

# Weekly COVID-19 Vaccine Updates

Number 26, 16 September 2021

# 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 Delta VOC at-a-glance.....	7
Vaccine Efficacy/Effectiveness in High-Risk Groups at-a-glance.....	8
Vaccine Efficacy/Effectiveness in Children.....	9
Vaccine Efficacy/Effectiveness Against Transmission.....	10
Mixed Dose Vaccine Safety and Immune Responses.....	11
Adverse Events Following Immunisation with WHO EUL Vaccines.....	12
Serious Adverse Events.....	13
Risk of Rare Unusual Blood Clotting with Low Blood Platelets (Thrombosis with Thrombocytopaenia Syndrome – TTS).....	14
Who Can be Vaccinated Based on WHO SAGE Recommendations?.....	15
Vaccine Development Pipeline.....	16
WHO SAGE Emergency Use Listing and Prequalification Timeline.....	16
References.....	18
Acknowledgements.....	22
Appendix 1: COVID-19 Vaccine Effectiveness.....	23
Appendix 2: Vaccine Efficacy/Effectiveness Against Variants.....	24
Appendix 3: Vaccine Efficacy/Effectiveness in High-Risk Groups.....	25

# 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 (including circulation of variants of concern)
- All COVID-19 vaccines in late phase development report high vaccine efficacy against severe COVID-19 and favourable safety profiles
- Pfizer/BioNTech and AstraZeneca both have high vaccine effectiveness against the Delta variant and both vaccines are similarly effective against transmission in the UK. Sinovac has shown high vaccine effectiveness in Chile where the Gamma and Alpha variants are circulating. Sinopharm has shown high vaccine effectiveness in Bahrain and several vaccines have shown effectiveness against mortality in infected adults in Bahrain: Unvaccinated: 1.32% mortality (857 deaths); Sinopharm: 0.46% (112 deaths); Pfizer/BioNTech: 0.15% (3 deaths); Sputnik: 0.09 (3 deaths); AstraZeneca: 0.03% (1 death).<sup>1</sup> The Johnson & Johnson and Moderna vaccines have both shown good vaccine effectiveness against infection in the US. One or 2 doses of the Moderna vaccine is effective against the Alpha variant in Canada, and a single dose is effective against infection and very effective against severe disease with the Delta variant.
- The US FDA, UK MHRA, EU EMA, NZ Medsafe, Health Canada and the Australian TGA have authorised the Pfizer/BioNTech vaccine for emergency use in adolescents aged 12-15 years.<sup>2-6</sup> The EMA, MHRA and TGA have also authorised the Moderna vaccine in this age group.<sup>7-9</sup>
- Mixed vaccine schedules (i.e. delivering different types of vaccine for the first and second dose) are under investigation as these could facilitate better protection against variants of concern and enable vaccination programs to continue if a particular vaccine is unavailable
- Seven intranasal vaccines are in development (6 live-attenuated viruses or virus-vectored vaccines; 1 protein subunit).<sup>10</sup> These may be beneficial in preventing transmission (Page 15)
- A very rare clotting disorder with low platelets (Thrombosis with Thrombocytopenia Syndrome – TTS) has been associated with the AstraZeneca and Johnson & Johnson vaccines.<sup>11-13</sup> 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.<sup>14,15</sup> 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.<sup>16</sup>
- The risk of TTS following the first dose of Johnson & Johnson vaccine has been estimated as 1 in 319,000 in the USA<sup>17</sup>
- 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.<sup>18</sup> Highest rate in in males 16-17 years of age following Pfizer/BioNTech vaccine but no clear difference in risk between Moderna and Pfizer/BioNTech.<sup>19</sup> There is a small increase in risk of myocarditis in females <30 and males >50 years of age.
- Appropriate communication on the benefit-risk profile of COVID-19 vaccines (Page 14) 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):

- Effectiveness of the Moderna vaccine in USA generally similar across age, sex, and racial/ethnic subgroups (Pages 6, 8, 10 and 23):
  - Any infection overall: 87.4% (84.8-89.6)
  - Any infection ≥75 years: 83.0% (76.8-87.6)
  - Symptomatic infection: 88.3% (86.1-90.2)
  - Asymptomatic infection: 72.7% (53.4-84.0)
  - Hospitalisation: 95.8% (90.7-98.1)
  - Death: 97.9% (66.9-99.9)
- Vaccine effectiveness against infection by variant in Norway (mostly Pfizer/BioNTech and Moderna vaccines with <10% AstraZeneca and mixed dosing):
  - Alpha: 84.4% (81.8-86.5)
  - Delta: 64.6% (60.6-68.2)
- Waning effectiveness of Pfizer/BioNTech vaccine in Israel:
  - Between 11-31 July in Israel, those aged ≥60 years who received their second dose in March 2021 were 1.6 (1.3-2.0) times more protected against infection and 1.7 (1.0-2.7) times more protected against severe COVID-19 compared to those who received their second dose in January 2021
- Effect of a third booster dose of Pfizer/BioNTech vaccine at least 5 months after the second dose in Israel:
  - Infection: 11.4-fold (10.0-12.9) decrease in relative risk compared to those yet to receive a third booster
  - Severe disease: 15.5-fold (10.5-22.8) decrease in relative risk
- Vaccine effectiveness against Delta reported to wane in the UK following a peak in effectiveness in the early weeks following Pfizer/BioNTech and AstraZeneca vaccines (longer follow-up not available for the Moderna vaccine). Waning effectiveness was greater in older adults (Pages 6, 7, 8 and 24):
  - PF: Symptomatic infection
    - Overall: 2-9 weeks: 89.8% (89.6-90.0); ≥20 weeks: 69.7% (68.7-70.5)
    - ≥65 years: 2-9 weeks: 80.1% (77.5-82.4); ≥20 weeks: 55.3% (50.2-60.0)
  - PF: Hospitalisation
    - 2-9 weeks: 99.7% (97.6-100.0); ≥20 weeks: 92.7% (90.3-94.6)
  - PF: Death
    - 2-9 weeks: 98.2% (95.9-99.2); ≥20 weeks: 90.4% (85.1-93.8)
  - AZ: Symptomatic infection
    - Overall: 2-9 weeks: 66.7% (66.3-67.0); ≥20 weeks: 47.3% (45.0-49.6)
    - ≥65 years: 2-9 weeks: 58.9% (54.8-62.6); ≥20 weeks: 36.6% (28.7-43.7)
  - AZ: Hospitalisation
    - 2-9 weeks: 93.9% (91.3-95.7); ≥20 weeks: 77.0% (70.3-82.3)
  - AZ: Death
    - 2-9 weeks: 94.1% (91.8-95.8); ≥20 weeks: 78.7% (52.7-90.4)
  - MD: Symptomatic infection
    - Overall: 2-9 weeks: 95.2% (94.4-95.9); ≥20 weeks: n/a
  - MD: Hospitalisation
    - 2-9 weeks: 97.5% (82.3-99.7); ≥20 weeks: n/a
- The UK JCVI is advising that people with severely weakened immune systems should have a third vaccine dose as part of their primary COVID-19 vaccination schedule due to antibody responses being low in this population after 2 doses
- The Chief Medical Officers of the UK have advised the government to offer a single dose of the Pfizer/BioNTech vaccine to all 12-15 year olds, a key reason being to minimise disruption to face-to-face learning (Page 9)

