3
Tokelau	1,160	151	<1	<1
Tonga	99,419	12,924	0.5-2.7	0.3-2.5
Tuvalu	10,507	1,366	<1	<1
Vanuatu	272,173	35,382	1.3-7.5	0.7-6.9
Wallis and Futuna	11,558	1,503	<1	<1
All Pacific Island Countries	10,976,992	1,427,009	53.4-302.5	29.5-279.0

* Based on estimate of 13% of population aged 12-17 years

** Based on estimates of myo/pericarditis occurring in 212 per million second doses of Pfizer/BioNTech in 12-17 year olds in Hong Kong and 37.4 per million second doses in 16-17 year olds in USA (VAERS data)^{155,181}

*** Based on estimates of myo/pericarditis occurring in 195.5 per million doses in 18-24 year olds in Canada (data not available for <18 years) and 20.7 per million second doses in 18-24 year olds in USA (VAERS data; not available for <18 years)^{155,173}

Who Can be Vaccinated Based on WHO SAGE Recommendations?

WHO SAGE have made recommendations for use of AstraZeneca, Moderna, Pfizer/BioNTech, Johnson & Johnson, Sinopharm, Sinovac, Bharat Biotech and Novavax vaccines:

<https://www.who.int/groups/strategic-advisory-group-of-experts-on-immunization/covid-19-materials>

	ASTRAZENECA	MODERNA	PFIZER/BIONTECH	JOHNSON & JOHNSON	SINOPHARM	SINOVAC	BHARAT BIOTECH	NOVAVAX
Minimum Age	18 years	18 years	5 years	18 years	18 years	18 years	18 years	18 years
Maximum Age (SAGE WHO)	None	None	None	None	None	None	None	None
Pregnancy	Yes if high priority group & approved by health provider	Yes if high priority group & approved by health provider	Yes if high priority group & approved by health provider	Yes if high priority group & approved by health provider	Yes if high priority group & approved by health provider	Yes if high priority group & approved by health provider	Yes if the benefits outweigh the potential risks	Yes if the benefits outweigh the potential risks
Breastfeeding	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
People previously infected with SARS-CoV-2	May delay 6 months; Within 90 days if VOCs associated with reduced effectiveness are circulating (e.g. Beta)	May delay 6 months; Within 90 days if VOCs associated with reduced effectiveness are circulating (e.g. Beta)	May delay 6 months; Within 90 days if VOCs associated with reduced effectiveness are circulating (e.g. Beta)	May delay 6 months; <6 months may be advisable if VOCs with reduced neutralisation activity are circulating	May delay 6 months; <6 months may be advisable if VOCs associated with reduced effectiveness are circulating	May delay 6 months; <6 months may be advisable if VOCs associated with reduced effectiveness are circulating	May delay 6 months; <6 months may be advisable if VOCs associated with reduced effectiveness are circulating	May delay 6 months; <6 months may be advisable if VOCs associated with reduced effectiveness are circulating
Immunocompromised Including HIV	An additional dose at least 1 month, and within 3 months, after completing the primary series	An additional dose at least 1 month, and within 3 months, after completing the primary series	An additional dose at least 1 month, and within 3 months, after completing the primary series	An additional dose at least 1 month, and within 3 months, after completing the primary series	An additional dose at least 1 month, and within 3 months, after completing the primary series	An additional dose at least 1 month, and within 3 months, after completing the primary series	An additional dose at least 1 month, and within 3 months, after completing the primary series	An additional dose at least 1 month, and within 3 months, after completing the primary series
History of Anaphylaxis (Severe Allergy)	Yes (unless the allergy is to the vaccine or its components)	Yes (unless the allergy is to the vaccine or its components)	Yes (unless the allergy is to the vaccine or its components)	Yes (unless the allergy is to the vaccine or its components)	Yes (unless the allergy is to the vaccine or its components)	Yes (unless the allergy is to the vaccine or its components)	Yes (unless the allergy is to the vaccine or its components)	Yes (unless the allergy is to the vaccine or its components)

Vaccine Development Pipeline

WHO has recommended that vaccines adopted by countries have WHO SAGE EUL and/or Stringent Regulatory Approval. Last updated 7 February 2021.

VACCINE TYPE	NUMBER OF VACCINE CANDIDATES AT EACH PHASE OF DEVELOPMENT				
	PRE-CLINICAL	PHASE I/II	PHASE III	PHASE IV	IN USE*
RNA	25	13	3	2	2 (Pfizer/BioNTech, Moderna)
DNA	16	9	4	0	1 (Zydus Cadila Healthcare Limited)
Vector (non-replicating)	26	8	2	3	4 (CanSino, Gamaleya, Johnson & Johnson, AstraZeneca)
Vector (replicating)	18	7	1	0	0
Inactivated	5	9	7	3	9 (Sinopharm/BIBP; Sinopharm/WIBP; Sinovac; Bharat; Chumakov; Research Institute for Biological Safety Problems; Shenzhen Kangtai Biological Products; Shifa Pharmed, Erciyes University)
Live-attenuated	2	1	0	0	0
Protein subunit	72	20	16	1	11 (Novavax; Vector institute; Anhui Zhifei Longcom Biopharmaceutical Chinese Academy of sciences; Center for Genetic Engineering and Biotechnology; Instituto Finlay de Vacunas [peptides 1 and 2]; Medigen Vaccine Biologics; Vaxine Pty Medytox CinnaGen Co; Biological E Ltd; Razi Vaccine and Serum Research Institute; National Vaccine and Serum Institute/Lanzhou Institute of Biological Products Co Ltd)
Virus-like particle	21	4	2	0	0
Other/unknown	32	6	0	0	0

*Not all vaccines in use have SRA (as recognised by WHO) approval (see Vaccine specifications table and WHO SAGE Emergency Use Listing and prequalification timeline for approval status of vaccines).

Source: London School of Hygiene and Tropical Medicine COVID-19 vaccine tracker.

Weekly COVID-19 Vaccine Updates
Number 45, 17 February 2022



WHO SAGE Emergency Use Listing and Prequalification Timeline

MANUFACTURER	NAME OF VACCINE	PLATFORM	STATUS OF ASSESSMENT	ANTICIPATED DECISION DATE
Pfizer/BioNTech	BNT162b2/COMIRNATY Tozinameran (INN)	mRNA	Final decision made	Authorised 31/12/20
AstraZeneca	AZD1222	Adenoviral vector	Final decision made	SK Bio: Authorised 15/02/21 EU nodes: Authorised 16/04/21 CSL, Australia: Authorised 09/07/21 Daiichi Sankyo, Japan: Authorised 09/07/21
Serum Institute of India	Covishield (ChAdOx1_nCoV19)	Adenoviral vector	Final decision made	Authorised 15/02/21
Sinopharm/Beijing Institute of Biological Products (BIBP)	SARS-CoV-2 Vaccine (Vero Cell), Inactivated (InCoV)	Inactivated	In progress	Authorised: 07/05/2021
Sinovac	SARS-CoV-2 Vaccine (Vero Cell), Inactivated	Inactivated	In progress	Authorised 01/06/2021
Moderna	mRNA-1273	mRNA	In progress (to use abridged procedure relying on EMA)	Authorised 30/04/2021
Johnson & Johnson	Ad26.COV2.S	Adenoviral vector	Final decision made	Authorised 12/03/21
Russian Direct Investment Fund	Sputnik V	Adenoviral vector	Process restarted, awaiting completion of rolling submission	Will be determined when all data are submitted
Bharat Biotech	Covaxin; BBV152	Inactivated	Rolling data assessment started 6 July 2021	Authorised 03/11/2021
CanSino Biologics	Ad5-nCoV	Adenoviral vector	Rolling data assessment started 9 August 2021	TBC
Novavax	NVX-CoV2373	Protein subunit	Rolling data assessment started 19 August 2021	Authorised 20/12/2021
CureVac	Zorecimeran	mRNA	Application withdrawn by manufacturer	-
Clover Biopharmaceuticals	SCB-2019 (CpG 1018/Alum)	Protein subunit	Rolling data starting 20 September	TBC

Source: WHO Guidance Document: Status of COVID-19 Vaccines within WHO EUL/PQ evaluation process.
Available at: <https://www.who.int/teams/regulation-prequalification/eul/covid-19>

References

- World Health Organisation. Extraordinary meeting of the Strategic Advisory Group of Experts on Immunization (SAGE) – 19 January 2022. Available at:
- Australian Technical Advisory Group on Immunisation (ATAGI). ATAGI update following weekly COVID-19 meeting – 26 May 2021. Available at: <https://www.health.gov.au/news/atagi-update-following-weekly-covid-19-meeting-26-may-2021>.
- Australian Technical Advisory Group on Immunisation (ATAGI) recommendations on the use of a booster dose of COVID-19 vaccine 27 October 2021. Available at: <https://www.health.gov.au/sites/default/files/documents/2021/10/atagi-recommendations-on-the-use-of-a-booster-dose-of-covid-19-vaccine.pdf>.
- UK Government Department of Health and Social Care press release 14 September 2021. Most vulnerable to be offered COVID-19 booster vaccines from next week. Available at: https://cdn.who.int/media/docs/default-source/immunization/sage/2021/october/sage_oct2021_meetinghighlights.pdf?sfvrsn=3dcae610_11.
- United States Centers for Disease Control and Prevention. Who Is Eligible for a COVID-19 Vaccine Booster Shot? Updated 7 October 2021. Available at: <https://www.cdc.gov/coronavirus/2019-ncov/vaccines/booster-shot.html#Data>.
- Lund FE, Randall TD. Scent of a vaccine. *Science (80-)*. 2021;373(6553):397-399. doi:10.1126/science.abg9857
- Center for Disease Control (CDC) Advisory Committee on Immunization Practices (ACIP). Thrombosis with thrombocytopenia syndrome (TTS) following Janssen COVID-19 vaccine 23 April 2021. Available at: <https://www.cdc.gov/vaccines/acip/meetings/downloads/slides-2021-04-23/03-COVID-Shimabukuro-508.pdf>.
- European Medicines Agency (EMA). AstraZeneca's COVID-19 vaccine: EMA finds possible link to very rare cases of unusual blood clots with low blood platelets 7 April 2021. Available at: <https://www.ema.europa.eu/en/news/astrazenecas-covid-19-vaccine-ema-finds-possible-link-very-rare-cases-unusual-blood-clots-low-blood>.
- European Medicines Agency (EMA). COVID-19 Vaccine Janssen: EMA finds possible link to very rare cases of unusual blood clots with low blood platelets 20 April 2021. Available at: <https://www.ema.europa.eu/en/news/covid-19-vaccine-janssen-ema-finds-possible-link-very-rare-cases-unusual-blood-clots-low-blood>.
- European Medicines Agency (EMA) press release. AstraZeneca's COVID-19 vaccine: benefits and risks in context 23 April 2021. Available at: <https://www.ema.europa.eu/en/news/astrazenecas-covid-19-vaccine-benefits-risks-context>.
- Australian Government Therapeutic Goods Administration (TGA). COVID-19 vaccine weekly safety report - 12-08-2021. Available at: <https://www.tga.gov.au/periodic/covid-19-vaccine-weekly-safety-report-12-08-2021>.
- UK Government Medicines and Healthcare Products Regulatory Agency. Coronavirus vaccine - weekly summary of Yellow Card reporting 17 June 2021. <https://www.gov.uk/government/publications/coronavirus-covid-19-vaccine-adverse-reactions/coronavirus-vaccine-summary-of-yellow-card-reporting>.
- Centers for Disease Control and Prevention (CDC). Selected Adverse Events Reported after COVID-19 Vaccination. Updated 27 May 2021. Available at: <https://www.cdc.gov/coronavirus/2019-ncov/vaccines/safety/adverse-events.html>.
- United States Advisory Committee on Immunization Practices (ACIP) ACIP Presentation Slides: June 23-25, 2021 Meeting. Available at: <https://www.cdc.gov/vaccines/acip/meetings/slides-2021-06.html>.
- United States Advisory Committee on Immunization Practices (ACIP). ACIP Presentation Slides: August 30, 2021 Meeting. Available at: <https://www.cdc.gov/vaccines/acip/meetings/slides-2021-08-30.html>.
- Voysey M, Costa Clemens SA, Madhi SA, et al. Single-dose administration and the influence of the timing of the booster dose on immunogenicity and efficacy of ChAdOx1 nCoV-19 (AZD1222) vaccine: a pooled analysis of four randomised trials. *Lancet*. 2021;397(10277):881-891. doi:10.1016/S0140-6736(21)00432-3
- AstraZeneca press release. AZD1222 US Phase III primary analysis confirms safety and efficacy 25 March 2021. Available at: <https://www.astrazeneca.com/media-centre/press-releases/2021/azd1222-us-phase-iii-primary-analysis-confirms-safety-and-efficacy.html#:~:text=Positive high-level results from,on Monday 22 March 2021.&text=The vaccine was well tolerated,to the vaccine were>.
- Ella R, Reddy S, Blackwelder W, et al. Efficacy, safety, and lot-to-lot immunogenicity of an inactivated SARS-CoV-2 vaccine (BBV152): interim results of a randomised, double-blind, controlled, phase 3 trial. *Lancet*. November 2021;2021.06.30.21259439. doi:10.1016/S0140-6736(21)02000-6
- Bravo L, Smolenov I, Han HH, et al. Efficacy of the adjuvanted subunit protein COVID-19 vaccine, SCB-2019: a phase 2 and 3 multicentre, double-blind, randomised, placebo-controlled trial. *Lancet*. 2022;399(10323):461-472. doi:10.1016/S0140-6736(22)00055-1
- Logunov DY, Dolzhikova I V, Shcheblyakov D V, et al. Safety and efficacy of an rAd26 and rAd5 vector-based heterologous prime-boost COVID-19 vaccine. *Lancet*. 2021.
- Russian Direct Investment Fund Press Release 2 June 2021. Sputnik Light (the first component of Sputnik V vaccine) demonstrates 78.6-83.7% efficacy among the elderly in Argentina. Available at: <https://sputnikvaccine.com/newsroom/pressreleases/sputnik-light-vaccine-the-first-component-of-sputnik-v-vaccine-demonstrates-78-6-83-7-efficacy-among/>.
- El Sahly HM, Baden LR, Essink B, et al. Efficacy of the mRNA-1273 SARS-CoV-2 Vaccine at Completion of Blinded Phase. *N Engl J Med*. September 2021. doi:10.1056/NEJMoa2113017
- Sadoff J, Gray G, Vandebosch A, et al. Final Analysis of Efficacy and Safety of Single-Dose Ad26.COV2.S. *N Engl J Med*. February 2022. doi:10.1056/NEJMoa2117608
- US federal Drug Administration (FDA) Briefing Document Janssen Ad26.COV2.S Vaccine for the Prevention of COVID-19. Vaccines and Related Biological Products Advisory Committee Meeting February 26, 2021. Available at: <https://www.fda.gov/media/146217/download>.
- Sadoff J, Gray G, Vandebosch A, et al. Safety and Efficacy of Single-Dose Ad26.COV2.S Vaccine against Covid-19. *N Engl J Med*. 2021;384(23):2187-2201. doi:10.1056/NEJMoa2101544
- Sisonke Phase 3b clinical trial. Available at: <http://sisonkestudy.samrc.ac.za/>.
- Baden LR, El Sahly HM, Essink B, et al. Efficacy and Safety of the mRNA-1273 SARS-CoV-2 Vaccine. *N Engl J Med*. 2021. doi:10.1056/nejmoa2035389
- Moderna press release. Moderna Provides Clinical and Supply Updates on COVID-19 Vaccine Program Ahead of 2nd Annual Vaccines Day 13 April 2021. Available at: <https://investors.modernatx.com/news-releases/news-release-details/moderna-provides-clinical-and-supply-updates-covid-19-vaccine>.
- Ali K, Berman G, Zhou H, et al. Evaluation of mRNA-1273 SARS-CoV-2 Vaccine in Adolescents. *N Engl J Med*. August 2021;NEJMoa2109522. doi:10.1056/NEJMoa2109522
- Heath PT, Galiza EP, Baxter DN, et al. Safety and Efficacy of NVX-CoV2373 Covid-19 Vaccine. *N Engl J Med*. June 2021;NEJMoa2107659. doi:10.1056/NEJMoa2107659
- Dunkle LM, Kotloff KL, Gay CL, et al. Efficacy and Safety of NVX-CoV2373 in Adults in the United States and Mexico. *N Engl J Med*. December 2021;2021.10.05.21264567. doi:10.1056/NEJMoa2116185
- World Health Organisation (WHO). *Background Document on the mRNA Vaccine BNT162b2 (Pfizer-BioNTech) against COVID-19*; 2021. [https://www.who.int/publications/i/item/background-document-on-mrna-vaccine-bnt162b2-\(pfizer-biontech\)-against-covid-19](https://www.who.int/publications/i/item/background-document-on-mrna-vaccine-bnt162b2-(pfizer-biontech)-against-covid-19).
- Thomas SJ, Moreira ED, Kitchin N, et al. Safety and Efficacy of the BNT162b2 mRNA Covid-19 Vaccine through 6 Months. *N Engl J Med*. September 2021. doi:10.1056/NEJMoa2110345
- World Health Organisation Extraordinary meeting of the Strategic Advisory Group of Experts on Immunization (SAGE) – 29 April 2021. Available at: [https://www.who.int/news-room/events/detail/2021/04/29/default-calendar/extraordinary-meeting-of-the-strategic-advisory-group-of-experts-on-immunization-\(sage\)-29-april-2021](https://www.who.int/news-room/events/detail/2021/04/29/default-calendar/extraordinary-meeting-of-the-strategic-advisory-group-of-experts-on-immunization-(sage)-29-april-2021).
- Tanriover MD, Doğanay HL, Akova M, et al. Efficacy and safety of an inactivated whole-virion SARS-CoV-2 vaccine (CoronaVac): interim results of a double-blind, randomised, placebo-controlled, phase 3 trial in Turkey. *Lancet*. 2021;398(10296):213-222. doi:10.1016/S0140-6736(21)01429-X
- Palacios R, Batista AP, Albuquerque CSN, et al. Efficacy and Safety of a COVID-19 Inactivated Vaccine in Healthcare Professionals in Brazil: The PROFISCOV Study. *SSRN Electron J*. 2021.
- Halperin SA, Ye L, MacKinnon-Cameron D, et al. Final efficacy analysis, interim safety analysis, and immunogenicity of a single dose of recombinant novel coronavirus vaccine (adenovirus type 5 vector) in adults 18 years and older: an international, multicentre, randomised, double-blind, placebo-cont. *Lancet*. December 2021. doi:10.1016/S0140-6736(21)02753-7
- Lopez Bernal J, Andrews N, Gower C, et al. Effectiveness of Covid-19 Vaccines against the B.1.617.2 (Delta) Variant. *N Engl J Med*. July 2021;NEJMoa2108891. doi:10.1056/NEJMoa2108891
- Sheikh A, McMenamin J, Taylor B, Robertson C. SARS-CoV-2 Delta VOC in Scotland: demographics, risk of hospital admission, and vaccine effectiveness. *Lancet*. June 2021. doi:10.1016/S0140-6736(21)01358-1
- Pouwels KB, Pritchard E, Matthews PC, et al. Effect of Delta variant on viral burden and vaccine effectiveness against new SARS-CoV-2 infections in the UK. *Nat Med*. October 2021. doi:10.1038/s41591-021-01548-7
- Martinez-Baz I, Trobajo-Sanmartín C, Miquelz A, et al. Product-specific COVID-19 vaccine effectiveness against secondary infection in close contacts, Navarre, Spain, April to August 2021. *Eurosurveillance*. 2021;26(39). doi:10.2807/1560-7917.ES.2021.26.39.2100894
- Chadeau-Hyam M, Wang H, Eales O, et al. REACT-1 study round 14: High and increasing prevalence of SARS-CoV-2 infection among school-aged children during September 2021 and vaccine effectiveness against infection in England. *medRxiv*. January 2021;2021.10.14.21264965. doi:10.1101/2021.10.14.21264965
- Thiruvengadam R, Awasthi A, Medigeshi G, et al. Effectiveness of ChAdOx1 nCoV-19 vaccine against SARS-CoV-2 infection during the delta (B.1.617.2) variant surge in India: a test-negative, case-control study and a mechanistic study of post-vaccination immune responses. *Lancet Infect Dis*. November 2021. doi:10.1016/S1473-3099(21)00680-0
- Cerqueira-Silva T, Oliveira V de A, Pescarini J, et al. Influence of age on the effectiveness and duration of protection in Vaxzevria and CoronaVac vaccines. *medRxiv*. January 2021;2021.08.21.21261501. doi:10.1101/2021.08.21.21261501
- Nasreen S, Chung H, He S, et al. Effectiveness of COVID-19 vaccines against variants of concern in Ontario, Canada. *medRxiv*. January 2021;2021.06.28.21259420. doi:10.1101/2021.06.28.21259420
- Whitaker HJ, Tsang RS, Byford R, et al. Pfizer-BioNTech and Oxford AstraZeneca COVID-19 vaccine effectiveness and immune response among individuals in clinical risk groups. Khub preprint. <https://khub.net/documents/135939561/430986542/RCPGP+VE+riskgroups+paper.pdf/a6b54cd9-419d-9b63-e2bf-5dc796f5a91f>. Published 2021.
- Vacunas contra SARS- CoV-2 utilizadas en Chile mantienen altos niveles de efectividad para evitar hospitalización, ingreso a UCI y muerte. 3 August 2021. Available at: <https://www.minsal.cl/vacunas-contra-sars-cov-2-utilizadas-en-chile-mantienen-altos-niveles-de-efectividad-para-evitar-hospitalizacion-ingreso-a-uci-y-muerte/>.
- Andrews N, Tessier E, Stowe J, et al. Vaccine effectiveness and duration of protection of Comirnaty, Vaxzevria and Spikevax against mild and severe COVID-19 in the UK. *medRxiv*. 2021. doi:10.1101/2021.09.15.21263583
- Skowronski DM, Setayeshgar S, Febriani Y, et al. Two-dose SARS-CoV-2 vaccine effectiveness with mixed schedules and extended dosing intervals: test-negative design studies from British Columbia and Quebec, Canada. *medRxiv*. January 2021;2021.10.26.21265397.

- doi:10.1101/2021.10.26.21265397
50. Andrews N, Stowe J, Kirsebom F, et al. Effectiveness of COVID-19 vaccines against the Omicron (B.1.1.529) variant of concern. *medRxiv*. 2021. doi:10.1101/2021.12.14.21267615
51. Ferguson N, Ghani A, Cori A, Hogan A, Hinsley W, Volz E. Growth, population distribution and immune escape of the Omicron in England. *Imp Coll London*.
52. Kalikreddi SV, Cequeira-Silva T, Vasileiou E, et al. Two-dose ChAdOx1 nCoV-19 vaccine protection against COVID-19 hospital admissions and deaths over time: a retrospective, population-based cohort study in Scotland and Brazil. *Lancet*. December 2021. doi:10.1016/S0140-6736(21)02754-9
53. Andrews N, Tessier E, Stowe J, et al. Duration of Protection against Mild and Severe Disease by Covid-19 Vaccines. *N Engl J Med*. January 2022. doi:10.1056/NEJMoa2115481
54. Martínez-Baz I, Miqueleiz A, Casado I, et al. Effectiveness of COVID-19 vaccines in preventing SARS-CoV-2 infection and hospitalisation, Navarre, Spain, January to April 2021. *Eurosurveillance*. 2021;26(21). doi:10.2807/1560-7917.ES.2021.26.21.2100438
55. Kissling E, Hooiveld M, Sandois Martín V, et al. Vaccine effectiveness against symptomatic SARS-CoV-2 infection in adults aged 65 years and older in primary care: I-MOVE-COVID-19 project, Europe, December 2020 to May 2021. *Eurosurveillance*. 2021;26(29). doi:10.2807/1560-7917.ES.2021.26.29.2100670
56. de Gier B, Kooijman M, Kemmeren J, et al. COVID-19 vaccine effectiveness against hospitalizations and ICU admissions in the Netherlands, April- August 2021. *medRxiv*. January 2021:2021.09.15.21263613. doi:10.1101/2021.09.15.21263613
57. McKeigue PM, McAllister DA, Robertson C, et al. Efficacy of two doses of COVID-19 vaccine against severe COVID-19 in those with risk conditions and residual risk to the clinically extremely vulnerable: the REACT-SCOT case-control study. *medRxiv*. January 2021:2021.09.13.21262360. doi:10.1101/2021.09.13.21262360
58. McKeigue PM, McAllister DA, Hutchinson SJ, et al. Efficacy of vaccination against severe COVID-19 in relation to Delta variant and time since second dose: the REACT-SCOT case-control study. *medRxiv*. January 2021:2021.09.12.21263448. doi:10.1101/2021.09.12.21263448
59. Public Health England (PHE) press release. Vaccines highly effective against hospitalisation from Delta variant. Available at: <https://www.gov.uk/government/news/vaccines-highly-effective-against-hospitalisation-from-delta-variant>.
60. Vasileiou E, Simpson CR, Robertson C, et al. Effectiveness of First Dose of COVID-19 Vaccines Against Hospital Admissions in Scotland: National Prospective Cohort Study of 5.4 Million People. *SSRN Electron J*. 2021. doi:10.2139/ssrn.3789264
61. Sheikh A, Robertson C, Taylor B. BNT162b2 and ChAdOx1 nCoV-19 Vaccine Effectiveness against Death from the Delta Variant. *N Engl J Med*. October 2021. doi:10.1056/NEJMoc2113864
62. Desai D, Khan AR, Soneja M, et al. Effectiveness of an inactivated virus-based SARS-CoV-2 vaccine, BBV152, in India: a test-negative, case-control study. *Lancet Infect Dis*. November 2021. doi:10.1016/S1473-3099(21)00674-5
63. Corchado-García J, Puyraimond-Zemmour D, Hughes T, et al. Real-world effectiveness of Ad26.COV2.S adenoviral vector vaccine for COVID-19. *medRxiv*. January 2021:2021.04.27.21256193. doi:10.1101/2021.04.27.21256193
64. Polinski JM, Weckstein AR, Batech M, et al. Effectiveness of the Single-Dose Ad26.COV2.S COVID Vaccine. *medRxiv*. January 2021:2021.09.10.21263385. doi:10.1101/2021.09.10.21263385
65. Cohn BA, Cirillo PM, Murphy CC, Krigbaum NY, Wallace AW. Breakthrough SARS-CoV-2 infections in 620,000 U.S. Veterans, February 1, 2021 to August 13, 2021. *medRxiv*. January 2021:2021.10.13.21264966. doi:10.1101/2021.10.13.21264966
66. Corchado-García J, Zemmour D, Hughes T, et al. Analysis of the Effectiveness of the Ad26.COV2.S Adenoviral Vector Vaccine for Preventing COVID-19. *JAMA Netw Open*. 2021;4(11):e2132540. doi:10.1001/jamanetworkopen.2021.32540
67. Self WH, Tenforde MW, Rhoads JP, et al. Comparative Effectiveness of Moderna, Pfizer-BioNTech, and Janssen (Johnson & Johnson) Vaccines in Preventing COVID-19 Hospitalizations Among Adults Without Immunocompromising Conditions — United States, March–August 2021. *MMWR Morb Mortal Wkly Rep*. 2021;70(38):1337–1343. doi:10.15585/mmwr.mm7038e1
68. Cohn BA, Cirillo PM, Murphy CC, Krigbaum NY, Wallace AW. SARS-CoV-2 vaccine protection and deaths among US veterans during 2021. *Science (80-)*. November 2021. doi:10.1126/science.abm0620
69. Puranik A, Lenehan PJ, Silvert E, et al. Comparison of two highly-effective mRNA vaccines for COVID-19 during periods of Alpha and Delta variant prevalence. *medRxiv*. January 2021:2021.08.06.21261707. doi:10.1101/2021.08.06.21261707
70. Bruxvoort K, Sy LS, Qian L, et al. Real-World Effectiveness of the mRNA-1273 Vaccine Against COVID-19: Interim Results from a Prospective Observational Cohort Study. *SSRN Electron J*. 2021. doi:10.2139/ssrn.3916094
71. Chemaitelly H, Tang P, Hasan MR, et al. Waning of BNT162b2 Vaccine Protection against SARS-CoV-2 Infection in Qatar. *N Engl J Med*. October 2021. doi:10.1056/NEJMoa2114114
72. Bruxvoort KJ, Sy LS, Qian L, et al. Effectiveness of mRNA-1273 against Delta, Mu, and other emerging variants. *medRxiv*. January 2021:2021.09.29.21264199. doi:10.1101/2021.09.29.21264199
73. Hansen CH, Scheide AB, Moustsen-Helm IR, et al. Vaccine effectiveness against SARS-CoV-2 infection with the Omicron or Delta variants following a two-dose or booster BNT162b2 or mRNA-1273 vaccination series: A Danish cohort study. *medRxiv*. 2021. doi:10.1101/2021.12.20.21267966
74. Tseng HF, Ackerson BK, Luo Y, et al. Effectiveness of mRNA-1273 against SARS-CoV-2 omicron and delta variants. *medRxiv*. January 2022:2022.01.07.22268919. doi:10.1101/2022.01.07.22268919
75. Chung H, He S, Nasreen S, et al. Effectiveness of BNT162b2 and mRNA-1273 covid-19 vaccines against symptomatic SARS-CoV-2 infection and severe covid-19 outcomes in Ontario, Canada: test negative design study. *BMJ*. August 2021:n1943. doi:10.1136/bmj.n1943
76. Chemaitelly H, Ayoub HH, AlMukdad S, et al. Duration of protection of BNT162b2 and mRNA-1273 COVID-19 vaccines against symptomatic SARS-CoV-2 Omicron infection in Qatar. *medRxiv*. January 2022:2022.02.07.22270568. doi:10.1101/2022.02.07.22270568
77. Public Health England. COVID-19 vaccine surveillance report: 1 July 2021 (week 26). Available at: <https://www.gov.uk/government/publications/covid-19-vaccine-surveillance-report>.
78. Emborg H-D, Valentiner-Branth P, Scheide AB, et al. Vaccine effectiveness of the BNT162b2 mRNA COVID-19 vaccine against RT-PCR confirmed SARS-CoV-2 infections, hospitalisations and mortality in prioritised risk groups. *medRxiv*. January 2021:2021.05.27.21257583. doi:10.1101/2021.05.27.21257583
79. Moustsen-Helms IR, Emborg H-D, Nielsen J, et al. Vaccine effectiveness after 1st and 2nd dose of the BNT162b2 mRNA Covid-19 Vaccine in long-term care facility residents and healthcare workers – a Danish cohort study. *medRxiv*. January 2021:2021.03.08.21252200. doi:10.1101/2021.03.08.21252200
80. Britton A, Jacobs Silfka KM, Edens C, et al. Effectiveness of the Pfizer-BioNTech COVID-19 Vaccine Among Residents of Two Skilled Nursing Facilities Experiencing COVID-19 Outbreaks — Connecticut, December 2020–February 2021. *MMWR Morb Mortal Wkly Rep*. 2021;70(11):396–401. doi:10.15585/mmwr.mm7011e3
81. Cavanaugh AM, Fortier S, Lewis P, et al. COVID-19 Outbreak Associated with a SARS-CoV-2 R.1 Lineage Variant in a Skilled Nursing Facility After Vaccination Program — Kentucky, March 2021. *MMWR Morb Mortal Wkly Rep*. 2021;70(17):639–643. doi:10.15585/mmwr.mm7017e2
82. Israel Ministry of Health press release. Data Compiled by the Vaccine Operation's Supervising Committee Published 22 July 2021. Available at: <https://www.gov.il/en/departments/news/22072021-03>.
83. Tartof SY, Slezak JM, Fischer H, et al. Effectiveness of mRNA BNT162b2 COVID-19 vaccine up to 6 months in a large integrated health system in the USA: a retrospective cohort study. *Lancet*. October 2021. doi:10.1016/S0140-6736(21)02183-8
84. Chodick G, Tene L, Rotem RS, et al. The effectiveness of the TWO-DOSE BNT162b2 vaccine: analysis of real-world data. *Clin Infect Dis*. May 2021. doi:10.1093/cid/ciab438
85. Haas EJ, Angulo FJ, McLaughlin JM, et al. Impact and effectiveness of mRNA BNT162b2 vaccine against SARS-CoV-2 infections and COVID-19 cases, hospitalisations, and deaths following a nationwide vaccination campaign in Israel: an observational study using national surveillance data. *Lancet*. 2021;397(10287):1819–1829. doi:10.1016/S0140-6736(21)00947-8
86. Dagan N, Barda N, Kepten E, et al. BNT162b2 mRNA Covid-19 Vaccine in a Nationwide Mass Vaccination Setting. *N Engl J Med*. February 2021:NEJMoa2101765. doi:10.1056/NEJMoa2101765
87. Tang L, Hijano DR, Gaur AH, et al. BNT162b2 mRNA Covid-19 Vaccine in a Routinely Screened Workforce. *JAMA*. May 2021. doi:10.1001/jama.2021.6564
88. Bedston S, Akbari A, Jarvis CI, et al. COVID-19 vaccine uptake, effectiveness, and waning in 82,959 health care workers: A national prospective cohort study in Wales. *Vaccine*. January 2022. doi:10.1016/j.vaccine.2021.11.061
89. Uruguay Ministry of Public Health. Third study of effectiveness of vaccination against SARS-CoV-2 in Uruguay as of June 30, 2021. Press release 3 July 2021. Available at: <https://www.gub.uy/ministerio-salud-publica/comunicacion/noticias/segundo-estudio-efectividad-vacunacion-anti-sars-cov-2-uruguay-8-junio-2021>.
90. Saciuk Y, Kertes J, Mandel M, Hemo B, Shamir Stein N, Zohar AE. Pfizer-BioNTech Vaccine Effectiveness Against SARS-CoV-2 Infection: Findings From a Large Observational Study in Israel. *SSRN Electron J*. 2021. doi:10.2139/ssrn.3868853
91. de Gier B, Andeweg S, Joosten R, et al. Vaccine effectiveness against SARS-CoV-2 transmission and infections among household and other close contacts of confirmed cases, the Netherlands, February to May 2021. *Eurosurveillance*. 2021;26(31). doi:10.2807/1560-7917.ES.2021.26.31.2100640
92. Tartof SY, Slezak JM, Puzniak L, et al. BNT162b2 (Pfizer–BioNTech) mRNA COVID-19 Vaccine Against Omicron-Related Hospital and Emergency Department Admission in a Large US Health System: A Test-Negative Design. *SSRN Electron J*. 2022. doi:10.2139/ssrn.4011905
93. UK Health Security Agency. COVID-19 vaccine weekly surveillance reports. Available at: <https://www.gov.uk/government/publications/covid-19-vaccine-weekly-surveillance-reports>.
94. Atmar RL, Lyke KE, Deming ME, et al. Homologous and Heterologous Covid-19 Booster Vaccinations. *N Engl J Med*. January 2022:2021.10.10.21264827. doi:10.1056/NEJMoa2116414
95. Gray GE, Collie S, Garrett N, et al. Vaccine effectiveness against hospital admission in South African health care workers who received a homologous booster of Ad26.COV2 during an Omicron COVID19 wave: Preliminary Results of the Sisonke 2 Study. *medRxiv*. January 2022:2021.12.28.21268436. doi:10.1101/2021.12.28.21268436
96. Discovery Health, South Africa's largest private health insurance administrator, releases at-scale, real-world analysis of Omicron outbreak based on 211 000 COVID-19 test results in South Africa. Press release 14 December 2021. Available at: <https://www.discovery.co.za/corporate/news-room>.
97. Andrews N, Stowe J, Kirsebom F, et al. Effectiveness of COVID-19 booster vaccines against covid-19 related symptoms, hospitalisation and death in England. *Nat Med*. January 2022. doi:10.1038/s41591-022-01699-1
98. United States Advisory Committee on Immunization Practices (ACIP). ACIP Presentation Slides: November 19, 2021 Meeting. Available at: <https://www.cdc.gov/vaccines/acip/meetings/slides-2021-11-19.html>.
99. Andrews N, Stowe J, Kirsebom F, Gower C, Ramsay M, Bernal J. Effectiveness of BNT162b2 (Cominaty, Pfizer-BioNTech) COVID-19 booster vaccine against covid-19 related symptoms in England: test negative case-control study. *medRxiv*. 2021. doi:10.1101/2021.11.15.21266341
100. Barda N, Dagan N, Cohen C, et al. Effectiveness of a third dose of the BNT162b2 mRNA COVID-19 vaccine for preventing severe outcomes in Israel: an observational study. *Lancet*. October 2021. doi:10.1016/S0140-6736(21)02249-2
101. Bar-On YM, Goldberg Y, Mandel M, et al. Protection against Covid-19 by BNT162b2 Booster across Age Groups. *N Engl J Med*. December 2021. doi:10.1056/NEJMoa2115926
102. Alkaabi N, Yang YK, Zhang J, et al. Safety and immunogenicity of a heterologous boost with a recombinant vaccine, NVSI-06-07, in the inactivated vaccine recipients from UAE: a phase 2 randomised, double-blinded, controlled clinical trial. *medRxiv*. January 2022:2021.12.29.21268499. doi:10.1101/2021.12.29.21268499
103. Pan H, Wu Q, Zeng G, et al. Immunogenicity and safety of a third dose, and immune persistence of CoronaVac vaccine in healthy adults aged 18-59 years: interim results from a double-blind, randomized, placebo-controlled phase 2 clinical trial. *medRxiv*. 2021. doi:10.1101/2021.07.23.21261026
104. Jara A, Undurraga EA, Zubizarreta JR, et al. Effectiveness of homologous and heterologous booster shots for an inactivated SARSCoV-2 vaccine: A large-scale observational study. *SSRN Prepr*. 2022.