# COVID-19 Vaccine Specifications

	ASTRAZENECA	GAMALEYA	JOHNSON & JOHNSON	MODERNA	NOVAVAX	PFIZER/BIONTECH	SINOVAC	SINOPHARM	BHARAT BIOTECH
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
Available Through COVAX	✓	-	✓	-	✓	✓	-	-	-
Doses Required	 8-12 weeks apart* 4-12 weeks apart (Product Information)	 3 weeks apart	 1 dose	 4 weeks apart*	 3 weeks apart	 3-4 weeks apart*	 2-4 weeks apart*	 3-4 weeks apart*	 3 weeks apart
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
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	Under review by WHO SAGE	WHO EUL, EMA, FDA, TGA, MHRA	WHO EUL	WHO EUL	-

\*Based on WHO Strategic Advisory Group of Experts on Immunization (SAGE) recommendations

WHO EUL:  
EMA:  
FDA:  
TGA:  
MHRA:

WHO Emergency Use Listing  
European Medicines Agency  
Food and Drug Administration (US)  
Therapeutic Goods Administration (Australia)  
Medicines and Healthcare Products Regulatory Agency

# COVID-19 Vaccine Efficacy

VACCINE	VACCINE EFFICACY			
	SYMPTOMATIC INFECTION	MODERATE-SEVERE	SEVERE	HOSPITALISATION/DEATH
<b>AstraZeneca</b>	UK: 66.7% (57.4-74.0) <sup>20</sup> USA, Chile, Peru: 76% <sup>21</sup> (not peer-reviewed) Single dose in UK (22-90 days post-vaccination): 76.0% (59.3 to 85.9) <sup>20</sup> Efficacy with different interval between doses in UK: 12+ weeks: 82.4% (2.7-91.7) <6 weeks: 54.9% (32.7-69.7) <sup>20</sup>	-	Severe/critical and hospitalisation in USA, Chile, Peru: 100% <sup>21</sup> (not peer-reviewed) UK: 100% (15 cases in the placebo group) <sup>20</sup>	Hospitalisation in UK: 100% (9 cases in placebo group) <sup>20</sup>
<b>Gamaleya</b>	Russia: 91.6% (85.6-95.2) <sup>22</sup> Single dose (Sputnik Light) in Argentina: 78.6% <sup>23</sup>	Moderate-severe: 100% (20 cases in the placebo group) <sup>22</sup>	-	-
<b>Johnson &amp; Johnson</b>	-	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) <sup>24,25</sup> South Africa: 67.7% <sup>26</sup>	85.4% (54.2-96.9) <sup>25</sup>	100% (5 deaths in placebo group) <sup>25</sup> Death in South Africa: 96% <sup>26</sup>
<b>Moderna</b>	USA: 94.1% (89.3-96.8) <sup>27</sup> USA: >90% <sup>28</sup> 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) <sup>29</sup>	-	USA: 100% (30 cases in placebo group) <sup>27</sup> US: >95% <sup>28</sup>	USA: 100% (1 death in placebo group) <sup>27</sup>
<b>Novavax</b>	UK: 89.7% (80.2-94.6) <sup>30</sup> US and Mexico: 90.4% (82.9-94.6) <sup>31</sup>	US and Mexico: 100% (87.0-100) <sup>31</sup>	-	-
<b>Pfizer/BioNTech</b>	Argentina, Brazil, Germany, South Africa, Turkey and the USA: 94.6% (89.9-97.3) <sup>32</sup> Infection over 6 months: 91.3% (89.0-93.2) <sup>33</sup>	-	Argentina, Brazil, Germany, South Africa, Turkey and the USA: 88.9% (20.1-99.7) <sup>32</sup>	-
<b>Sinovac</b>	Brazil: 50.7% (35.9-62.0) Chile: 67% (65-69) Indonesia: 65% (20-85) <sup>34</sup> Turkey: 83.5% (65.4-92.1) <sup>35</sup>	Requiring medical assistance in Brazil: 83.7% (58.0-93.7) Moderate-severe: 100% (56.4-100.0) <sup>36</sup>	-	Hospitalisation: Brazil: 100% (56-100) Chile: 85% (83-97) Turkey: 100% (20-100) <sup>34</sup>
<b>Sinopharm</b>	UAE, Bahrain, Egypt and Jordan: 78.1% (64.9-86.3) <sup>34</sup>	-	-	Hospitalisation in UAE, Bahrain, Egypt and Jordan: 78.7% (26.0-93.9) <sup>34</sup>
<b>Bharat Biotech</b>	India: 77.8% (65.2-86.4) <sup>37</sup>	-	India: 93.4% (57.1-99.8) <sup>37</sup>	-