105. Hyams C, Marlow R, Maseko Z, et al. Effectiveness of BNT162b2 and ChAdOx1 nCoV-19 COVID-19 vaccination at preventing hospitalisations in people aged at least 80 years: a test-negative, case-control study. *Lancet Infect Dis.* June 2021. doi:10.1016/S1473-3099(21)00330-3
106. Lopez Bernal J, Andrews N, Gower C, et al. Effectiveness of the Pfizer-BioNTech and Oxford-AstraZeneca vaccines on covid-19 related symptoms, hospital admissions, and mortality in older adults in England: test negative case-control study. *BMJ.* May 2021:n1088. doi:10.1136/bmj.n1088
107. Ismail S, Vilaplana T, Elgohari S, et al. Effectiveness of BNT162b2 mRNA and ChAdOx1 adenovirus vector COVID-19 vaccines on risk of hospitalisation among older adults in England: an observational study using surveillance data. *Khub Prepr* <https://khub.net/documents/135939561/430986542/Effectiveness%20of%2BBNT162b2%2BmRNA%2BAnd%2BChAdOx1%2BAdenovirus%2Bvector%2BCOVID-19%2Bvaccines%2BOn%2Bnisk%2Bof%2Bhospitalisation%2Bamong%2Bolder%2Badults%2Bin%2BEngland.pdf/9e18c525-dde6-5ee4>.
108. Mason T, Whitton M, Hodgson J, et al. Effects of BNT162b2 mRNA vaccine on Covid-19 infection and hospitalisation among older people: matched case control study for England. *medRxiv.* January 2021:2021.04.19.21255461. doi:10.1101/2021.04.19.21255461
109. Moderna press release. Moderna Announces Positive Top Line Data from Phase 2/3 Study of COVID-19 Vaccine in Children 6 to 11 Years of Age. 25 October 2021. Available at: <https://investors.modernatx.com/news-releases/news-release-details/moderna-announces-positive-top-line-data-phase-23-study-covid-19>.
110. Moderna press release. Moderna Announces TeenCOVE Study of its COVID-19 Vaccine in Adolescents Meets Primary Endpoint and Plans to Submit Data to Regulators in Early June 25 May 2021. Available at: <https://investors.modernatx.com/news-releases/news-release-details/moderna-announces-teencove-study-its-covid-19-vaccine>.
111. Walter EB, Talaat KR, Sabharwal C, et al. Evaluation of the BNT162b2 Covid-19 Vaccine in Children 5 to 11 Years of Age. *N Engl J Med.* November 2021. doi:10.1056/NEJMoa2116298
112. United States Food and Drug Administration (FDA). Vaccines and Related Biological Products Advisory Committee October 26, 2021 Meeting Document. Available at: <https://www.fda.gov/media/153409/download>.
113. Pfizer press release. Pfizer and BioNTech provide update on ongoing studies of COVID-19 vaccine December 17 2021. Available at: <https://www.pfizer.com/news/press-release/press-release-detail/pfizer-and-biontech-provide-update-ongoing-studies-covid-19>.
114. UK JCVI Independent report. JCVI statement on COVID-19 vaccination of children and young people: 22 December 2021. Available at: <https://www.jcvi.org.uk/2021/12/22/jcvi-statement-on-covid-19-vaccination-of-children-and-young-people-22-december-2021>.
115. New York State Department of Health Special Report. Pediatric COVID-19 update. 7 January 2022. Available at: https://www.health.ny.gov/press/releases/2022/docs/pediatric_covid-19_hospitalization_report_summary.pdf.
116. Frencik RW, Klein NP, Kitchin N, et al. Safety, Immunogenicity, and Efficacy of the BNT162b2 Covid-19 Vaccine in Adolescents. *N Engl J Med.* 2021;385(3):239-250. doi:10.1056/NEJMoa2107456
117. Pfizer press release. Follow-up data from phase 3 trial of Pfizer-BioNTech COVID-19 vaccine support safety and efficacy in adolescents 12 through 15 years of age. 22 November 2021. Available at: <https://www.pfizer.com/news/press-release/press-release-detail/follow-data-phase-3-trial-pfizer-biontech-covid-19-vaccine>.
118. Miron O, Wilf-Miron R, Davidovitch N. Effectiveness of COVID-19 vaccine BNT162b2 at age 12-15 years with one dose. *OSF Prepr.* 2021. doi:10.31219/osf.io/cnw5t
119. Reis BY, Barda N, Leshchinsky M, et al. Effectiveness of BNT162b2 Vaccine against Delta Variant in Adolescents. *N Engl J Med.* October 2021. doi:10.1056/NEJMc2114290
120. Olson SM, Newhams MM, Halasa NB, et al. Effectiveness of Pfizer-BioNTech mRNA Vaccination Against COVID-19 Hospitalization Among Persons Aged 12–18 Years — United States, June–September 2021. *MMWR Morb Mortal Wkly Rep.* 2021;70(42):1483-1488. doi:10.15585/mmwr.mm7042e1
121. Powell AA, Kirsebom F, Stowe J, et al. Adolescent vaccination with BNT162b2 (Comirnaty, Pfizer-BioNTech) vaccine and effectiveness of the first dose against COVID-19: national test-negative case-control study, England. *medRxiv.* January 2021:2021.12.10.21267408. doi:10.1101/2021.12.10.21267408
122. Zambrano LD, Newhams MM, Olson SM, et al. Effectiveness of BNT162b2 (Pfizer-BioNTech) mRNA Vaccination Against Multisystem Inflammatory Syndrome in Children Among Persons Aged 12–18 Years — United States, July–December 2021. *MMWR Morb Mortal Wkly Rep.* 2022;71(2). doi:10.15585/mmwr.mm7102e1
123. Olson SM, Newhams MM, Halasa NB, et al. Effectiveness of BNT162b2 Vaccine against Critical Covid-19 in Adolescents. *N Engl J Med.* January 2022. doi:10.1056/NEJMoa2117995
124. Han B, Song Y, Li C, et al. Safety, tolerability, and immunogenicity of an inactivated SARS-CoV-2 vaccine (CoronaVac) in healthy children and adolescents: a double-blind, randomised, controlled, phase 1/2 clinical trial. *Lancet Infect Dis.* June 2021. doi:10.1016/S1473-3099(21)00319-4
125. Hillson K, Clemens SC, Madi SA, Voysey M, Pollard AJ, Minassian AM. Fertility rates and birth outcomes after ChAdOx1 nCoV-19 (AZD1222) vaccination. *Lancet.* October 2021. doi:10.1016/S0140-6736(21)02282-0
126. Trostle ME, Agüero-Rosenfeld ME, Roman AS, Lighter JL. High antibody levels in cord blood from pregnant women vaccinated against COVID-19. *Am J Obstet Gynecol MFM.* September 2021:100481. doi:10.1016/j.ajogmf.2021.100481
127. Shimabukuro TT, Kim SY, Myers TR, et al. Preliminary Findings of mRNA Covid-19 Vaccine Safety in Pregnant Persons. *N Engl J Med.* April 2021:NEJMoa2104983. doi:10.1056/NEJMoa2104983
128. Shook LL, Atyeo CG, Yonker LM, et al. Durability of Anti-Spike Antibodies in Infants After Maternal COVID-19 Vaccination or Natural Infection. *JAMA.* February 2022. doi:10.1001/jama.2022.1206
129. Dagan N, Barda N, Biron-Shental T, et al. Effectiveness of the BNT162b2 mRNA COVID-19 vaccine in pregnancy. *Nat Med.* 2021;27(10):1693-1695. doi:10.1038/s41591-021-01490-8
130. Goldstein I, Nevo D, Steinberg DM, et al. Association Between BNT162b2 Vaccination and Incidence of SARS-CoV-2 Infection in Pregnant Women. *JAMA.* 2021;326(8):728. doi:10.1001/jama.2021.11035
131. United States National Institutes of Health (NIH) News release. NIH begins study of COVID-19 vaccination during pregnancy and postpartum. 23 June 2021. Available at: <https://www.nih.gov/news-events/news-releases/nih-begins-study-covid-19-vaccination-during-pregnancy-postpartum>.
132. Goldstein I, Steinberg DM, Kuint J, et al. Association of BNT162b2 COVID-19 Vaccination During Pregnancy With Neonatal and Early Infant Outcomes. *JAMA Pediatr.* February 2022. doi:10.1001/jamapediatrics.2022.0001
133. Hall VJ, Foulkes S, Saei A, et al. COVID-19 vaccine coverage in health-care workers in England and effectiveness of BNT162b2 mRNA vaccine against infection (SIREN): a prospective, multicentre, cohort study. *Lancet.* 2021;397(10286):1725-1735. doi:10.1016/S0140-6736(21)00790-X
134. Regev-Yochay G, Amit S, Bergwerk M, et al. Decreased Infectivity Following BNT162b2 Vaccination. *SSRN Electron J.* 2021. doi:10.2139/ssrn.3815668
135. Government of Spain Ministry of Health and Innovation. The combined use of AstraZeneca and Pfizer vaccines against SARS-CoV-2 offers a powerful immune response. Press release 18 May 2021. Available at: <https://www.isciii.es/Noticias/Noticias/Paginas/Noticias/Presentación-resultados-preliminares-CombivacS.aspx>.
136. Shaw RH, Stuart A, Greenland M, Liu X, Van-Tam JSN, Snape MD. Heterologous prime-boost COVID-19 vaccination: initial reactogenicity data. *Lancet.* 2021;397(10289):2043-2046. doi:10.1016/S0140-6736(21)01115-6
137. Hillus D. Reactogenicity of homologous and heterologous prime-boost immunisation with BNT162b2 and ChAdOx1-nCoV19: a prospective cohort study. *medRxiv Prepr.* doi:doi.org/10.1101/2021.05.19.21257334
138. Powell AA, Power L, Westrop S, et al. Real-world data shows increased reactogenicity in adults after heterologous compared to homologous prime-boost COVID-19 vaccination, March–June 2021, England. *Eurosurveillance.* 2021;26(28). doi:10.2807/1560-7917.ES.2021.26.28.2100634
139. Borobia AM, Carcas AJ, Pérez-Olmeda M, et al. Immunogenicity and reactogenicity of BNT162b2 booster in ChAdOx1-S-primed participants (CombivacS): a multicentre, open-label, randomised, controlled, phase 2 trial. *Lancet.* 2021;398(10295):121-130. doi:10.1016/S0140-6736(21)01420-3
140. Liu X, Shaw RH, Stuart AS, et al. Safety and Immunogenicity Report from the Com-COV Study – a Single-Blind Randomised Non-Inferiority Trial Comparing Heterologous And Homologous Prime-Boost Schedules with An Adenoviral Vected and mRNA COVID-19 Vaccine. *SSRN Electron J.* 2021. doi:10.2139/ssrn.3874014
141. Schmidt T, Klemis V, Schub D, et al. Immunogenicity and reactogenicity of a heterologous COVID-19 prime-boost vaccination compared with homologous vaccine regimens. *medRxiv.* January 2021:2021.06.13.21258859. doi:10.1101/2021.06.13.21258859
142. Barros-Martins J, Hammerschmidt SI, Cossmann A, et al. Humoral and cellular immune response against SARS-CoV-2 variants following heterologous and homologous ChAdOx1 nCoV-19/BNT162b2 vaccination. *medRxiv.* January 2021:2021.06.01.21258172. doi:10.1101/2021.06.01.21258172
143. Behrens GM, Cossmann A, Stankov M V, et al. SARS-CoV-2 delta variant neutralisation after heterologous ChAdOx1-S/BNT162b2 vaccination. *Lancet.* August 2021. doi:10.1016/S0140-6736(21)01891-2
144. Public Health Agency of Canada. An Advisory Committee Statement (ACS) National Advisory Committee on Immunization (NACI) Recommendations on the use of COVID-19 Vaccines. 17 June 2021. Available at: <https://www.canada.ca/content/dam/phac-aspc/documents/services/immunization/national-advisory-committee-on-immunization-naci/recommendations-use-covid-19-vaccines/recommendations-use-covid-19-vaccines-en.pdf>.
145. US National Library of Medicine ClinicalTrials.gov. Mix and Match of the Second COVID-19 Vaccine Dose for Safety and Immunogenicity (MOSAIC). Available at: <https://clinicaltrials.gov/ct2/show/NCT04894435?term=mixed+schedule%2C+covid19%2C+vaccine&draw=2&rank=1>.
146. Gram MA, Nielsen J, Schelde AB, et al. Vaccine effectiveness when combining the ChAdOx1 vaccine as the first dose with an mRNA COVID-19 vaccine as the second dose. *medRxiv.* January 2021:2021.07.26.21261130. doi:10.1101/2021.07.26.21261130
147. Australian Government Therapeutic Goods Administration (TGA). Australian Product Information - COVID-19 Vaccine AstraZeneca (ChAdOx1-S) solution for injection. Available at: <https://www.ebs.tga.gov.au/ebs/picmi/picmirepository.nsf/pdf?OpenAgent&id=CP-2021-PI-01194-1&d=202105261016933>.
148. US Federal Drug Administration (FDA). Fact sheet for healthcare providers administering vaccine (vaccination providers) emergency use authorisation (EUA) of the Moderna COVID-19 vaccine to prevent coronavirus disease 2019 (COVID-19). Available at: <https://www.modernatx.com/covid19vaccine-eua/eua-fact-sheet-providers.pdf>.
149. Australian Government Therapeutic Goods Administration (TGA). Australian Product Information - Comirnaty (BNT162b2 [mRNA]) COVID-19 Vaccine. Available at: <https://www.tga.gov.au/sites/default/files/covid-19-vaccine-pfizer-australia-comirnaty-bnt162b2-mrna-pi.pdf>.
150. US Federal Drug Administration (FDA). Fact sheet for healthcare providers administering vaccine (vaccination providers). Emergency use authorisation (EUA) of the Janssen COVID-19 vaccine to prevent coronavirus disease 2019 (COVID-19). Available at: <https://www.janssenlabels.com/emergency-use-authorization/Janssen+COVID-19+Vaccine-HCP-fact-sheet.pdf>.
151. Xia S, Zhang Y, Wang Y, et al. Safety and immunogenicity of an inactivated SARS-CoV-2 vaccine, BBIBP-CoVr: a randomised, double-blind, placebo-controlled, phase 1/2 trial. *Lancet Infect Dis.* 2021;21(1):39-51. doi:10.1016/S1473-3099(20)30831-8
152. Zhang Y, Zeng G, Pan H, et al. Safety, tolerability, and immunogenicity of an inactivated SARS-CoV-2 vaccine in healthy adults aged 18–59 years: a randomised, double-blind, placebo-controlled, phase 1/2 clinical trial. *Lancet Infect Dis.* 2021;21(2):181-192. doi:10.1016/S1473-3099(20)30843-4
153. European Medicines Agency (EMA). Meeting highlights from the Pharmacovigilance Risk Assessment Committee (PRAC) 3-6 May 2021. Available at: <https://www.ema.europa.eu/en/news/meeting-highlights-pharmacovigilance-risk-assessment-committee-prac-3-6-may-2021>.
154. Australian Government Therapeutic Goods Administration (TGA). COVID-19 vaccine weekly safety report - 08-07-2021. Available at: <https://www.tga.gov.au/periodic/covid-19-vaccine-weekly-safety-report-08-07-2021>.
155. United States Advisory Committee on Immunization Practices (ACIP). ACIP Presentation Slides: October 20-21, 2021 Meeting. Available at: <https://www.cdc.gov/vaccines/acip/meetings/slides-2021-10-20-21.html>.