# Vaccine Effectiveness Summary at-a-glance

Detailed summary available in Appendix 1

VACCINE	AGAINST DEATH	AGAINST HOSPITALISATION/ SEVERE DISEASE	AGAINST SYMPTOMATIC INFECTION	AGAINST ANY INFECTION
AstraZeneca	94-100% <sup>38,39</sup>	94-100% <sup>38,39</sup> Single dose: 92-94% <sup>40,41</sup>	67-78% <sup>38,42</sup> Single dose: 50-68% <sup>40,42,43</sup>	Single dose: 44% <sup>40</sup>
Johnson & Johnson	-	-	-	77% <sup>44</sup>
Moderna	98% <sup>45</sup>	92-98% <sup>39,45,46</sup>	88-95% <sup>39,45,47</sup> Single dose: 72% <sup>47,48</sup>	86-87% <sup>45,46</sup>
Pfizer/BioNTech	91-100% <sup>38,39,49-53</sup>	85-98% <sup>38-40,46,49-54</sup> Single dose: 85% <sup>41</sup>	82-97% <sup>38-40,42,47,49,53-55</sup> Single dose: 49-61% <sup>42,47,48</sup>	63-95% <sup>40,46,49,50,53,56-58</sup>
Sinovac	86-95% <sup>38,52</sup>	86-91% <sup>38,52</sup>	59% <sup>38</sup>	60% <sup>52</sup>
Sinopharm	-	-	90% <sup>34</sup>	-

# Vaccine Efficacy/Effectiveness Against Delta VOC at-a-glance

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

VACCINE	LAB STUDIES	VACCINE EFFECTIVENESS UNLESS OTHERWISE STATED		
		ANY INFECTION	SYMPTOMATIC INFECTION	HOSPITALISATION AND DEATH
AstraZeneca	✓	60-67% <sup>59-61</sup> Single dose 30-67% <sup>59,61,62</sup>	67% <sup>39</sup>	92-94% <sup>39,63</sup> Single dose: 71-88% <sup>62,63</sup>
Gamaleya	✓	-	-	-
Johnson & Johnson	✓	-	-	71% <sup>26</sup>
Moderna	✓	76% <sup>46</sup> Single dose: 72% <sup>62</sup>	95% <sup>39</sup>	81-98% <sup>39,46</sup> Single dose: 96% <sup>62</sup>
Pfizer/BioNTech	✓	39-88% <sup>46,59,60,64</sup> Single dose: 36-57% <sup>59,61,62</sup>	90% <sup>39</sup>	75-100% <sup>39,46,63,64</sup> Single dose: 78-94% <sup>62,63</sup>
Bharat Biotech	✓	Efficacy: 65.2% <sup>37</sup>	-	-

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

Detailed summary available in Appendix 3

VACCINE	VACCINE EFFICACY/EFFECTIVENESS			
	DIABETES	OBESITY	AT RISK FOR SEVERE COVID-19	ELDERLY*
<b>AstraZeneca</b>	-	-	Effectiveness of single dose against: Symptomatic infection: 60% <sup>42</sup>  Efficacy against symptomatic infection: 76% <sup>21</sup>  Effectiveness against symptomatic infection: 80% <sup>42</sup>	Effectiveness of single dose against: Symptomatic infection: 53-61% <sup>40,42</sup> Hospitalisation: 80% <sup>65</sup> Death: 83% <sup>48</sup>  Efficacy against infection: 85% <sup>21</sup>  Effectiveness against: <b>Symptomatic infection: 59-76%</b> <sup>39,42,66</sup> Hospitalisation: 37-73% <sup>66,67</sup> Death: 94% <sup>48</sup>
<b>Gamaleya</b>	-	-	-	Symptomatic infection: 92% <sup>22</sup>
<b>Johnson &amp; Johnson</b>	Efficacy: 23% <sup>24</sup>	Efficacy: 66% <sup>24</sup>	Efficacy: 59% <sup>24</sup>	Efficacy 66% <sup>24</sup>
<b>Moderna</b>	-	-	Efficacy against symptomatic infection: 91% <sup>27</sup>	Efficacy against symptomatic infection: 86% <sup>27</sup> <b>Effectiveness against infection: 83%</b> <sup>45</sup>
<b>Pfizer/BioNTech</b>	Effectiveness against infection: 82% <sup>56</sup> 89% <sup>51</sup>	Effectiveness against infection: 90% <sup>51</sup>	Effectiveness of single dose against symptomatic infection: 56% <sup>42</sup>  Efficacy against symptomatic infection: 95% <sup>32</sup>  Effectiveness against: Infection: 71-90% <sup>50,51</sup> Symptomatic infection: 89% <sup>42</sup> Hospitalisation: 81% <sup>50</sup>	Effectiveness of single dose against: Infection: 76% <sup>40</sup> Symptomatic infection: 40-56% <sup>42,47</sup> Hospitalisation: 71-81% <sup>65,67</sup> Death 77% <sup>48</sup>  Efficacy against symptomatic infection: 95-100% <sup>32</sup>  Effectiveness against: Infection: 70-89% <sup>50,51,56,68</sup> <b>Symptomatic infection: 61-93%</b> <sup>39,42,47,66</sup> Hospitalisation: 43-93% <sup>66-68</sup> Death: 98% <sup>48</sup>
<b>Novavax</b>			Efficacy against infection: 91% <sup>31</sup>	
<b>Sinovac</b>	-	75% <sup>34</sup>	49% <sup>34</sup>	-
<b>Sinopharm</b>	-	81% <sup>34</sup>	-	Effectiveness against symptomatic infection 91% <sup>34</sup>
<b>Bharat Biotech</b>	-	-	Efficacy against infection: 66% <sup>37</sup>	Efficacy against symptomatic infection: 68% <sup>37</sup>