156. Welsh KJ, Baumbblatt J, Chege W, Goud R, Nair N. Thrombocytopenia including immune thrombocytopenia after receipt of mRNA COVID-19 vaccines reported to the Vaccine Adverse Event Reporting System (VAERS). *Vaccine*. 2021;96(5):534-537. doi:10.1016/j.vaccine.2021.04.054
157. Vogel G. Israel reports link between rare cases of heart inflammation and COVID-19 vaccination in young men. *Science* (80-). June 2021. doi:10.1126/science.abj7796
158. Barda N, Dagan N, Ben-Shlomo Y, et al. Safety of the BNT162b2 mRNA Covid-19 Vaccine in a Nationwide Setting. *N Engl J Med*. August 2021:NEJMoa2110475. doi:10.1056/NEJMoa2110475
159. US Food and Drug Administration (FDA) press release. Coronavirus (COVID-19) Update: July 13, 2021. Available at: <https://www.fda.gov/news-events/press-announcements/coronavirus-covid-19-update-july-13-2021>.
160. Pavord S, Scully M, Hunt BJ, et al. Clinical Features of Vaccine-Induced Immune Thrombocytopenia and Thrombosis. *N Engl J Med*. August 2021:NEJMoa2109908. doi:10.1056/NEJMoa2109908
161. Government of Canada National Advisory Committee on Immunization (NACI) statement. NACI rapid response: Recommended use of AstraZeneca COVID-19 vaccine in younger adults.
162. Australian Technical Advisory Group on Immunisation (ATAGI) ATAGI statement on revised recommendations on the use of COVID-19 Vaccine AstraZeneca, 17 June 2021. Available at: <https://www.health.gov.au/news/atagi-statement-on-revised-recommendations-on-the-use-of-covid-19-vaccine-astrazeneca-17-june-2021>.
163. UK Government press release. JCVI advises on COVID-19 vaccine for people aged under 40. 7 May 2021. Available at: <https://www.gov.uk/government/news/jcvi-advises-on-covid-19-vaccine-for-people-aged-under-40>.
164. European Medicines Agency (EMA). Meeting highlights from the Pharmacovigilance Risk Assessment Committee (PRAC) 6-9 April 2021. Available at: <https://www.ema.europa.eu/en/news/meeting-highlights-pharmacovigilance-risk-assessment-committee-prac-6-9-april-2021>.
165. Statement of the WHO Global Advisory Committee on Vaccine Safety (GACVS) COVID-19 subcommittee on reports of Guillain-Barré Syndrome (GBS) following adenovirus vector COVID-19 vaccines 26 July 2021. Available at: <https://www.who.int/news/item/26-07-2021-statement-of-the-who-gacvs-covid-19-subcommittee-on-gbs>.
166. Patone M, Handunnethi L, Saatci D, et al. Neurological complications after first dose of COVID-19 vaccines and SARS-CoV-2 infection. *Nat Med*. October 2021. doi:10.1038/s41591-021-01556-7
167. Gordon SF, Clothier HJ, Morgan H, et al. Immune thrombocytopenia following immunisation with Vaxzevria ChadOx1-S (AstraZeneca) vaccine, Victoria, Australia. *Vaccine*. October 2021. doi:10.1016/j.vaccine.2021.10.030
168. Shimabukuro TT, Cole M, Su JR. Reports of Anaphylaxis After Receipt of mRNA COVID-19 Vaccines in the US—December 14, 2020–January 18, 2021. *JAMA*. 2021;325(11):1101. doi:10.1001/jama.2021.1967
169. World Health Organisation (WHO). COVID-19 subcommittee of the WHO Global Advisory Committee on Vaccine Safety (GACVS): updated guidance regarding myocarditis and pericarditis reported with COVID-19 mRNA vaccines. 9 July 2021. Available at: <https://www.who.int/news/item/09-07-2021-gacvs-guidance-myocarditis-pericarditis-covid-19-mrna-vaccines>.
170. Public Health Ontario enhanced epidemiological summary. Myocarditis and Pericarditis Following Vaccination with COVID-19 mRNA Vaccines in Ontario: December 13, 2020 to August 7, 2021. Available at: https://www.publichealthontario.ca/-/media/documents/ncov/epi/covid-19-myocarditis-pericarditis-vaccines-epi.pdf?sc_lang=en.
171. UK Medicines & Healthcare products Regulatory Agency. Coronavirus vaccine - weekly summary of Yellow Card reporting. Updated 7 October 2021. Available at: <https://www.gov.uk/government/publications/coronavirus-covid-19-vaccine-adverse-reactions/coronavirus-vaccine-summary-of-yellow-card-reporting>.
172. European Medicines Agency (EMA) Meeting highlights from the Pharmacovigilance Risk Assessment Committee (PRAC) 29 November - 2 December 2021. Available at: <https://www.ema.europa.eu/en/news/meeting-highlights-pharmacovigilance-risk-assessment-committee-prac-29-november-2-december-2021>.
173. Buchan SA, Seo CY, Johnson C, et al. Epidemiology of myocarditis and pericarditis following mRNA vaccines in Ontario, Canada: by vaccine product, schedule and interval. *medRxiv*. January 2021:2021.12.02.21267156. doi:10.1101/2021.12.02.21267156
174. Patone M, Mei XV, Handunnethi L, et al. Risks of myocarditis, pericarditis, and cardiac arrhythmias associated with COVID-19 vaccination or SARS-CoV-2 infection. *Nat Med*. December 2021. doi:10.1038/s41591-021-01630-0
175. Australian Government Therapeutic Goods Administration COVID-19 vaccine weekly safety report - 16-12-2021. Available at: <https://www.tga.gov.au/periodic/covid-19-vaccine-weekly-safety-report-16-12-2021#section-1326>.
176. Australian Therapeutic Goods Administration COVID-19 vaccine weekly safety report - 13-01-2022. Available at:
177. Novavax COVID-19 Vaccine Demonstrates 89.3% Efficacy in UK Phase 3 Trial. Novavax press release 28 January 2021. <https://ir.novavax.com/news-releases/news-release-details/novavax-covid-19-vaccine-demonstrates-893-efficacy-uk-phase-3>.
178. Witberg G, Barda N, Hoss S, et al. Myocarditis after Covid-19 Vaccination in a Large Health Care Organization. *N Engl J Med*. October 2021. doi:10.1056/NEJMoa2110737
179. Mevorach D, Anis E, Cedar N, et al. Myocarditis after BNT162b2 mRNA Vaccine against Covid-19 in Israel. *N Engl J Med*. October 2021. doi:10.1056/NEJMoa2109730
180. United States Food and Drug Administration (FDA). Vaccines and Related Biological Products Advisory Committee October 14-15, 2021 Meeting Presentation. Available at: <https://www.fda.gov/media/153086/download>.
181. Chua GT, Kwan MYW, Chui CSL, et al. Epidemiology of Acute Myocarditis/Pericarditis in Hong Kong Adolescents Following Cominarty Vaccination. *Clin Infect Dis*. November 2021. doi:10.1093/cid/ciab989
182. Hause AM, Baggs J, Marquez P, et al. COVID-19 Vaccine Safety in Children Aged 5–11 Years — United States, November 3–December 19, 2021. *MMWR Morb Mortal Wkly Rep*. 2021;70(5152):1755-1760. doi:10.15585/mmwr.mm705152a1
183. Ouldali N, Bagheri H, Salvo F, et al. Multisystemic inflammatory syndrome following COVID-19 mRNA vaccine in children: a national post-authorization pharmacovigilance study. *medRxiv*. January 2022:2022.01.17.22269263. doi:10.1101/2022.01.17.22269263
184. Yousaf AR, Cortese MM, Taylor AW, et al. Reported Cases of Multisystem Inflammatory Syndrome in Children (MIS-C) Aged 12–20 Years in the United States Who Received COVID-19 Vaccine, December 2020 through August 2021. *medRxiv*. January 2022:2022.01.03.22268681. doi:10.1101/2022.01.03.22268681
185. Chile Institute of Public Health. Informe Estadístico: ESAVI de Vacnus SARS-CoV-2 (CoronaVac) notificados en niños entre 6 a 11 años de edad, 13 Septiembre - 7 Octubre 2021. Available at: <https://ispch.cl/wp-content/uploads/2021/10/20211021-Informe-estadistico-ESAVI-ninos-6-y-11-anos-VFinal.pdf>.
186. Bernal J, Andrews N, Gower C, et al. Effectiveness of BNT162b2 mRNA vaccine and ChAdOx1 adenovirus vector vaccine on mortality following COVID-19. *Prepr medRxiv*. doi:10.1101/2021.05.14.21257218
187. Mateo-Urdiales A, Spila Alegiani S, Fabiani M, et al. Risk of SARS-CoV-2 infection and subsequent hospital admission and death at different time intervals since first dose of COVID-19 vaccine administration, Italy, 27 December 2020 to mid-April 2021. *Eurosurveillance*. 2021;26(25). doi:10.2807/1560-7917.ES.2021.26.25.2100507
188. University College London press release. Covid-19 vaccine: care home residents gain 62% protection from one dose. 29 March 2021.
189. Pritchard E, Matthews PC, Stoesser N, et al. Impact of vaccination on SARS-CoV-2 cases in the community: a population-based study using the UK's COVID-19 Infection Survey. *medRxiv*. January 2021:2021.04.22.21255913. doi:10.1101/2021.04.22.21255913
190. Johnson & Johnson press release. Johnson & Johnson Announces Real-World Evidence and Phase 3 Data Confirming Strong and Long-Lasting Protection of Single-Shot COVID-19 Vaccine in the U.S. 21 September 2021. Available at: <https://www.jnj.com/johnson-johnson-announces-real-world-evidence-and-phase-3-data-confirming-strong-and-long-lasting-protection-of-single-shot-covid-19-vaccine-in-the-u-s>.
191. Tenforde MW, Self WH, Naioti EA, et al. Sustained Effectiveness of Pfizer-BioNTech and Moderna Vaccines Against COVID-19 Associated Hospitalizations Among Adults — United States, March–July 2021. *MMWR Morb Mortal Wkly Rep*. 2021;70(34). doi:10.15585/mmwr.mm7034e2
192. Thompson MG, Natarajan K, Irving SA, et al. Effectiveness of a Third Dose of mRNA Vaccines Against COVID-19–Associated Emergency Department and Urgent Care Encounters and Hospitalizations Among Adults During Periods of Delta and Omicron Variant Predominance — VISION Network, 10 States, August 2021–. *MMWR Morb Mortal Wkly Rep*. 2022;71(4). doi:10.15585/mmwr.mm7104e3
193. Ferdinands JM, Rao S, Dixon BE, et al. Waning 2-Dose and 3-Dose Effectiveness of mRNA Vaccines Against COVID-19–Associated Emergency Department and Urgent Care Encounters and Hospitalizations Among Adults During Periods of Delta and Omicron Variant Predominance — VISION Network, 10 States, Aug. *MMWR Morb Mortal Wkly Rep*. 2022;71(7). doi:10.15585/mmwr.mm7107e2
194. Daniel W, Nivet M, Warner J, Podolsky DK. Early Evidence of the Effect of SARS-CoV-2 Vaccine at One Medical Center. *N Engl J Med*. March 2021:NEJMc2102153. doi:10.1056/NEJMc2102153
195. Thompson MG, Burgess JL, Naleway AL, et al. Interim Estimates of Vaccine Effectiveness of BNT162b2 and mRNA-1273 COVID-19 Vaccines in Preventing SARS-CoV-2 Infection Among Health Care Personnel, First Responders, and Other Essential and Frontline Workers — Eight U.S. Locations, December 2020–March. *MMWR Morb Mortal Wkly Rep*. 2021;70(13):495-500. doi:10.15585/mmwr.mm7013e3
196. Fowlkes A, Gaglani M, Groover K, These MS, Tyrner H, Ellington K. Effectiveness of COVID-19 Vaccines in Preventing SARS-CoV-2 Infection Among Frontline Workers Before and During B.1.617.2 (Delta) Variant Predominance — Eight U.S. Locations, December 2020–August 2021. *MMWR Morb Mortal Wkly Rep*. 2021;70(34):1167-1169. doi:10.15585/mmwr.mm7034e4
197. Benenson S, Oster Y, Cohen MJ, Nir-Paz R. BNT162b2 mRNA Covid-19 Vaccine Effectiveness among Health Care Workers. *N Engl J Med*. March 2021:NEJMc2101951. doi:10.1056/NEJMc2101951
198. World Health Organisation (WHO). Weekly epidemiological update on COVID-19 - 11 May 2021. Available at: <https://www.who.int/publications/m/item/weekly-epidemiological-update-on-covid-19---11-may-2021>.
199. World Health Organisation (WHO). Tracking SARS-CoV-2 variants. Available at: <https://www.who.int/en/activities/tracking-sars-cov-2-variants/>.
200. Emary KRW, Golubchik T, Aley PK, et al. Efficacy of ChAdOx1 nCoV-19 (AZD1222) vaccine against SARS-CoV-2 variant of concern 202012/01 (B.1.1.7): an exploratory analysis of a randomised controlled trial. *Lancet*. March 2021. doi:10.1016/S0140-6736(21)00628-0
201. Madhi SA, Baillie V, Cutland CL, et al. Safety and efficacy of the ChAdOx1 nCoV-19 (AZD1222) Covid-19 vaccine against the B.1.351 variant in South Africa. *Alex Sigal*. 2021.
202. Shinde V, Bhikha S, Hoosain Z, et al. Efficacy of NVX-CoV2373 Covid-19 Vaccine against the B.1.351 Variant. *N Engl J Med*. May 2021:NEJMoa2103055. doi:10.1056/NEJMoa2103055
203. Kustin T, Harel N, Finkel U, et al. Evidence for increased breakthrough rates of SARS-CoV-2 variants of concern in BNT162b2 mRNA vaccinated individuals. *medRxiv*. January 2021:2021.04.06.21254882. doi:10.1101/2021.04.06.21254882
204. Abu-Raddad LJ, Chemaitelly H, Butt AA. Effectiveness of the BNT162b2 Covid-19 Vaccine against the B.1.1.7 and B.1.351 Variants. *N Engl J Med*. May 2021:NEJMc2104974. doi:10.1056/NEJMc2104974
205. Hitchings MDT, Ranzani OT, Torres MSS, et al. Effectiveness of CoronaVac among healthcare workers in the setting of high SARS-CoV-2 Gamma variant transmission in Manaus, Brazil: A test-negative case-control study. *Lancet Reg Heal - Am*. July 2021:100025. doi:10.1016/j.lana.2021.100025
206. Ranzani OT, Hitchings M, Nieto MD, et al. Effectiveness of the CoronaVac vaccine in the elderly population during a P.1 variant-associated epidemic of COVID-19 in Brazil: A test-negative case-control study. *medRxiv*. January 2021:2021.05.19.21257472. doi:10.1101/2021.05.19.21257472
207. Ferguson N, Ghani A, Hinsley W, Volz E. Hospitalisation risk for Omicron cases in England. *Imp Coll London*. <https://www.imperial.ac.uk/media/imperial-college/medicine/mrc-gida/2021-12-22-COVID19-Report-50.pdf>.
208. Israel Ministry of Health press release. Decline in Vaccine Effectiveness Against Infection and Symptomatic Illness. 5 July 2021. Available at: <https://www.gov.il/en/departments/news/05072021-03>.
209. Li X, Huang Y, Wang W, et al. Efficacy of inactivated SARS-CoV-2 vaccines against the Delta variant infection in Guangzhou: A test-negative case-control real-world study. *Emerg Microbes Infect*. August 2021:1-32. doi:10.1080/22221751.2021.1969291
210. Arbel R, Hammerman A, Sergienko R, et al. BNT162b2 Vaccine Booster and Mortality Due to Covid-19. *N Engl J Med*. December 2021. doi:10.1056/NEJMoa2115624

211. Tenforde MW, Olson SM, Self WH, et al. Effectiveness of Pfizer-BioNTech and Moderna Vaccines Against COVID-19 Among Hospitalized Adults Aged ≥ 65 Years — United States, January–March 2021. *MMWR Morb Mortal Wkly Rep.* 2021;70(18). doi:10.15585/mmwr.mm7018e1
212. Nunes B, Rodrigues AP, Kislalya I, et al. mRNA vaccine effectiveness against COVID-19-related hospitalisations and deaths in older adults: a cohort study based on data linkage of national health registries in Portugal, February to August 2021. *Eurosurveillance.* 2021;26(38). doi:10.2807/1560-7917.ES.2021.26.38.2100833
213. Rossman H, Shilo S, Meir T, Gorfine M, Shalit U, Segal E. COVID-19 dynamics after a national immunization program in Israel. *Nat Med.* April 2021. doi:10.1038/s41591-021-01337-2
214. Shrotri M, Krutikov M, Palmer T, et al. Vaccine effectiveness of the first dose of ChAdOx1 nCoV-19 and BNT162b2 against SARS-CoV-2 infection in residents of long-term care facilities in England (VIVALDI): a prospective cohort study. *Lancet Infect Dis.* June 2021;2021.03.26.21254391. doi:10.1016/S1473-3099(21)00289-9
215. Harris RJ, Hall JA, Zaidi A, Andrews NJ, Dunbar JK, Dabrera G. Effect of Vaccination on Household Transmission of SARS-CoV-2 in England. *N Engl J Med.* June 2021;NEJMc2107717. doi:10.1056/NEJMc2107717
216. Clifford S, Waight P, Hackman J, et al. Effectiveness of BNT162b2 and ChAdOx1 against SARS-CoV-2 household transmission: a prospective cohort study in England. *medRxiv.* January 2021;2021.11.24.21266401. doi:10.1101/2021.11.24.21266401
217. Pritchard E, Matthews PC, Stoesser N, et al. Impact of vaccination on new SARS-CoV-2 infections in the United Kingdom. *Nat Med.* June 2021. doi:10.1038/s41591-021-01410-w
218. Menni C, Klaser K, May A, et al. Vaccine side-effects and SARS-CoV-2 infection after vaccination in users of the COVID Symptom Study app in the UK: a prospective observational study. *Lancet Infect Dis.* 2021;21(7):939-949. doi:10.1016/S1473-3099(21)00224-3
219. V Shah AS, Gribben C, Bishop J, et al. Effect of vaccination on transmission of COVID-19: an observational study in healthcare workers and their households. *medRxiv.* January 2021;2021.03.11.21253275. doi:10.1101/2021.03.11.21253275
220. Singanayagam A, Hakki S, Dunning J, et al. Community transmission and viral load kinetics of the SARS-CoV-2 delta (B.1.617.2) variant in vaccinated and unvaccinated individuals in the UK: a prospective, longitudinal, cohort study. *Lancet Infect Dis.* October 2021. doi:10.1016/S1473-3099(21)00648-4
221. Cavanaugh AM, Spicer KB, Thoroughman D, Glick C, Winter K. Reduced Risk of Reinfection with SARS-CoV-2 After COVID-19 Vaccination — Kentucky, May–June 2021. *MMWR Morb Mortal Wkly Rep.* 2021;70(32):1081-1083. doi:10.15585/mmwr.mm7032e1
222. Pawlowski C, Lenehan P, Puranik A, et al. FDA-authorized COVID-19 vaccines are effective per real-world evidence synthesized across a multi-state health system. *medRxiv.* January 2021;2021.02.15.21251623. doi:10.1101/2021.02.15.21251623
223. Thompson MG, Burgess JL, Naleway AL, et al. Interim Estimates of Vaccine Effectiveness of BNT162b2 and mRNA-1273 COVID-19 Vaccines in Preventing SARS-CoV-2 Infection Among Health Care Personnel, First Responders, and Other Essential and Frontline Workers.
224. Tande AJ, Pollock BD, Shah ND, et al. Impact of the COVID-19 Vaccine on Asymptomatic Infection Among Patients Undergoing Pre-Procedural COVID-19 Molecular Screening. *Clin Infect Dis.* March 2021. doi:10.1093/cid/ciab229
225. White EM, Yang X, Blackman C, Feifer RA, Gravenstein S, Mor V. Incident SARS-CoV-2 Infection among mRNA-Vaccinated and Unvaccinated Nursing Home Residents. *N Engl J Med.* May 2021;NEJMc2104849. doi:10.1056/NEJMc2104849
226. Lipsitch M, Kahn R. Interpreting vaccine efficacy trial results for infection and transmission. *Vaccine.* June 2021. doi:10.1016/j.vaccine.2021.06.011
227. Amit S, Regev-Yochay G, Afek A, Kreiss Y, Leshem E. Early rate reductions of SARS-CoV-2 infection and COVID-19 in BNT162b2 vaccine recipients. *Lancet.* 2021;397(10277):875-877. doi:10.1016/S0140-6736(21)00448-7
228. Prunas O, Warren JL, Crawford FW, et al. Vaccination with BNT162b2 reduces transmission of SARS-CoV-2 to household contacts in Israel. *medRxiv.* January 2021;2021.07.13.21260393. doi:10.1101/2021.07.13.21260393
229. Layan M, Gilboa M, Gonen T, et al. Impact of BNT162b2 vaccination and isolation on SARS-CoV-2 transmission in Israeli households: an observational study. *medRxiv.* January 2021;2021.07.12.21260377. doi:10.1101/2021.07.12.21260377
230. Michael Weekes, Nick K Jones, Lucy Rivett, et al. Single-dose BNT162b2 vaccine protects against asymptomatic SARS-CoV-2 infection. *Authorea.* February 24, 2021. doi:10.22541/au.161420511
231. Salo J, Hägg M, Kortelainen M, et al. The indirect effect of mRNA-based Covid-19 vaccination on unvaccinated household members. *medRxiv.* January 2021;2021.05.27.21257896. doi:10.1101/2021.05.27.21257896
232. Levine-Tiefenbrun M, Yelin I, Katz R, et al. Initial report of decreased SARS-CoV-2 viral load after inoculation with the BNT162b2 vaccine. *Nat Med.* 2021;27(5):790-792. doi:10.1038/s41591-021-01316-7
233. Milman O, Yelin I, Aharony N, et al. SARS-CoV-2 infection risk among unvaccinated is negatively associated with community-level vaccination rates. *medRxiv.* January 2021;2021.03.26.21254394. doi:10.1101/2021.03.26.21254394
234. De Salazar PM, Link N, Lamarca K, Santillana M. High coverage COVID-19 mRNA vaccination rapidly controls SARS-CoV-2 transmission in Long-Term Care Facilities. *medRxiv.* January 2021;2021.04.08.21255108. doi:10.1101/2021.04.08.21255108
235. United Nations Children's Fund (UNICEF), Pacific Office. Situation Analysis of Children in the Pacific Island Countries. December 2017.

Acknowledgements

This document was compiled by Dr John Hart

Technical leads: Professor Fiona Russell and Professor Kim Mulholland

Quality checks: Professor Julie Bines, Associate Professor Nigel Crawford and Associate Professor Margie Danchin

Other resources on COVID-19 vaccines:

WHO COVID-19 vaccines website: <https://www.who.int/emergencies/diseases/novel-coronavirus-2019/covid-19-vaccines>

EMA COVID-19 vaccines website: <https://www.ema.europa.eu/en/human-regulatory/overview/public-health-threats/coronavirus-disease-covid-19/treatments-vaccines/covid-19-vaccines>

To subscribe to receive the weekly updates, please email kase.anderson@unimelb.edu.au

Murdoch Children's Research Institute

50 Flemington Rd, Parkville

Victoria 3052 Australia

ABN 21 006 566 972

<https://www.mcri.edu.au/research/themes/infection-and-immunity/asia-pacific-health>

Weekly COVID-19 Vaccine Updates
Number 45, 17 February 2022



Appendix 1: COVID-19 Vaccine Effectiveness

VACCINE	SEVERE / HOSPITALISATION / DEATH	INFECTION AND OTHER OUTCOMES
AstraZeneca	<p>Single dose in Scotland: 94% (73-99)⁵⁰ Risk of death in vaccine failures compared to unvaccinated cases in England reduced by: 55% (41-66)¹⁰⁶ (not peer reviewed)</p> <p>Single dose against hospitalisation in Spain: 92% (46-99)⁵⁴ Pooled analysis of AstraZeneca, Pfizer/BioNTech and Moderna vaccines in Italy: Hospitalisation: 89% (85-91); Death: 93% (89-96)¹⁰⁷ Chile: Hospitalisation: 100%; ICU admission: 100%; Death: 100%⁴⁷ Scotland: Hospitalisation: 94% (90-99)⁵⁷ Netherlands: Hospitalisation: 94% (92-95)⁵⁹ Spain: Hospitalisation: 95% (79-99)⁴¹ Scotland: Death: 91% (86-94)⁶¹ British Columbia and Quebec, Canada: Hospitalisation: 94% (90-96); 94% (89-97)⁴⁹ Scotland and Brazil, <i>respectively</i> (delta variant dominant in Scotland; gamma variant common in Brazil): Hospitalisation or death: Single dose: 49.3% (43.3-54.6); 57.9% (56.9-58.9); 2 doses: 2-3 weeks: 83.7% (79.7-87.0); 86.4% (85.4-87.3); 2 doses 18-19 weeks: 63.7% (59.6-67.4); 42.2% (32.4-50.6)⁵² England: Hospitalisation: 2-9 weeks: 95.2% (94.7-95.7); ≥20 weeks: 80.0% (76.8-82.7) Death: 2-9 weeks: 95.0% (93.1-96.4); ≥20 weeks: 84.8% (76.2-90.3)⁶³</p>	<p>Pooled analysis of Pfizer/BioNTech and AstraZeneca vaccines in elderly care home residents in UK: Reduction in risk of infection 4 weeks after single dose: 56% Reduction in risk of infection 5 weeks after single dose: 62%¹⁰⁸</p> <p>Pooled analysis of Pfizer/BioNTech and AstraZeneca vaccines: reduced odds of infection post-second dose: 70% (62-77)¹⁰⁹ Single dose in Spain: Any infection: 44% (31-54); Symptomatic infection: 50% (37-61)⁶⁴ Pooled analysis of AstraZeneca, Pfizer/BioNTech and Moderna vaccines in Italy: Infection: 78% (76-79)¹⁰⁷ Single dose against symptomatic infection in multiple European countries: 68% (39-83)⁶⁵ Symptomatic infection in 16-64 years in UK: single dose: 50.2% (40.8-58.2); 2 doses: 78.0% (69.7-84.0)⁴⁶ Symptomatic infection in Chile: 68.7% (39.8-83.7)⁶⁷ Spain: Any infection: 54% (48-60); Symptomatic infection: 56% (48-63)⁴¹ British Columbia and Quebec, Canada: Symptomatic infection: 71% (69-74); 73% (69-77)⁴⁹ England REACT-1 study: Any infection: 44.8% (22.5-60.7)⁶² India: Any infection: 2 doses: 63.1% (51.5-72.1); Single dose: 46.2% (31.6-57.7); Moderate-severe disease: 2 doses: 81.5% (9.9-99.0); Single dose: 79.2% (46.1-94.0)⁴³ UK: Symptomatic infection: 2-9 weeks: 76.2% (63.7-84.4); 15-19 weeks: 48.5% (44.7-52.0) 20-24 weeks: 45.4% (43.0-47.6); ≥25 weeks: 41.8% (39.4-44.1)⁵⁰ Brazil: Infection: 72.9% (71.9-73.8); Hospitalisation: 88.0% (86.8-89.2); Death: 90.2% (88.5-91.5)⁴⁴ England: Omicron: Symptomatic infection: -39% (-50-30); Delta: 25.0% (24.3-25.7)⁶¹ Scotland and Brazil, <i>respectively</i> (delta variant dominant in Scotland; gamma variant common in Brazil): Symptomatic infection: Single dose: 37.6% (34.6-40.5); 37.6% (37.3-37.9); 2 doses 2-3 weeks: 67.9% (65.9-69.8); 69.8% (69.3-70.4); 2 doses 18-19 weeks: 44.6% (41.5-47.6); 57.7% (55.4-60.0)⁶² England: Symptomatic infection: 2-9 weeks: 67.6% (67.3-67.9); ≥20 weeks: 44.3% (43.2-45.4)⁶³</p>
Johnson & Johnson	<p>USA: Hospitalisation: 81% (79-84)⁶⁴ USA: 71% (56-81)⁶⁷ Netherlands: Hospitalisation: 91% (88-94)⁵⁹ Spain: Hospitalisation: 74% (43-88)⁴¹ Death in veterans in USA: <65 years: 73.0% (52.0-84.8); ≥65 years: 52.2% (37.2-63.6)⁶⁸ South Africa: Booster against hospitalisation during Omicron wave: 85% (54-95)⁶⁵</p>	<p>USA: Any infection: 76.7% (30.3-95.3)⁶³ USA: Infection: 79% (77-80)⁶⁴ Efficacy following booster 2 months after first dose: Moderate-Severe infection in USA: 94% (58-100); worldwide: 75% (55-87)¹⁰⁰ Spain: Any infection: 50% (42-57); Symptomatic infection: 54% (45-62)⁴¹ Symptomatic infection in veterans in USA: 88% (87-89)⁶⁵ Any infection in USA: 73.6% (65.9-79.9)⁶⁶ Infection in veterans in USA: March: 86.4% (85.2-87.6); September: 13.1% (9.2-16.8)⁶⁸</p>
Moderna	<p>Pooled analysis of AstraZeneca, Pfizer/BioNTech and Moderna in Italy: Hospitalisation: 89% (85-91); Death: 93% (89-96)¹⁰⁷ Pooled analysis of Pfizer/BioNTech and Moderna against hospitalisation: 2-12 weeks after second dose: 86% (82%-90%) 13-24 weeks after second dose: 84% (77%-90%)¹⁹¹ USA: Hospitalisation: 95.8% (90.7-98.1); Death: 97.9% (66.9-99.9)⁷⁰ Scotland: Pooled Pfizer/BioNTech and Moderna against hospitalisation: 92% (85-99)⁵⁷ USA: 93% (91-95)⁶⁷ Spain: Hospitalisation: 98% (82-100)⁴¹ Qatar: Decline in effectiveness accelerated beyond the fourth month after the second dose; First month after second dose: 96.0% (93.9-97.4); ≥7 months: 55.6% (-44.3-86.3)⁷¹ USA: Hospitalisation: 97.6% (92.8-99.2)⁷² Moderna and Pfizer/BioNTech in British Columbia and Quebec, Canada: Hospitalisation: 98% (97-98); 97% (96-97)⁴⁹ Death in veterans in USA: <65 years: 81.5% (70.7-88.4); ≥65 years: 75.5% (71.8-78.7)⁶⁸ USA: Hospitalisation with Delta: Single dose: 68.9% (0.0-99.4); 2 doses Delta: 98.0% (87.2-99.7)⁷⁴ USA: Moderna and Pfizer: Hospitalisation: Delta: 2 doses: <6 months: 90% (89-90); ≥6 months: 81% (80-82); 3 doses: 94% (93-95); Omicron: 2 doses: <6 months: 81% (65-90); ≥6 months: 57% (39-70); 3 doses: 90% (80-94)¹⁹² USA: Pooled Pfizer/BioNTech and Moderna against hospitalisation: Delta: 2 doses: <2 months: 94 (92-96); ≥5 months: 82 (82-83); 3 doses: <2 months: 96 (95-97); ≥4 months: 76 (14-93); Omicron: 2 doses: <2 months: 71 (51-83); ≥5 months: 54 (48-59); 3 doses: <2 months: 91 (88-93); ≥4 months: 78 (67-85)¹⁹³ Qatar (Omicron): Hospitalisation: 2 doses: 1-3 months: 76.9% (19.2-93.4); ≥7 months: 64.0% (39.1-78.7)⁶</p>	<p>Pooled analysis of Moderna and Pfizer/BioNTech vaccines in USA: Infections in nonvaccinated: 234 of 8969; 2.61% (2.29-2.96) Fully vaccinated: 4/8121; 0.05% (0.01-0.13)¹⁹⁴ Pooled analysis of Moderna and Pfizer/BioNTech vaccines against infection in USA: Fully vaccinated: 90% (68-97) Two weeks after first dose: 80% (69-90)¹⁹⁵ Pooled analysis of AstraZeneca, Pfizer/BioNTech and Moderna vaccines in Italy: Infection: 78% (76-79)¹⁰⁷ Single dose against symptomatic disease in the UK: Age 15-39 years: 72% (46-86)⁷⁷ Minnesota, USA: January to July 2021 (Delta variant <0.7% in May): Infection: 86% (81-91); Hospitalisation: 92% (81-97) July (Delta variant >70%): Infection: 76% (58-87); Hospitalisation: 81% (33-96)⁶⁹ Infection in USA (98% vaccines used Pfizer/BioNTech and Moderna): Pre-Delta variant predominant: 91% (81-96); Delta variant predominant: 66% (26-84)¹⁹⁶ Infection in Canada: 1 dose: 72% (63-80); 2 doses: 94% (86-97)⁷⁵ USA: Any infection: 87.4% (84.8-89.6); Symptomatic infection: 88.3% (86.1-90.2)⁷⁰ Spain: Any infection: 82% (78-86); Symptomatic infection: 85% (80-89)⁴¹ Qatar: First month after second dose: 77.5% (76.4-78.6); ≥7 months: 22.3% (-1.7-40.7)⁷¹ USA: Any infection: 86.7% (84.3-88.7)⁷² Moderna and Pfizer/BioNTech in British Columbia and Quebec, Canada: Symptomatic infection: 90% (89-90); 88% (88-89)⁴⁹ Infection in veterans in USA: March: 89.2% (88.8-89.6); September: 58.0% (56.9-59.1)⁶⁸ Denmark: Effectiveness against infection: Omicron: First month: 36.7% (-69.9-76.4); Third month: 4.2% (-30.8-29.8); Delta: First month: 88.2% (83.1-91.8); Third month: 72.2% (70.4-74.0); Booster first month: 82.8% (58.8-92.9)⁷³ USA: Any infection: Single dose: Delta: 60.2% (42.6-72.3); Omicron: 20.3% (0.0-39.8); 2 doses: Delta 14-90 days: 82.8% (69.6-90.3); 181-270 days: 61.4% (56.8-66.5); Omicron 14-90 days: 30.4% (5.0-49.0); 181-270 days: 0.0% (0.0-1.2); 3 doses: Delta ≤2 months: 95.7% (94.2-96.9); >2 months: 90.7% (81.4-95.3); Omicron ≤2 months: 63.6% (57.4-68.9); >2 months: 39.1% (3.8-61.5)⁷⁴ Qatar (Omicron): Symptomatic infection: Single dose: -1.6% (-56.8-34.1); 2 doses: 1-3 months: 44.8% (16.0-63.8); ≥7 months: -9.3% (-16.3-2.8); 3 doses: 4-5 weeks: 54.6% (41.1-65.0); ≥6 weeks: 38.6% (19.4-53.1)⁷⁵</p>
Pfizer/BioNTech	<p>Severe in Israel: 92% (75-100)⁸⁶ Severe/critical in Israel: 97.5% (97.1-97.8)⁸⁵ Single dose against hospitalisation in Scotland: 85% (76-91)⁶⁰ Risk of death in vaccine failures compared to unvaccinated cases in England reduced by: Single dose: 44% (32-53) Fully vaccinated: 69% (31-86)¹⁰⁶ (not peer reviewed) Israel:</p>	<p>Pooled analysis of Moderna and Pfizer/BioNTech vaccines in USA: Infections in nonvaccinated: 234 of 8969; 2.61% (2.29-2.96) Fully vaccinated: 4/8121; 0.05% (0.01-0.13)¹⁹⁴ Pooled analysis of Moderna and Pfizer/BioNTech vaccines in USA: Fully vaccinated: 90% (68-97); Two weeks after first dose: 80% (69-90)¹⁹⁵ Symptomatic infection in Israel: 94% (87-98)⁸⁶ Any infection in Israel: 90% (79-95)⁸⁴</p>