\*Estimates in those ≥60 years to ≥80 years



# Vaccine Efficacy/Effectiveness in Children

VACCINE	VACCINE EFFICACY/EFFECTIVENESS	COUNTRIES VACCINATING CHILDREN BY AGE GROUP
AstraZeneca	Trials suspended when evidence emerged of the higher risk of TTS in younger adults compared to older adults	-
Gamaleya	-	-
Johnson & Johnson	-	-
Moderna	Efficacy in USA, 12-15 years: 96% <sup>69</sup> (Studies in children aged 6 months-11 years underway)	Authorised in those aged ≥12 years by EMA and MHRA France, Italy: ≥12 years
Pfizer/BioNTech	Efficacy in USA, 12-15 years: 100% <sup>70</sup> (Studies in children aged 6 months-11 years underway)	Authorised in those aged ≥12 years by EMA, FDA, TGA, Medsafe UK, Sweden: 16-17 years and high-risk groups ≥12 years US, Canada, France, Spain, Italy, Netherlands, Germany, Singapore, Australia: ≥12 years The UK Chief Medical Officers have advised the government to offer a single dose to all 12-15 year olds <sup>71</sup>
Novavax	Study in 12-18 years has started recruitment and study in birth-11 years is planned	-
Sinovac	Phase I/II studies complete in 3-17 year olds in China <sup>72</sup> ; efficacy studies underway	Indonesia: ≥12 years China: ≥3 years
Sinopharm	Phase I/II studies in 3-17 year olds in China	China: ≥3 years
Bharat Biotech	-	-

# 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
<b>AstraZeneca</b>	EFFICACY (UK only): 22.2% (-9.9-45.0); Symptomatic and asymptomatic combined (UK, SOUTH AFRICA & BRAZIL): 54.1% (44.7-61.9) <sup>20</sup> ENGLAND: Hazard ratio for single dose in vaccinated vs. unvaccinated care facility residents: 0.32 (0.15-0.66) <sup>73</sup> ; Odds ratio for household contacts of vaccinated vs non-vaccinated health workers testing positive: 0.52 (0.43-0.62) <sup>74</sup> UK: Regular testing of randomly selected households: 79% (65-88) <sup>75</sup> ; Single dose against symptomatic and asymptomatic infection: 60% (49-68) <sup>76</sup> NETHERLANDS: Effectiveness against transmission (secondary attack rate among household contacts): 58% (-12-84) <sup>77</sup>	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) <sup>78</sup>
<b>Johnson &amp; Johnson</b>	EFFICACY (multiple countries): Asymptomatic infection: 59.7% (32.8-76.6) <sup>24</sup> UK: Single dose against symptomatic and asymptomatic infection: 60% (49-68) <sup>76</sup> Netherlands: Effectiveness against transmission (secondary attack rate among household contacts): 77% (6-94) <sup>77</sup>	USA (Kentucky): OR for reinfection in unvaccinated vs vaccinated with Johnson & Johnson, Moderna or Pfizer/BioNTech): 2.34 (1.58-3.47) <sup>79</sup>
<b>Moderna</b>	USA: <b>Asymptomatic infection: 72.7% (53.4-84.0)<sup>45</sup></b> USA: POOLED ANALYSIS OF PFIZER/BIONTECH AND MODERNA: 88.7% (68.4-97.1) <sup>80</sup> ; 90% (68%-97) <sup>81</sup> ; single dose: 80% (59-90) <sup>81</sup> ; Relative risk of infection in asymptomatic pre-surgical patients >10 days after first dose compared to unvaccinated residents: 0.21 (0.12-0.37) <sup>82</sup> ; Incident cases in unvaccinated nursing home residents decreased from 4.3% within 14 days of the first vaccination clinic to 0.3% after 42 days <sup>83</sup> MODELLING: Reduced potential for transmission: at least 61% <sup>84</sup> UK: Single dose against symptomatic and asymptomatic infection: 60% (49-68) <sup>76</sup> Netherlands: Effectiveness against transmission (secondary attack rate among household contacts): 88% (50-97) <sup>77</sup>	USA (Kentucky): OR for reinfection in unvaccinated vs vaccinated with Johnson & Johnson, Moderna or Pfizer/BioNTech): 2.34 (1.58-3.47) <sup>79</sup>
<b>Pfizer/BioNTech</b>	ENGLAND: 86% (76-97) 7 days after 2 doses; 72% (58-86) 21 days after 1 dose <sup>85</sup> ISRAEL: 92% (88-95) <sup>84</sup> ; 91.5% (90.7-92.2) <sup>49</sup> ; 65% (45-79%) <sup>86</sup> ; single dose: 75% (72-84) <sup>87</sup> ; Effectiveness against transmission: 88.5% (82.3-94.8) <sup>88</sup> ; Effectiveness against infection in the household: 78% (30-94) <sup>89</sup> USA: Asymptomatic screening: 90% (78-96) <sup>55</sup> USA: POOLED ANALYSIS OF PFIZER/BIONTECH AND MODERNA: 88.7% (68.4-97.1) <sup>80</sup> ; 90% (68%-97) <sup>81</sup> ; single dose: 80% (59-90) <sup>81</sup> ; Relative risk of infection in asymptomatic pre-surgical patients >10 days after first dose compared to unvaccinated residents: 0.21 (0.12-0.37) <sup>82</sup> ; Incident cases in unvaccinated nursing home residents decreased from 4.3% within 14 days of the first vaccination clinic to 0.3% after 42 days <sup>83</sup> UK: single dose: 4-fold decrease in risk amongst HCWs ≥12 days post-vaccination <sup>90</sup> ; Regular testing of randomly selected households: 80% (73-85) <sup>75</sup> ; Single dose against symptomatic and asymptomatic infection: 72% (63-79) <sup>76</sup> ; 60% (49-68) <sup>76</sup> 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) <sup>91</sup> Netherlands: Effectiveness against transmission (secondary attack rate among household contacts): 70% (61-77) <sup>77</sup> Finland: Effectiveness against transmission to unvaccinated household contacts of vaccinated cases: 42.9% (22.3-58.1) <sup>91</sup>	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 infectiousness <sup>92</sup> ; 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 unvaccinated <sup>83</sup> ; Substantially decreased viral load for infections occurring 12-37 days after the first dose of vaccine, indicating likely lower infectiousness <sup>92</sup> Detectable transmission in long-term care facilities in Spain reduced by 90% (76-93) <sup>94</sup> ENGLAND: Odds ratio for household contacts of vaccinated health workers vs non-vaccinated health workers testing positive: 0.54 (0.47-0.62) <sup>74</sup> 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) <sup>73</sup> USA (Kentucky): OR for reinfection in unvaccinated vs vaccinated with Johnson & Johnson, Moderna or Pfizer/BioNTech): 2.34 (1.58-3.47) <sup>79</sup>
<b>Bharat Biotech</b>	EFFICACY IN INDIA: Asymptomatic: 63.6% (29.0-82.4); Symptomatic and asymptomatic combined: 68.8% (46.7-82.5) <sup>37</sup>	-

\* Nationwide vaccination program including Pfizer/BioNTech, Moderna and Johnson & Johnson vaccines

# 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
<b>AstraZeneca followed by Pfizer/BioNTech</b>	<p>Spain: Similar side effects to those receiving 2 doses of the same vaccine; no safety concerns (not peer reviewed)<sup>95</sup></p> <p>UK: Greater systemic side effects (mild-moderate symptoms) following the booster dose than with 2 doses of the same vaccine; no safety concerns<sup>96</sup></p> <p>Germany: greater reactogenicity with first dose of AstraZeneca than with the Pfizer/BioNTech booster<sup>97</sup></p> <p>Increased reactogenicity (54.4%; 49.4-59.5) vs AstraZeneca-AstraZeneca (33.5%; 28.0-39.2)<sup>98</sup></p> <p>Total adverse event reporting in Korea: 0.28% (vs AZ-AZ: 0.22%; and PF-PF: 0.31%)</p>	<p>Spain: <math>\geq 8</math> week dose interval: Stronger immune response following Pfizer/BioNTech than after 2 doses of AstraZeneca vaccine (not peer reviewed)<sup>95</sup></p> <p>Spain: 8-12 week dose interval: robust antibody response<sup>99</sup></p> <p>UK: 4 week dose interval: stronger antibody and cellular response than after 2 doses of AstraZeneca vaccine<sup>100</sup></p> <p>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)<sup>101</sup></p> <p>Germany: 4-fold greater immune response than 2 doses of AstraZeneca<sup>102</sup></p> <p>South Korea: 6-fold greater neutralising antibody response than 2 doses of AstraZeneca</p> <p>Germany: Higher neutralising antibody response against wild-type, Alpha, Beta, Gamma and Delta variants than AZ-AZ<sup>103</sup></p>	Canada, Denmark, Finland, France, Germany, Sweden, Norway, Spain and South Korea <sup>104</sup>
<b>Pfizer/BioNTech followed by AstraZeneca</b>	<p>UK: Greater systemic side effects (mild-moderate symptoms) following the booster dose than with 2 doses of the same vaccine; no safety concerns<sup>96</sup></p> <p>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)<sup>98</sup></p>	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) <sup>100</sup>	-
<b>Pfizer/BioNTech or Johnson &amp; Johnson followed by Moderna</b>	-	USA: Trial underway with 12-20 week dose interval <sup>105</sup>	-
<b>AstraZeneca, Moderna and Pfizer/BioNTech</b>	-	<p>Canada: Trial underway mixing and matching all three vaccines with study arms assessing 4 week and 16 week dose intervals<sup>106</sup></p> <p>Denmark: Vaccine effectiveness against infection: AZ-PF or AZ-MO: 88% (83-92)<sup>107</sup></p>	AstraZeneca followed by either Moderna or Pfizer/BioNTech: Denmark, Finland, France, Germany, Sweden, Norway and Spain <sup>104</sup>
<b>Sinovac followed by AstraZeneca</b>	-	-	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
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/ redness<sup>108</sup></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%)<sup>109</sup></p>	<p>Very common: headache, muscle pain, joint pain, injection site pain/ swelling, fatigue, fever, chills;</p> <p>Common: nausea, injection site redness<sup>108</sup></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 paralysis<sup>6</sup></p>	<p>Injection site pain/ redness/ swelling, headache, fatigue, muscle pain, nausea, fever<sup>110</sup></p>	<p>Injection site pain (16%)/ itch (1%)/ swelling (2%)/ redness (1%), fever (4%), fatigue (3%), nausea (1%), headache (1%), diarrhoea (1%), muscle pain (&lt;1%), itch (non-injection site) (1%)<sup>111</sup></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%)<sup>112</sup></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)<sup>113</sup></p> <p>Australia: Guillain-Barre syndrome: 52 cases (10.4 per million doses)<sup>114</sup></p>	<p>USA: Myocarditis/pericarditis: 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+;<sup>115</sup></p> <p>&gt;1 in 20,000 males under 25 years of age<sup>18</sup></p> <p>Immune thrombocytopenia (ITP)**<sup>116</sup></p>	<p>USA: Myocarditis/pericarditis: 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+;<sup>115</sup></p> <p>&gt;1 in 20,000 males under 25 years of age<sup>18</sup></p> <p>Israel: 1 to 5 cases of myocarditis per 100,000 persons<sup>117,118</sup></p> <p>ITP**<sup>116</sup></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 &gt;50 years)<sup>119</sup></p>	-	-