	<p>Hospitalisation: 97.2% (96.8-97.5); Death: 96.7% (96.0-97.3)⁸⁵ Hospitalisation in Spain: 94% (60-99)⁵⁴ Priority groups in Denmark: Hospitalisation: 93% (89-96); Death: 94% (90-96)⁷⁸ Pooled analysis of AstraZeneca, Pfizer/BioNTech and Moderna vaccines in Italy: Hospitalisation: 89% (85-91); Death: 93% (89-96)¹⁸⁷ USA care facility: Hospitalisation: 94.4 (73.9-98.8); Death 94.4 (44.6-99.4)⁸¹ Uruguay: Hospitalisation: 97.8% (96.0-98.8); Death: 96.2 (95.4-96.8)⁸⁹ Israel: Hospitalisation: 93.4% (91.9-94.7); Death: 91.1% (86.5-94.1)⁹⁰ Chile: Hospitalisation: 97.2% (96.6-97.6); ICU admission: 98.3% (97.6-98.8); Death: 100%⁴⁷ Pooled analysis of Pfizer/BioNTech and Moderna against hospitalisation: 2-12 weeks after second dose: 86% (82%-90%) 13-24 weeks after second dose: 84% (77%-90%)¹⁹¹ Pooled analysis of Moderna and Pfizer/BioNTech against hospitalisation or death: 98% (83-100)⁷⁵ Pooled Pfizer/BioNTech and Moderna against hospitalisation in Scotland: 92% (85-99)⁵⁷ USA: 88% (85-91)⁸⁷ Netherlands: Hospitalisation: 96% (95-96)⁵⁸ USA: Hospitalisation: 93% (84-96)⁸³ Spain: Hospitalisation: 93% (88-96)⁴¹ Scotland: Death: 90% (83-94)⁸¹ Moderna and Pfizer/BioNTech in British Columbia and Quebec, Canada: Hospitalisation: 98% (97-98); 97% (96-97)¹⁹ Death in veterans in USA: <65 years: 84.3% (76.3-89.7); ≥65 years: 70.1% (66.1-73.6)⁶⁸ Israel: Booster ≥5 months after the primary series: Hospitalisation: 93%; Death 81%¹⁰⁰ USA: Hospitalisation: Delta: 2 doses <3 months: 88% (71-95); ≥6 months: 74% (65-80); 3 doses <3 months: 95% (91-97); ≥3 months: 65% (16-85) Omicron: 2 doses: <3 months: 70% (41-84); ≥6 months: 68% (56-76); 3 doses: <3 months: 89% (83-92); ≥3 months: 90% (57-98)⁹² USA: Moderna and Pfizer: Hospitalisation: Delta: 2 doses: <6 months: 90% (89-90); ≥6 months: 81% (80-82); 3 doses: 94% (93-95); Omicron: 2 doses: <6 months: 81% (65-90); ≥6 months: 57% (39-70); 3 doses: 90% (80-94)¹⁹² England: Hospitalisation: 2-9 weeks: 98.7% (98.3-99.0); ≥20 weeks: 91.7% (90.2-93.0); Death: 2-9 weeks: 98.5% (96.5-99.3); ≥20 weeks: 91.9% (88.5-94.3)⁸³ Pfizer/BioNTech and Moderna against hospitalisation: Delta: 2 doses: <2 months: 94 (92-96); ≥5 months: 82 (82-83); 3 doses: <2 months: 96 (95-97); ≥4 months: 76 (14-93); Omicron: 2 doses: <2 months: 71 (51-83); ≥5 months: 54 (48-59); 3 doses: <2 months: 91 (88-93); ≥4 months: 78 (67-85)¹⁹³ Qatar (Omicron): Hospitalisation: 2 doses: 1-6 months: 73.7% (46.8-87.0); ≥7 months: 80.7% (71.3-87.0); 3 doses: 1-6 weeks: 90.6% (77.8-96.0); ≥7 months: 90.8% (81.5-95.5)⁷⁶</p>	<p>Israel: Any infection: 95.3% (94.9-95.7); Symptomatic infection: 97.0% (96.7-97.2)⁸⁵ Pooled analysis of Pfizer/BioNTech and AstraZeneca vaccines in elderly care home residents in UK: 4 weeks after first dose: 56%; 5 weeks after first dose: 62%¹⁸⁸ Documented infection in Israel: incidence decreased from 9.4 infections per 1,000 HCWs in the week following first dose to <1.0 infection per 1,000 HCWs per week from 1 week after the second dose¹⁹⁷ Pooled analysis of Pfizer/BioNTech and AstraZeneca vaccines: reduced odds of infection post-second dose: 70% (62-77)¹⁸⁹ Spain: Any infection: 65% (56-73); Symptomatic infection: 82% (73-88)⁵⁴ Infection in priority groups in Denmark: 82% (79-84)⁷⁸ USA: Symptomatic infection: 84% (75-90)⁸⁷ Denmark: Infection in care facility residents: >14 days after first dose: 17% (4-28); >7 days after second dose: 64% (14-84)⁷⁹ USA: Single dose against infection in 2 care facilities: 63% (33-79)⁸⁰ A care facility in USA: Infection 66% (41-81); Symptomatic illness 87% (66-95)⁸¹ Pooled analysis of AstraZeneca, Pfizer/BioNTech and Moderna vaccines in Italy: Infection: 78% (76-79)¹⁸⁷ Uruguay: Infection: 78.1% (77.0-79.1)⁸⁹ Israel: Infection: 93.0% (92.6-93.4)⁹⁰ Single dose against symptomatic disease in the UK: Age 15-39 years: 61% (56-66)⁷⁷ Symptomatic infection in multiple European countries: single dose: 61% (39-75); 2 doses: 87% (74-93)⁵⁵ Symptomatic infection in 16-64 years in UK: single dose: 48.6% (27.9-63.3); 2 doses: 93.3% (85.8-96.8)⁴⁶ Symptomatic infection in Chile: 87.7% (87.3-88.1)¹⁷ Minnesota, USA: January to July 2021 (Delta variant <0.7% in May): Infection: 76% (69-81); Hospitalisation: 85% (73-93) July (Delta variant >70%): Infection: 42% (13-62); Hospitalisation: 75% (24-94)⁹⁹ Infection in USA (98% vaccines used Pfizer/BioNTech and Moderna): Pre-Delta variant predominant: 91% (81-96); Delta variant predominant: 66% (26-84)¹⁹⁸ Infection in Canada: 1 dose: 59% (55-62); 2 doses: 91% (88-93)⁷⁵ Any infection with Delta in USA: 1 month after vaccination: 93% (85-97); 4 months: 53% (39-65)⁸³ Spain: Any infection: 69% (66-72); Symptomatic infection: 72% (69-75)⁴¹ Moderna and Pfizer/BioNTech in British Columbia and Quebec, Canada: Symptomatic infection: 90% (89-90); 88% (88-89)¹⁹⁹ Symptomatic infection in veterans in USA: 91% (91-92) England REACT-1 study: Any infection: 71.3% (56.6-81.0)⁴² Infection in veterans in USA: March: 86.9% (86.5-87.3); September: 43.3% (41.9-44.6)⁶⁸ UK: Symptomatic infection: 2-9 weeks: 88.2% (86.7-89.5); 15-19 weeks: 72.2% (71-73.4); 20-24 weeks: 64.8% (62.6-66.9); ≥25 weeks: 63.5% (61.4-65.5)⁹⁰ England: Omicron: Symptomatic infection: Single dose: 2% (-7-11); 2 doses: -18% (-26--11); Delta: Single dose: 33.1% (32.7-33.6); 2 doses: 55.9% (55.5-56.3)¹⁵¹ Denmark: Effectiveness against infection: Omicron: First month: 55.2% (23.5-73.7); Third month: 9.8% (-10.0-26.1); Booster first month: 54.6% (30.4-70.4); Delta: First month: 86.7% (84.6-88.6); Third month: 72.8% (71.7-73.8); Booster first month: 81.2% (79.2-82.9)⁷³ England: Symptomatic infection: 2-9 weeks: 89.7% (89.5-89.8); ≥20 weeks: 66.3% (65.7-66.9)⁸³ Wales: Any infection: Single dose: 52% (45-58); 2 doses: 2-5 weeks: 86% (79-91); ≥26 weeks: 45% (39-51)⁸⁹ Qatar (Omicron): Symptomatic infection: Single dose: 26.1% (5.8-42.0); 2 doses: First month: 61.9% (49.9-71.1); Seventh month: 9.6% (2.4-16.3); 3 doses: 4-5 weeks: 56.6% (50.8-61.7); ≥12 weeks: 37.6% (28.8-45.4)⁷⁶</p>
Sinovac	<p>Uruguay: Hospitalisation: 90.9% (88.6-92.7); Death: 94.7% (93.4-95.7)⁸⁹ Chile: Hospitalisation: 86.0% (85.6-86.5); ICU admission: 89.7% (89.1-90.2); Death: 86.4% (85.6-87.2)⁴⁷</p>	<p>Uruguay: Infection: 59.9% (59.1-60.7)⁸⁹ Symptomatic infection in Chile: 58.5% (58.0-59.0)⁴⁷ Brazil: Infection: 52.7% (52.1-53.4); Hospitalisation: 72.8% (71.8-73.7); Death: 73.7% (72.3-75.0)⁴⁴</p>
Sinopharm	-	Symptomatic infection in Bahrain: 90% (88-91) ³⁴
Bharat Biotech	-	India: Symptomatic infection: 50% (33-62) ⁶²

Appendix 2: Vaccine Efficacy/Effectiveness Against Variants

Refer to Appendix 1 for vaccine effectiveness results for the Pfizer/BioNTech vaccine in Scotland, England and Israel, where all locations had predominant B.1.1.7 circulation. There are four Variants of Concern listed by WHO.¹⁹⁸ The WHO recommends labelling SARS-CoV-2 variants with letters of the Greek alphabet, as in the tables below.¹⁹⁹

VACCINE	VACCINE EFFICACY/EFFECTIVENESS (EFFECTIVENESS AGAINST INFECTION UNLESS SPECIFIED)		
	B.1.1.7 (ALPHA) VARIANT	B.1.351 (BETA) VARIANT	P.1 (GAMMA) VARIANT
AstraZeneca	UK: 70.4% (43.6-84.5) (vs. 81.5% (67.9-89.4) against wild variant) ²⁰⁰ England: ≥21 days after one dose: 48.7% (45.2-51.9); ≥14 days after two doses: 74.5% (68.4-79.4) ³³ Scotland: 73% (66-78) ²⁵ Canada: Single dose: 64% (60-68) ⁴⁵ UK: Single dose: 63% (55-69); 2 doses: 79% (56-90) ⁴⁰ Severe disease in Canada: Single dose: 85% (81-88) ⁴⁵	South Africa: 10.4% (-76.8 to 54.8) ²⁰¹ Study against severe disease underway ²⁴	Brazil: Symptomatic infection: Single dose: 37.6% (37.3-37.9); 2 doses 2-3 weeks: 69.8% (69.3-70.4); 2 doses 18-19 weeks: 57.7% (55.4-60.0); Hospitalisation or death: Single dose: 57.9% (56.9-58.9); 2 doses 2-3 weeks: 86.4% (85.4-87.3); 2 doses 18-19 weeks: 42.2% (32.4-50.6) ⁵²
Johnson & Johnson	-	Moderate to severe/critical: 64.0% (41.2-78.7) Severe/critical: 81.7% (46.2-95.4) ²⁴ Efficacy against hospitalisation in South Africa: 67% ²⁶	Moderate to severe/critical: 68.1% (48.8-80.7); Severe/critical: 87.6% (7.8-99.7) ²⁴
Moderna	Canada: Single dose: 83% (80-86); 2 doses: 92% (86-96) ⁴⁵ Severe disease in Canada: Single dose: 79% (74-83); 2 doses: 94% (89-97) ⁴⁵	-	-
Novavax	UK: 86.3% (71.3-93.5) (vs. 96.4% (73.8-99.5) against wild variant) ³⁰	South Africa: 51.0% (-0.6 to 76.2) ²⁰²	-
Pfizer/BioNTech	Case-control study in Israel: After one dose, vaccinees were disproportionately infected with B.1.1.7 (OR: 26:10) ²⁰³ Qatar: 89.5% (85.9-92.3) ²⁰⁴ England: ≥21 days after one dose: 47.5% (41.6 to 52.8) ≥14 days after second dose: 93.7% (91.6-95.3) ³⁸ Scotland: 92% (90-93) ²⁹ Canada: Single dose: 66% (64-68); 2 doses: 89% (86-91) ⁴⁵ UK: Single dose: 59% (52-65); 2 doses: 78% (68-84) ⁴⁰ Severe disease in Qatar: 100% (81.7-100) ²⁰⁴ Severe disease in Canada: Single dose: 80% (78-82); 2 doses: 95% (92-97) ⁴⁵	Israel case-control study: Vaccinees infected at least 1 week after the second dose were disproportionately infected with B.1.351 (odds ratio: 8:1) ²⁰³ Qatar: 75.0% (70.5-78.9) ²⁰⁴ South Africa: 100% (53.5-100) ³³ Severe disease in Qatar: 100% (73.7-100) ²⁰⁴	-
Sinovac	Chile: 67% (65-69) ³⁴	-	Brazil: 1 or 2 doses: 37.9% (-46.4-73.6) ²⁰⁵ Chile: 67% (65-69) ³⁴ Brazil: ≥70 years: 41.8% (26.9-53.3); 70-74 years: 61.8% (34.8-77.7); 75-79 years: 48.9% (23.3-66.0); ≥80 years: 28.0% (0.6-47.9) ²⁰⁶

* While it is known P.1. and B.1.1.7 were circulating at the time of the study, the extent is unknown based on available surveillance

VACCINE	VACCINE EFFICACY/EFFECTIVENESS (EFFECTIVENESS AGAINST INFECTION UNLESS SPECIFIED)	
	B.1.617.2 (DELTA) VARIANT	OMICRON VARIANT
AstraZeneca	<p>England: ≥21 days after one dose: 30.0% (24.3-35.3); ≥14 days after second dose: 67.0% (61.3-71.8)³⁸ Scotland: 60% (53-66)³⁹ Canada: Single dose: 67% (44-80)⁴⁵ UK: Single dose: 46% (35-55); 2 doses: 67% (62-71)⁴⁰ Symptomatic infection in England: 66.7% (66.3-67.0)⁴⁸ Hospitalisation in England: 1 dose: 71% (51-83); 2 doses: 92% (75-97)⁵⁰; 93.9% (91.3-95.7)⁴⁸ Death in England: 94.1% (81.8-95.8)⁴⁸ Severe disease in Canada: Single dose: 88% (60-96)⁴⁵ Hospitalisation and death in Scotland: 88% (85-90)³⁹ Scotland: Death: 91% (86-94)⁵¹ India: Any infection: 2 doses: 63.1% (51.5-72.1); Single dose: 46.2% (31.6-57.7); Moderate-severe: 2 doses: 81.5% (9.9-99.0); Single dose: 79.2% (46.1-94.0)⁴⁵ UK: Symptomatic infection: 2-9 weeks: 76.2% (63.7-84.4); 15-19 weeks: 48.5% (44.7-52.0) 20-24 weeks: 45.4% (43.0-47.6); ≥25 weeks: 41.8% (39.4-44.1)⁵⁰ England: Symptomatic infection: 25% (24.3-25.7)⁵¹ Scotland: Symptomatic infection: Single dose: 37.6% (34.6-40.5); 2 doses 2-3 weeks: 67.9% (65.9-69.8); 2 doses 18-19 weeks: 44.6% (41.5-47.6); Hospitalisation or death: Single dose: 49.3% (43.3-54.6); 2 doses: 2-3 weeks: 83.7% (79.7-87.0); 2 doses 18-19 weeks: 63.7% (59.6-67.4)⁵² England: Symptomatic infection: 2-9 weeks: 67.6% (67.3-67.9); ≥20 weeks: 44.3% (43.2-45.4); Hospitalisation: 2-9 weeks: 95.2% (94.7-95.7); ≥20 weeks: 80.0% (76.8-82.7); Death: 2-9 weeks: 95.0% (93.1-96.4); ≥20 weeks: 84.8% (76.2-90.3)⁵³</p>	<p>UK: No protective effect beyond 15 weeks⁵⁰ England: Symptomatic infection: -39% (-50--30)⁵¹ England: Hazard ratio for hospitalisation with Omicron relative to primary Delta infection in unvaccinated: Single dose: 0.42; 2 doses: 0.37; 2 doses plus Pfizer booster: 0.21²⁰⁷</p>
Johnson & Johnson	<p>Efficacy against hospitalisation in South Africa: 71%²⁵ USA: Infection: 78% (73-82); Hospitalisation: 85% (73-91)⁶⁴</p>	<p>South Africa: Booster against hospitalisation: 85% (54-95)⁹⁵</p>
Moderna	<p>Canada: Single dose: 72% (57-82)⁴⁵ Minnesota, USA: 76% (58-87)⁶⁹ England: 95.2% (94.4-95.9)⁴⁸ Severe disease in Canada: Single dose: 96% (72-99)⁴⁵ Severe disease in Minnesota: 81% (33-96)⁶⁹ Hospitalisation in England: 97.5% (82.3-99.7)⁴⁸ Pooled Pfizer/BioNTech and Moderna against hospitalisation and death in Scotland: 91% (88-93)⁵⁸ USA: Infection: 86.7% (84.3-88.7); Hospitalisation: 97.6% (92.8-99.2)⁷² Denmark: First month: 88.2% (83.1-91.8); Third month: 72.2% (70.4-74.0); Booster first month: 82.8% (58.8-92.9)⁷³ USA: Infection: Single dose: 60.2% (42.6-72.3); 2 doses: 14-90 days: 82.8% (69.6-90.3); 181-270 days: 61.4% (56.8-65.5); 3 doses: ≤2 months: 95.7% (94.2-96.9); >2 months: 90.7% (81.4-95.3); Hospitalisation: Single dose: 68.9% (0.0-99.4); 2 doses: 98.0% (87.2-99.7)⁷⁴ Moderna and Pfizer in USA: Hospitalisation: 2 doses: <6 months: 90% (89-90); ≥6 months: 81% (80-82); 3 doses: 94% (93-95)¹⁹²</p>	<p>Denmark: First month: 36.7% (-69.9-76.4); Third month: 4.2% (-30.8-29.8)⁷³ USA: Infection: Single dose: 20.3% (0.0-39.8); 2 doses: 14-90 days: 30.4% (5.0-49.0); 181-270 days: 0.0% (0.0-1.2); 3 doses: ≤2 months: 63.6% (57.4-68.9); >2 months: 39.1% (3.8-61.5)⁷⁴ Moderna and Pfizer in USA: Hospitalisation: 2 doses: <6 months: 81% (65-90); ≥6 months: 57% (39-70); 3 doses: 90% (80-94)¹⁹² Qatar: Symptomatic infection: Single dose: -1.6% (-56.8-34.1); 2 doses: 1-3 months: 44.8% (16.0-63.8); ≥7 months: -9.3% (-16.3--2.8); 3 doses: 4-5 weeks: 54.6% (41.1-65.0); ≥6 weeks: 38.6% (19.4-53.1); Hospitalisation: 2 doses: 1-3 months: 76.9% (19.2-93.4); ≥7 months: 64.0% (39.1-78.7)⁷⁶</p>
Pfizer/BioNTech	<p>England: ≥21 days after one dose: 35.6% (22.7-46.4); ≥14 days after second dose: 88.0% (85.3-90.1)³⁸ Scotland: 79% (75-82)³⁹ Canada: Single dose: 56% (45-64); 2 doses: 87% (64-95)⁴⁵ Effectiveness in Israel: Infection: 64%; Symptomatic illness: 64%²⁰⁸ Israel 6m after roll out: 39.0% (9.0-59.0)⁹² Minnesota, USA: 42% (13-62)⁶⁹ UK: Single dose: 57% (50-63); 2 doses: 80% (77-83)⁴⁰ England: 89.8% (89.6-90.0)⁴⁸ Hospitalisation in England: 1 dose: 94% (46-99); 2 doses: 96% (86-99)⁵⁰; 99.7% (97.6-100.0)⁴⁸ Death in England: 98.2% (95.9-99.2)⁴⁸ Severe disease in Canada: Single dose: 78% (65-86)⁴⁵ Hospitalisation in Israel: 93%²⁰⁸ Severe disease in Israel: 91.4% (82.5-95.7)⁹² Severe disease in Minnesota: 75% (24-94)⁶⁹ Pooled Pfizer/BioNTech and Moderna against hospitalisation and death in Scotland: 91% (88-93)⁵⁸ Scotland: Death: 90% (83-94)⁵¹ UK: Symptomatic infection: 2-9 weeks: 88.2% (86.7-89.5); 15-19 weeks: 72.2% (71-73.4); 20-24 weeks: 64.8% (62.6-66.9); ≥25 weeks: 63.5% (61.4-65.5)⁵⁰ Denmark: First month: 86.7% (84.6-88.6); Third month: 72.8% (71.7-73.8); Booster first month: 81.2% (79.2-82.9)⁷³ USA: Hospitalisation: 2 doses: <3 months: 88% (71-95); ≥6 months: 74% (65-80); 3 doses: <3 months: 95% (91-97); ≥3 months: 65% (16-85)⁹² Moderna and Pfizer in USA: Hospitalisation: Delta: 2 doses: <6 months: 90% (89-90); ≥6 months: 81% (80-82); 3 doses: 94% (93-95)¹⁹² England: Symptomatic infection: 2-9 weeks: 89.7% (89.5-89.8); ≥20 weeks: 66.3% (65.7-66.9); Hospitalisation: 2-9 weeks: 98.7% (98.3-99.0); ≥20 weeks: 91.7% (90.2-93.0); Death: 2-9 weeks: 98.5% (96.5-99.3); ≥20 weeks: 91.9% (88.5-94.3)⁹³</p>	<p>UK: Symptomatic infection: Single dose: 34.2% (-3.5-58.1); 2 doses: 2-9 weeks: 88.0% (65.9-95.8); 15-19 weeks: 34.1% (9.7-52.0); Booster after PF primary series: 75.5% (56.1-86.3); Booster after AZ primary series: 71.4% (41.8-86.0)⁵⁰ South Africa: Symptomatic infection: 33%; Hospitalisation: 70% (risk of hospital admission 29% lower for Omicron compared to first wave in mid-2020, adjusted for vaccination status)⁹⁸ England: Hazard ratio for hospitalisation with Omicron relative to primary Delta infection in unvaccinated: Single dose: 0.66; 2 doses: 0.26; 3 doses: 0.37²⁰⁷ Denmark: First month: 55.2% (23.5-73.7); Third month: 9.8% (-10.0-26.1); Booster first month: 54.6% (30.4-70.4)⁷³ USA: Effectiveness against hospitalisation: 2 doses: <3 months: 70% (41-84); ≥6 months: 68 (56-76); 3 doses: <3 months: 89% (83-92); ≥3 months: 90% (57-98)⁹² Moderna and Pfizer in USA: Hospitalisation: Omicron: 2 doses: <6 months: 81% (65-90); ≥6 months: 57% (39-70); 3 doses: 90% (80-94)¹⁹² Qatar: Symptomatic infection: Single dose: 26.1% (5.8-42.0); 2 doses: First month: 61.9% (49.9-71.1); Seventh month: 9.6% (2.4-16.3); 3 doses: 4-5 weeks: 56.6% (50.8-61.7); ≥12 weeks: 37.6% (28.8-45.4); Hospitalisation: 2 doses: 1-6 months: 73.7% (46.8-87.0); ≥7 months: 80.7% (71.3-87.0); 3 doses: 1-6 weeks: 90.6% (77.8-96.0); ≥7 months: 90.8% (81.5-95.5)⁹⁵</p>

Sinovac	China (combined Sinovac and Sinopharm): Single dose: 13.8% (-60.2-54.8); 2 doses: 59.0% (16.0-81.6) Severe disease: 100% ²⁰⁹	-
Sinopharm	China (combined Sinovac and Sinopharm): Single dose: 13.8% (-60.2-54.8); 2 doses: 59.0% (16.0-81.6) Severe disease: 100% ²⁰⁹	-
Bharat Biotech	Efficacy against infection in India: 65.2% (33.1-83.0) ¹⁸ India: Symptomatic infection: 50% (33-62) ⁶²	-
Clover	Efficacy in Philippines, Colombia, Brazil, South Africa and Belgium: Symptomatic infection: 78.7% (57.3-90.4); Mod-Severe: 81.7% (35.9-96.6) ¹⁹	-

Appendix 3: Vaccine Efficacy/Effectiveness and Immunogenicity of Boosters Against Delta

Booster refers to an additional dose administered at least 5 months after completion of the primary series.
Booster efficacy/effectiveness reported relative to primary series (not unvaccinated) unless otherwise specified.

VACCINE	IMMUNOGENICITY	VACCINE EFFECTIVENESS UNLESS OTHERWISE STATED			
		ANY INFECTION	SYMPTOMATIC INFECTION	HOSPITALISATION	DEATH
Johnson & Johnson	Strong antibody response ⁹⁴	-	-	-	-
Moderna	Strong antibody response ⁹⁴	USA (relative to unvaccinated): Delta: ≤2 months: 95.7% (94.2-96.9); >2 months: 90.7% (81.4-95.3) ⁷⁴	England (after Pfizer primary series): Relative to primary series at least 6 months earlier: 86.8% (81.5-90.5); relative to unvaccinated: 94.8% (92.7-96.3) ⁹⁷	Moderna and Pfizer in USA: 94% (93-95) ¹⁹²	-
Pfizer/BioNTech	Strong antibody response ⁹⁴	Israel; Infection ~10 times lower in boosted group (range across five age groups, 9.0 to 17.2) ¹⁰¹ Denmark (relative to unvaccinated): First month: 54.6% (30.4-70.4) ⁷³	Efficacy: ≥6 months (median 10.8 months) in USA, South Africa, Brazil: 95.3 (89.5-98.3) ⁹⁸ UK: Relative to primary series at least 4.6 months earlier: PF primary: 84.4% (82.8-85.8); AZ primary: 87.4% (84.9-89.4); Relative to unvaccinated: PF primary: 94.0% (93.4-94.6); AZ primary: 93.1% (91.7-94.3) ⁹⁹ UK: relative to unvaccinated: PF primary: 92.6% (92.0-93.1); AZ primary: 93.8% (93.2-94.3) ⁵⁰ England: PF primary: 88.6% (88.1-89.1) AZ primary: 89.7% (88.9-90.4) ⁵¹ England: Relative to primary series at least 6 months earlier: 85.6% (84.9-86.3); relative to unvaccinated: 94.4% (94.1-94.7) ⁹⁷	Israel ≥5 months: 93% (88-97) ¹⁰⁰ Israel: Severe disease: ≥60 years: 17.9 times lower in boosted group (15.1-21.2); 40-59 years: 21.7 times lower (10.6-44.2) ¹⁰¹ USA: <3 months: 95% (91-97); ≥3 months: 65% (16-85) ⁹² Moderna and Pfizer in USA: 94% (93-95) ¹⁹² England: Relative to unvaccinated: 98.6 (98.0 to 99.0) ⁹⁷	Israel ≥5 months: 81% (59-97) ¹⁰⁰ Israel ≥5 months: 90% (86-93) ²¹⁰ Israel ≥60 years: mortality 14.7 times lower in boosted group: (10.0-21.4) ¹⁰¹ England: Relative to unvaccinated: 98.7% (97.4-99.4) ⁹⁷
Sinovac	Strong antibody response ¹⁰³	-	Chile: 78.8% (76.8-80.6) ¹⁰⁴	Chile: 86.3% (83.7-88.5) ¹⁰⁴	Chile: 86.7% (80.5-91.0) ¹⁰⁴