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

VACCINE	VACCINE SAFETY
<b>AstraZeneca</b>	<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)<sup>20</sup>            US Phase III study: No serious safety concerns involving 32,449 participants<sup>21</sup> (not peer-reviewed)</p> <p>EMA investigation: possible link between the AstraZeneca vaccine and Thrombosis with Thrombocytopaenia 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 effects<sup>12</sup>            UK: Risk factors for death in patients with TTS following the AstraZeneca vaccine: baseline platelet count; and intracranial haemorrhage<sup>120</sup>            TTS reported to occur in ~1 in 50,000 vaccinated adults in Australia<sup>15</sup></p> <p>Several countries introduced age recommendations for the vaccine: &gt;60 years in Germany and Australia; &gt;55 years in France and Canada; &gt;40 years in the UK<sup>121-123</sup>            EMA has started a review of reports of capillary leak syndrome following 5 cases of this very rare disorder post vaccination<sup>124</sup>            WHO GACVS reports Guillain Barre Syndrome (GBS) rates following adenovirus vector vaccines: EU/EEA: 4.4; AUS: 9.7; KOR: 0.4; PHL: &lt;1<sup>125</sup></p>
<b>Gamaleya</b>	<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)<sup>22</sup></p>
<b>Johnson &amp; Johnson</b>	<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)<sup>24</sup>            EMA investigation of 8 reports of TTS. Most cases occurred in women &lt;60 years of age but specific risk factors have not been confirmed<sup>13</sup>            The CDC and FDA have now recommenced the vaccination program in the USA following a thorough safety review<sup>126</sup>            15 cases of TTS have been reported in 7.98 million people vaccinated in USA<sup>11</sup>            Guillain-Barre Syndrome: 100 preliminary reports of GBS following 12.5 million doses of vaccine administered in USA (mostly males &gt;50 years)<sup>119</sup>            WHO GACVS reports Guillain Barre Syndrome (GBS) rates following adenovirus vector vaccines: USA: 7.8; KOR: 0.9; EU/EEA: AZ: 2.1<sup>125</sup></p>
<b>Moderna</b>	<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)<sup>27</sup>            Anaphylaxis reported in the US at a rate of 2.5 per million doses<sup>127</sup>            No obvious safety signals among pregnant women who received mRNA COVID-19 vaccines in USA<sup>128</sup>            USA: Myopericarditis highest in males 18-34 years: 37.7 cases per million doses<sup>19</sup>            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+<sup>115</sup></p>
<b>Novavax</b>	<p>SAEs at low levels and similar between vaccine and placebo groups<sup>130</sup></p>
<b>Pfizer/BioNTech</b>	<p>SAEs and deaths were low and comparable between vaccine and placebo groups (total 37,586 participants)<sup>32</sup>            Anaphylaxis reported in the US at a rate of 4.7 per million doses<sup>127</sup>            No obvious safety signals among pregnant women who received mRNA COVID-19 vaccines in USA<sup>128</sup>            USA: Myopericarditis highest in males 16-17 years: 71.5 cases per million doses<sup>19</sup>            USA: Myopericarditis 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+<sup>115</sup>            Brazil: SAEs: 5.4/100,000 doses</p>
<b>Sinovac</b>	<p>Brazil: SAEs: 79.7/100,000 doses</p>

# Risk of Rare Unusual Blood Clotting with Low Blood 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
<b>All Pacific Island Countries</b>	<b>10,976,992</b>	<b>6,586,195</b>	<b>65.9-131.7</b>	<b>20.8</b>

\* Based on estimate of 60% of population aged ≥18 years<sup>13</sup>

\*\* 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<sup>14,15</sup>

\*\*\* 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)<sup>17</sup>

# Who Can be Vaccinated Based on WHO SAGE Recommendations?

So far, WHO SAGE have made recommendations for use of AstraZeneca, Moderna, Pfizer/BioNTech, Johnson & Johnson and Sinopharm vaccines:  
<https://www.who.int/groups/strategic-advisory-group-of-experts-on-immunization/covid-19-materials>

	ASTRAZENECA	MODERNA	PFIZER/BIONTECH	JOHNSON & JOHNSON	SINOPHARM	SINOVAC
<b>Minimum Age</b>	18 years	18 years	12 years	18 years	18 years	18 years
<b>Maximum Age (SAGE WHO)</b>	None	None	None	None	None	None
<b>Pregnancy</b>	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
<b>Breastfeeding</b>	Yes	Yes	Yes	Yes	Yes	Yes
<b>Timing after previous SARS-CoV-2 infection</b>	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
<b>Immunocompromised Including HIV</b>	✓	✓	✓	✓	✓	✓
<b>People Previously Infected by SARS-CoV-2 (PCR Confirmed)</b>	Yes, although that person may choose to delay vaccination by 6 months	Yes, although that person may choose to delay vaccination by 6 months	Yes, although that person may choose to delay vaccination by 6 months	Yes, although that person may choose to delay vaccination by 6 months	Yes, although that person may choose to delay vaccination by 6 months	Yes, although that person may choose to delay vaccination by 6 months
<b>History of Anaphylaxis (Severe Allergy)</b>	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 8 September 2021.

VACCINE TYPE	NUMBER OF VACCINE CANDIDATES AT EACH PHASE OF DEVELOPMENT				
	PRE-CLINICAL	PHASE I/II	PHASE III	PHASE IV	IN USE*
RNA	27	10	3	2	2 (Pfizer/BioNTech, Moderna)
DNA	17	7	3	0	1 (Zydus Cadila Healthcare Limited)
Vector (non-replicating)	27	7	2	3	4 (CanSino, Gamaleya, Johnson & Johnson, AstraZeneca)
Vector (replicating)	18	6	1	0	0
Inactivated	7	7	8	2	8 (Sinopharm/BIBP; Sinopharm/WIBP; Sinovac; Bharat; Chumakov; Research Institute for Biological Safety Problems; Shenzhen Kangtai Biological Products; Shifa Pharmed)
Live-attenuated	2	1	0	0	0
Protein subunit	73	23	12	1	6 (Vector institute; Anhui Zhifei Longcom Biopharmaceutical Chinese Academy of sciences; Center for Genetic Engineering and Biotechnology; Instituto Finlay de Vacunas, Cuba [peptides 1 and 2]; Medigen Vaccine Biologics, Taiwan)
Virus-like particle	20	4	1	0	0
Other/unknown	32	5	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.