Appendix 4: Vaccine Efficacy/Effectiveness in High-Risk Groups

VACCINE	VACCINE EFFICACY UNLESS OTHERWISE STATED			
	DIABETES	OBESITY	AT RISK FOR SEVERE COVID-19	ELDERLY
AstraZeneca	-	-	76% against symptomatic infection in a sample where 60% had comorbidities, including diabetes, severe obesity or cardiac disease ¹⁷ (not peer-reviewed) Effectiveness against symptomatic infection in the UK in those with comorbidities and ≥65 years: Single dose: 60.0% (46.5-70.1); 2 doses: 79.7% (61.6-89.3) ⁴⁶ Hospitalisation in Scotland: 63% (46-75) ²⁷	In ≥65 years: 85% ¹⁷ (not peer-reviewed) Effectiveness against hospitalisation at 28-34 days after a single dose (pooled analysis of AstraZeneca and Pfizer vaccines): 18-64 years: 85% (68-93); 65-79 years: 79% (17-95); ≥80 years: 81% (65-90) ⁹⁰ Effectiveness of single dose against hospitalisation in England: ≥80 years: 73% (60-81) ¹⁰⁷ Effectiveness in England: Symptomatic infection ≥70 years: 73% (27-90); Hospitalisation ≥80 years: 37% (3-59) ¹⁰⁸ Hospitalisation following single dose in the UK: ≥80 years: 80.4% (36.4-94.5) ¹⁰⁵ Single dose in Spain: ≥60 years: 53% (19-72) vs. 18-59 years: 50% (34-62) ⁵⁴ Effectiveness against death in the UK: ≥65 years: Single dose: 83% (78-86); Two doses: 94% (80-98) ⁷⁷ Effectiveness against symptomatic infection in the UK, ≥65 years: single dose: 60.9% (49.0-70.0); 2 doses: 76.4% (58.8-86.5) ⁴⁶ Effectiveness against death in Scotland ≥60 years: 90% (84-94) ⁵¹ Brazil: Infection: 80-89 years: 73.1% (71.2-74.9); ≥90 years: 39.0% (23.5-51.4); Hospitalisation: 80-89 years: 85.1% (83.0-86.9); ≥90 years: 50.9% (31.3-64.9); Death: 80-89 years: 89.9% (87.7-91.7); ≥90 years: 65.4% (46.1-77.8) ¹⁴ England: ≥65 years: Symptomatic infection: 2-9 weeks: 59.1% (55.4-62.6); ≥25 weeks: 27.8% (16.3-37.8); Hospitalisation: 2-9 weeks: 91.7% (88.8-93.9); ≥20 weeks: 81.8% (76.6-85.9); Death: 2-9 weeks: 94.1% (89.6-96.7); ≥20 weeks: 82.1% (70.1-89.3) ³³
Gamaleya	-	-	-	Symptomatic infection ≥60 years: 91.8% (67.1-98.3) ²⁰
Johnson & Johnson	Moderate to severe/critical: 23.0% (-90.1-69.8) ²⁴	Moderate to severe/critical: 65.9% (47.8-78.3) ²⁴	Moderate to severe/critical: With any comorbidity: 58.6% (40.6-71.6) ²⁴ No comorbidity: 68.8% (59.0-76.6) ²⁴	Moderate-severe/critical disease ≥28 post vaccination: 18-59 years: 66.1% (53.3-75.8) 60+ years: 66.2% (36.7-83.0) ²⁴
Moderna	-	-	Symptomatic infection, comorbidities, including diabetes and obesity: In low risk: 95.1% (89.6-97.7) In high risk: 90.9% (74.7-96.7) ²⁷ Pooled Pfizer/BioNTech and Moderna against hospitalisation in Scotland: 72% (51-84) ²⁷ Netherlands: Hospitalisation in a population at high risk for severe COVID-19: 84% (80-87) ⁵²	Symptomatic infection: 18-64 years: 95.6% (90.6-97.9) ≥65 years: 86.4% (61.4-95.2) ²⁷ Pooled Moderna and Pfizer vaccines against hospitalisation ≥65 years: 94% (49-99) ²¹¹ Infection in Canada: 1 dose ≥70 years: 54% (31-69); 2 doses ≥70 years: 95% (83-98) ⁷⁵ Pooled Moderna and Pfizer vaccines in Portugal: Hospitalisation 65-79 years: 94% (88-97); ≥80 years: 82% (72-89); Death 65-79 years: 96% (92-98); Death ≥80 years: 81% (74-87) ²¹² USA: Hospitalisation: ≥65 years: 75.2% (59.6-84.8) vs 18-64 years: 87.9% (85.5-89.9) ⁷² USA: Effectiveness against infection: Delta ≥65 years: 97.2% (94.1-98.7); Omicron ≥65 years: 57.1% (14.2-78.6) ¹⁴
Pfizer/BioNTech	Effectiveness in Israel: Diabetes or cardiovascular disease: 82% (62-92) ⁵⁴ Effectiveness against infection in Israel: 88.9% (87.3-90.2) ⁹⁰	Effectiveness against infection in Israel: (89.7% (88.6-90.7)) ⁹⁰	Symptomatic infection: With any comorbidity or obesity: 95.3% With no comorbidity: 94.7% ⁵² Denmark: Infection: 71% (58-80); Hospitalisation: 81% (49-93) ⁹ Effectiveness against infection in Israel: Hypertension: (89.7% (88.6-91.7)) ⁹⁰ Effectiveness against symptomatic infection in the UK in those with comorbidities and ≥65 years: Single dose: 56.4% (46.2-64.6) 2 doses: 88.5% (81.5-92.9) ⁴⁶ Pooled Pfizer/BioNTech and Moderna against hospitalisation in Scotland: 72% (51-84) ²⁷	Efficacy against infection ≥75 years: 96.2% (76.9-99.9) ¹³ Mympomatic infection: >55 years: 93.7% (80.6-98.8); >65 years: 94.7% (66.7-99.9); >75 years: 100% (-13.1-100) ³² Effectiveness against hospitalisation 28-34 days after a single dose (pooled analysis of AstraZeneca and Pfizer vaccines): 18-64 years: 85% (68-93); 65-79 years: 79% (17-95); ≥80 years: 81% (65-90) ⁹⁰ England 80-83 years: Documented infection: 70.1% (56.1-80.1) Hospital attendance: 78.9% (60.0-89.9); Hospital admission: 75.6% (52.8-87.6) ¹⁰⁸ Reduction in incidence of infection in vaccinated people aged ≥60 years and unvaccinated people aged 20-39 years, respectively: Documented infection: 45% versus 28%; Hospitalisation: 68% versus 22% ²¹³ Pooled Moderna and Pfizer vaccines against hospitalisation ≥65 years: 94% (49-99) ²¹¹ Effectiveness in England: Symptomatic infection ≥70 years: 61% (51-69); Hospitalisation ≥80 years: 43% (33-52); Death ≥80 years (vaccine failure vs non-vaccinated): 51% (37-62) ¹⁰⁸ Effectiveness against hospitalisation in England ≥80 years: Single dose: 81% (76-85) Fully vaccinated: 93% (89-95) ¹⁰⁷ (not peer reviewed) Effectiveness in Israel: 65-74 years: 82% (63-92); ≥75 years: 82% (61-91) ⁸⁴ Hospitalisation following single dose in the UK: ≥80 years: 71.4% (43.1-86.2) ¹⁰⁵ Single dose in Spain: ≥60 years: 76% (55-87) vs. 18-59 years: 85% (74-91) ⁵⁴ Effectiveness against infection in Denmark: ≥80 years: 77% (50-89) ³⁸ Effectiveness against infection in Israel: ≥70 years: 89.1% (83-93) ⁹⁰ Effectiveness against death in the UK: ≥65 years: Single dose: 77% (72-81); Two doses: 98% (94-99) ⁷⁷ Effectiveness against symptomatic infection in the UK, ≥65 years: single dose: 56.6% (47.6-64.1); 2 doses: 86.7% (80.1-91.1) ⁴⁶ Infection in Canada: 1 dose ≥70 years: 40% (29-50); 2 doses ≥70 years: 93% (82-98) ⁷⁵ Pooled Moderna and Pfizer vaccines in Portugal: Hospitalisation 65-79 years: 94% (88-97); ≥80 years: 82% (72-89); Death 65-79 years: 96% (92-98); Death ≥80 years: 81% (74-87) ²¹² Effectiveness against death in Scotland ≥60 years: 87% (77-93) ⁵¹ England: ≥65 years: Symptomatic infection: 2-9 weeks: 79.6% (77.0-81.8); ≥25 weeks: 51.8% (45.4-57.4); Hospitalisation: 2-9 weeks: 98.0% (95.9-99.1); ≥20 weeks: 90.5% (87.6-92.7); Death 2-9 weeks: 97.1% (91.7-99.0); ≥65 years, ≥20 weeks: 90.2% (85.3-93.5) ³³
Novavax	-	-	Any infection with comorbidity, age ≥65 years or frequent COVID-19 exposure in USA and Mexico: 91.0% (83.6-95.0) ⁵¹	-
Sinovac	-	74.9% (53.7-86.4) ³⁴	Any comorbidity: 48.9% (26.6-64.5) ³⁴	Brazil: Infection: 80-89 years: 55.6% (53.3-57.8); ≥90 years: 27.6% (20.5-34.0); Hospitalisation: 80-89 years: 63.5% (60.4-66.3); ≥90 years: 31.8% (21.9-40.5); Death: 80-89 years: 67.2% (63.6-70.5); ≥90 years: 33.6% (21.9-43.5) ⁴⁴
Sinopharm	-	80.7% (56.7-91.4) ³⁴	-	Effectiveness against symptomatic infection in Bahrain: ≥60 years: 91% (87-94) ³⁴
Bharat Biotech	-	-	Any infection with comorbidity: 66.2% (33.8-84.0) ¹⁸	Symptomatic infection in India: ≥60 years: 67.8% (8.0-90.0) vs 18-59 years: 79.4% (66.0-88.2) ¹⁸

Appendix 5: Vaccine Efficacy/Effectiveness Against Transmission

There are limitations related to the analysis and comparison of transmission data between studies and vaccines. Criteria for testing vary between studies and may include, for example, random testing, testing at defined intervals, or retrospective serology.

VACCINE	EFFICACY/EFFECTIVENESS AGAINST ASYMPTOMATIC INFECTION	OTHER OUTCOMES
AstraZeneca	<p>EFFICACY (UK only): 22.2% (-9.9-45.0); Symptomatic and asymptomatic combined (UK, SOUTH AFRICA & BRAZIL): 54.1% (44.7-61.9)¹⁶</p> <p>ENGLAND: Hazard ratio for single dose in vaccinated vs. unvaccinated care facility residents: 0.32 (0.15-0.66)²¹⁴;</p> <p>Odds ratio for household contacts of vaccinated vs non-vaccinated health workers testing positive: 0.52 (0.43-0.62)²¹⁵</p> <p>Effectiveness against household transmission of Delta: 42% (14-69); Vaccination of household contacts against infection from a symptomatic household index case: 14% (-5-46)²¹⁸</p> <p>UK: Regular testing of randomly selected households: 79% (65-88)²¹⁷; Single dose against symptomatic and asymptomatic infection: 60% (49-68)²¹⁸</p> <p>NETHERLANDS: Effectiveness against transmission (secondary attack rate among household contacts): 58% (-12-84)⁹¹</p>	<p>SCOTLAND: POOLED ANALYSIS OF PFIZER/BIONTECH AND ASTRAZENECA: Hazard ratio for household contacts of vaccinated vs non-vaccinated health workers testing positive: 0.70 (0.63-0.78)²¹⁹</p> <p>PF and AZ: Secondary attack rates in household contacts in the UK: Vaccinated contacts: 25% (18-33); Unvaccinated contacts: 38% (24-53); Unvaccinated index cases: 23% (15-31); Vaccinated index cases: 25% (15-35)²²⁰</p>
Bharat Biotech	<p>EFFICACY IN INDIA: Asymptomatic: 63.6% (29.0-82.4); Symptomatic and asymptomatic combined: 68.8% (46.7-82.5)¹⁸</p>	-
Johnson & Johnson	<p>EFFICACY (multiple countries): Asymptomatic infection: 59.7% (32.8-76.6)⁹⁴</p> <p>UK: Single dose against symptomatic and asymptomatic infection: 60% (49-68)²¹⁸</p> <p>Netherlands: Effectiveness against transmission (secondary attack rate among household contacts): 77% (6-94)⁹¹</p>	<p>USA (Kentucky): OR for reinfection in unvaccinated vs vaccinated with Johnson & Johnson, Moderna or Pfizer/BioNTech): 2.34 (1.58-3.47)²²¹</p>
Moderna	<p>USA: Asymptomatic infection: 72.7% (53.4-84.0)⁷⁵</p> <p>USA: POOLED ANALYSIS OF PFIZER/BIONTECH AND MODERNA: 88.7% (68.4-97.1)²²²; 90% (68%-97)²²³; single dose: 80% (59-90)²²³;</p> <p>Relative risk of infection in asymptomatic pre-surgical patients >10 days after first dose compared to unvaccinated residents: 0.21 (0.12-0.37)²²⁴;</p> <p>Incident cases in unvaccinated nursing home residents decreased from 4.3% within 14 days of the first vaccination clinic to 0.3% after 42 days²²⁵</p> <p>MODELLING: Reduced potential for transmission: at least 61%²²⁶</p> <p>UK: Single dose against symptomatic and asymptomatic infection: 60% (49-68)²¹⁸</p> <p>Netherlands: Effectiveness against transmission (secondary attack rate among household contacts): 88% (50-97)⁹¹</p> <p>USA: 63.0% (56.6-68.5)²²</p> <p>Qatar: First month after second dose: 73.1% (70.3-75.5); declining to no evidence of any effect by 4 months post-vaccination⁷¹</p>	<p>USA (Kentucky): OR for reinfection in unvaccinated vs vaccinated with Johnson & Johnson, Moderna or Pfizer/BioNTech): 2.34 (1.58-3.47)²²¹</p>
Pfizer/BioNTech	<p>ENGLAND: 86% (76-97) 7 days after 2 doses; 72% (58-86) 21 days after 1 dose¹³³</p> <p>Effectiveness against household transmission of Delta: 31% (-3-61); Vaccination of household contacts against infection from a symptomatic household index case: 24% (-2-64)²¹⁶</p> <p>ISRAEL: 92% (88-95)⁸⁶; 91.5% (90.7-92.2)⁸⁵; 65% (45-79%)¹³⁴; single dose: 75% (72-84)²²⁷;</p> <p>Effectiveness against transmission: 88.5% (82.3-94.8)²²⁸; Effectiveness against infection in the household: 78% (30-94)²²⁹</p> <p>USA: Asymptomatic screening: 90% (78-96)⁹⁷</p> <p>USA: POOLED ANALYSIS OF PFIZER/BIONTECH AND MODERNA: 88.7% (68.4-97.1)²²²; 90% (68%-97)²²³; single dose: 80% (59-90)²²³;</p> <p>Relative risk of infection in asymptomatic pre-surgical patients >10 days after first dose compared to unvaccinated residents: 0.21 (0.12-0.37)²²⁴;</p> <p>Incident cases in unvaccinated nursing home residents decreased from 4.3% within 14 days of the first vaccination clinic to 0.3% after 42 days²²⁵</p> <p>UK: single dose: 4-fold decrease in risk amongst HCWs ≥12 days post-vaccination²³⁰; Regular testing of randomly selected households: 80% (73-85)²¹⁷;</p> <p>Single dose against symptomatic and asymptomatic infection: 72% (63-79)²¹⁸; 60% (49-68)²¹⁸</p> <p>FINLAND: Effectiveness against transmission to unvaccinated household contacts: 2 weeks after first dose: 8.7% (-28.9-35.4); 10 weeks after first dose: 42.9% (22.3-58.1)²³¹</p> <p>Netherlands: Effectiveness against transmission (secondary attack rate among household contacts): 70% (61-77)⁹¹</p> <p>Finland: Effectiveness against transmission to unvaccinated household contacts of vaccinated cases: 42.9% (22.3-58.1)²³¹</p>	<p>ISRAEL: Lower viral load in vaccine failure cases 12-37 days after the first dose of vaccine compared to within the first 11 days, indicating potentially lower infectiousness²³²;</p> <p>Data from 223 communities: strong correlation between community vaccination rate and a later decline in infection among children under 16 years of age who were unvaccinated²³³;</p> <p>Substantially decreased viral load for infections occurring 12-37 days after the first dose of vaccine, indicating likely lower infectiousness²³²</p> <p>Detectable transmission in long-term care facilities in Spain reduced by 90% (76-93)²³⁴</p> <p>ENGLAND: Odds ratio for household contacts of vaccinated health workers vs non-vaccinated health workers testing positive: 0.54 (0.47-0.62)²¹⁵</p> <p>SCOTLAND: POOLED ANALYSIS OF PFIZER/BIONTECH AND ASTRAZENECA: Hazard ratio for single dose in vaccinated vs. unvaccinated care facility residents: 0.35 (0.17-0.71)²¹⁴</p> <p>USA (Kentucky): OR for reinfection in unvaccinated vs vaccinated with Johnson & Johnson, Moderna or Pfizer/BioNTech): 2.34 (1.58-3.47)²²¹</p> <p>PF and AZ: Secondary attack rates in household contacts in the UK: Vaccinated contacts: 25% (18-33); Unvaccinated contacts: 38% (24-53); Unvaccinated index cases: 23% (15-31); Vaccinated index cases: 25% (15-35)²²⁰</p>

Appendix 6: Risk of Rare Unusual Blood Clotting with Low Platelets (Thrombosis with Thrombocytopenia Syndrome – TTS)

Estimated number of TTS that potentially might occur in Pacific Island Countries if all adults received the AstraZeneca or Johnson & Johnson vaccines, based on most recent official estimate of the adult population in each country and the incidence of these events in Europe and Australia.

COUNTRY	TOTAL POPULATION	ESTIMATED POPULATION AGED 18 YEARS AND OVER*	POTENTIAL NUMBER OF TTS CASES IF ALL ADULTS IN EACH COUNTRY RECEIVED ASTRAZENECA VACCINE**	POTENTIAL NUMBER OF TTS CASES IF ALL ADULTS IN EACH COUNTRY RECEIVED JOHNSON & JOHNSON VACCINE***
American Samoa	55,519	33,311	<1	<1
Cook Islands	15,300	9,180	<1	<1
Federated States of Micronesia	102,300	61,380	0.6-1.2	<1
Fiji	867,000	520,200	5.2-10.4	1.6
French Polynesia	275,918	165,551	1.7-3.3	<1
Guam	159,358	95,615	1.0-1.9	<1
Kiribati	113,400	68,040	0.7-1.4	<1
Marshall Islands	54,900	32,940	<1	<1
Nauru	10,900	6,540	<1	<1
New Caledonia	271,407	162,844	1.6-3.3	<1
Niue	1,611	967	<1	<1
Northern Mariana Islands	53,883	32,330	<1	<1
Palau	18,000	10,800	<1	<1
Papua New Guinea	7,744,700	4,646,820	46.5-92.9	14.6
Samoa	195,979	117,587	1.2-2.4	<1
Solomon Islands	642,000	385,200	3.9-7.7	1.2
Tokelau	1,160	696	<1	<1
Tonga	99,419	59,651	0.6-1.2	<1
Tuvalu	10,507	6,304	<1	<1
Vanuatu	272,173	163,304	1.6-3.3	<1
Wallis and Futuna	11,558	6,935	<1	<1
All Pacific Island Countries	10,976,992	6,586,195	65.9-131.7	20.8

* Based on estimate of 60% of population aged ≥18 years²³⁵

** Based on estimates of TTS occurring in ~1 in 100,000 vaccinated adults by the European Medicines Agency and ~1 in 50,000 in Australia^{10,11}

*** Based on estimates of TTS occurring in ~1 in 319,000 vaccinated adults in USA (may be an underestimate as only cerebral venous sinus thrombosis are reported)¹³