# 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
The Gamaleya National Center	Sputnik V	Adenoviral vector	On hold, awaiting completion of rolling submission	Will be determined when all data are submitted
CanSinoBIO	Ad5-nCoV	Adenoviral vector	Rolling data assessment starting August 2021	-
Novavax	NVX-CoV2373	Protein subunit	Pre-submission meeting held; rolling data starting in August 2021	-
CureVac	Zorecimeran	mRNA	Expression of interest accepted; Pre-submission meeting planned for Q4 2021	-
Bharat Biotech	Covaxin; BBV152	Inactivated	Rolling data assessment started 6 July 2021	-
Clover Biopharmaceuticals	SCB-2019 (CpG 1018/Alum)	Protein subunit	Pre-submission meeting being planned	-

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

- AlQahtani M, Bhattacharyya S, Alawadi A, et al. Morbidity and mortality from COVID-19 postvaccination breakthrough infections in association with vaccines and the emergence of variants in Bahrain. *Res Sq Prepr*. doi:10.21203/rs.3.rs-828021/v1
- Wallace M, Woodworth KR, Gargano JW, et al. The Advisory Committee on Immunization Practices' Interim Recommendation for Use of Pfizer-BioNTech COVID-19 Vaccine in Adolescents Aged 12–15 Years — United States, May 2021. *MMWR Morb Mortal Wkly Rep*. 2021;70(20):749–752. doi:10.15585/mmwr.mm7020e1
- UK Government Medicines and Healthcare Products Regulatory Agency (MHRA). The MHRA concludes positive safety profile for Pfizer/BioNTech vaccine in 12- to 15-year-olds. 4 June 2021. Available at: <https://www.gov.uk/government/news/the-mhra-concludes-positive-safety-profile-for-pfizerbiontech-vaccine-in-12-to-15-year-olds>.
- European Medicines Agency (EMA). First COVID-19 vaccine approved for children aged 12 to 15 in EU 28 May 2021. Available at: <https://www.ema.europa.eu/en/news/first-covid-19-vaccine-approved-children-aged-12-15-eu>.
- Government of Canada. Health Canada authorizes use of the Pfizer-BioNTech COVID-19 vaccine in children 12 to 15 years of age - 5 May 2021. Available at: <https://www.canada.ca/en/health-canada/news/2021/05/health-canada-authorizes-use-of-the-pfizer-biontech-covid-19-vaccine-in-children-12-to-15-years-of-age.html>.
- 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>.
- Moderna COVID-19 vaccine approved by MHRA in 12-17 year olds. Press release 17 August 2021. Available at: <https://www.gov.uk/government/news/moderna-covid-19-vaccine-approved-by-mhra-in-12-17-year-olds>.
- European Medicines Agency (EMA). COVID-19 vaccine Spikevax approved for children aged 12 to 17 in EU. 23 July 2021. Available at: <https://www.ema.europa.eu/en/news/covid-19-vaccine-spikevax-approved-children-aged-12-17-eu>.
- Australian Government Therapeutic Goods Administration. Australian Product Information - Spikevax (Elasmoran) COVID-19 Vaccine. Available at: <https://www.tga.gov.au/sites/default/files/auspar-elasmoran-210903-pi.pdf>.
- 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>.
- 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/>.
- 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
- Novavax press release. Novavax COVID-19 Vaccine Demonstrates 90% Overall Efficacy and 100% Protection Against Moderate and Severe Disease in PREVENT-19 Phase 3 Trial. 14 June 2021. Available at: <https://ir.novavax.com/news-releases/news-release-details/novavax-covid-19-vaccine-demonstrates-90-overall-efficacy-and>.
- 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. Six Month Safety and Efficacy of the BNT162b2 mRNA COVID-19 Vaccine. *medRxiv*. January 2021:2021.07.28.21261159. doi:10.1101/2021.07.28.21261159
- 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.
- Ella R, Reddy S, Blackwelder W, et al. Efficacy, safety, and lot to lot immunogenicity of an inactivated SARS-CoV-2 vaccine (BBV152): a, double-blind, randomised, controlled phase 3 trial. *medRxiv*. January 2021:2021.06.30.21259439. doi:10.1101/2021.06.30.21259439
- 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. *Khub Prepr Available*. <https://khub.net/documents/13593956/1338928724/Vaccine+effectiveness+and+duration+of+protection+of+covid+vaccines+against+mild+and+severe+COVID-19+in+the+UK.pdf/10dcd99c-0441-0403-dfd8-11ba2c6f5801>.
- 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
- 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

42. 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/RCGP+VE+riskgroups+paper.pdf?6b54cd9-419d-9b63-e2bf-5dc796f5a91f>. Published 2021.
43. Kissling E, Hooiveld M, Sandonis Martin 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
44. Corchado-Garcia J, Puyraimond-Zemmour D, Hughes T, et al. Real-world effectiveness of Ad26.COVID.S adenoviral vector vaccine for COVID-19. *medRxiv*. January 2021:2021.04.27.21256193. doi:10.1101/2021.04.27.21256193
45. 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
46. 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
47. 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
48. 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>.
49. 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
50. Emborg H-D, Valentiner-Branch P, Schelde 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
51. 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
52. 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>.
53. 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
54. 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
55. Tang L, Hijano DR, Gaur AH, et al. Asymptomatic and Symptomatic SARS-CoV-2 Infections After BNT162b2 Vaccination in a Routinely Screened Workforce. *JAMA*. May 2021. doi:10.1001/jama.2021.6564
56. 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
57. 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
58. Britton A, Jacobs Slika 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
59. 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
60. 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
61. Pouwels K, Pritchard E, Matthews PC, et al. Impact of Delta on viral burden and vaccine effectiveness against new SARS-CoV-2 infections in the UK. *Univ Oxford Nuff Dep Med Prepr*.
62. 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
63. 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>.
64. 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>.
65. 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
66. 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
67. 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%20BNT162b2%20mRNA%20and%20ChAdOx1%20adenovirus%20vector%20COVID-19%20vaccines%20on%20risk%20of%20hospitalisation%20among%20older%20adults%20in%20England.pdf?9e18c525-dda6-5ee4>.
68. Mason T, Whitston 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
69. 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>.
70. Mahase E. Covid-19: Pfizer reports 100% vaccine efficacy in children aged 12 to 15. *BMJ*. April 2021:n881. doi:10.1136/bmj.n881
71. UK Government Department of Health & Social Care correspondence. Universal vaccination of children and young people aged 12 to 15 years against COVID-19. Published 13 September 2021. <https://www.gov.uk/government/publications/universal-vaccination-of-children-and-young-people-aged-12-to-15-years-against-covid-19/universal-vaccination-of-children-and-young-people-aged-12-to-15-years-against-covid-19>.
72. 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
73. 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
74. 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
75. 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
76. 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
77. 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
78. 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
79. 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
80. 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
81. 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 .
82. 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
83. 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
84. Lipsitch M, Kahn R. Interpreting vaccine efficacy trial results for infection and transmission. *Vaccine*. June 2021. doi:10.1016/j.vaccine.2021.06.011
85. 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
86. Regev-Yochay G, Amit S, Bergwerk M, et al. Decreased Infectivity Following BNT162b2 Vaccination. *SSRN Electron J*. 2021. doi:10.2139/ssrn.3815668
87. 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
88. 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
89. 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
90. Michael Weekes, Nick K Jones, Lucy Rivett, et al. Single-dose BNT162b2 vaccine protects against asymptomatic SARS-CoV-2 infection. *Authora*. February 24, 2021. doi:10.22541/au.161420511
91. 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
92. 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
93. 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
94. 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
95. 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>.
96. Shaw RH, Stuart A, Greenland M, Liu X, Van-Tam JSN, Snape MD. Heterologous prime-boost COVID-19 vaccination: initial reactivity data. *Lancet*. 2021;397(10289):2043-2046. doi:10.1016/S0140-6736(21)01115-6
97. 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
98. 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
99. 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
100. 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 Vectedored and mRNA COVID-19 Vaccine. *SSRN Electron J*. 2021. doi:10.2139/ssrn.3874014
101. 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
102. 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
103. 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
104. 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>.
105. United States National Institutes of Health (NIH) press release. NIH clinical trial evaluating mixed COVID-19 vaccine schedules begins. Available at: <https://clinicaltrials.gov/ct2/show/NCT04894435?term=mixed+schedule%2C+covid19%2C+vaccine&draw=2&rank=1>.
106. 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>.
107. 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
108. 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>.
109. 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>.
110. 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>.
111. 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
112. 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
113. 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>.
114. 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>.
115. 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>.
116. Welsh KJ, Baumball 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
117. 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
118. 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
119. 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>.
120. 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
121. Government of Canada National Advisory Committee on Immunization (NACI) statement. NACI rapid response: Recommended use of AstraZeneca COVID-19 vaccine in younger adults.
122. 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>.
123. 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>.
124. 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>.
125. 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>.
126. US Food and Drug Administration (FDA) press release. FDA and CDC Lift Recommended Pause on Johnson & Johnson (Janssen) COVID-19 Vaccine Use Following Thorough Safety Review 23 April 2021. Available at: <https://www.fda.gov/news-events/press-announcements/fda-and-cdc-lift-recommended-pause-johnson-johnson-janssen-covid-19-vaccine-use-following-thorough>.
127. 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
128. 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
129. Høeg TB, Krug A, Stevenson J, Mandrola J. SARS-CoV-2 mRNA Vaccination-Associated Myocarditis in Children Ages 12-17: A Stratified National Database Analysis. *medRxiv*. January 2021:2021.08.30.21262866. doi:10.1101/2021.08.30.21262866
130. 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-eficacy-uk-phase-3>.



131. United Nations Children's Fund (UNICEF), Pacific Office. Situation Analysis of Children in the Pacific Island Countries. December 2017.
132. 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
133. 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
134. University College London press release. Covid-19 vaccine: care home residents gain 62% protection from one dose. 29 March 2021.
135. 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
136. 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
137. 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
138. 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
139. Fowlkes A, Gaglani M, Groover K, Thiese MS, Tyner H, Ellingson 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
140. 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
141. 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>.
142. World Health Organisation (WHO). Tracking SARS-CoV-2 variants. Available at: <https://www.who.int/en/activities/tracking-SARS-CoV-2-variants/>.
143. 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
144. 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.
145. 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
146. 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
147. 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
148. 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>.
149. 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
150. 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
151. 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
152. 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
153. 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

# 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](mailto:kase.anderson@unimelb.edu.au)

### Murdoch Children's Research Institute

50 Flemington Rd, Parkville  
Victoria 3052 Australia  
ABN 21 006 566 972

Weekly COVID-19 Vaccine Updates  
Number 26, 16 September 2021



# Appendix 1: COVID-19 Vaccine Effectiveness

VACCINE	SEVERE / HOSPITALISATION / DEATH	INFECTION AND OTHER OUTCOMES
<b>AstraZeneca</b>	<p>Single dose in Scotland: 94% (73-99)<sup>41</sup>                      Risk of death in vaccine failures compared to unvaccinated cases in England reduced by: 55% (41-66)<sup>132</sup> (not peer reviewed)                      Single dose against hospitalisation in Spain: 92% (46-99)<sup>40</sup>                      Pooled analysis of AstraZeneca, Pfizer/BioNTech and Moderna vaccines in Italy: Hospitalisation: 89% (85-91); Death: 93% (89-96)<sup>133</sup>                      Chile: Hospitalisation: 100%; ICU admission: 100%; Death: 100%<sup>38</sup></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%<sup>134</sup>                      Pooled analysis of Pfizer/BioNTech and AstraZeneca vaccines: reduced odds of infection post-second dose: 70% (62-77)<sup>135</sup>                      Single dose in Spain: Any infection: 44% (31-54); Symptomatic infection: 50% (37-61)<sup>40</sup>                      Pooled analysis of AstraZeneca, Pfizer/BioNTech and Moderna vaccines in Italy: Infection: 78% (76-79)<sup>133</sup>                      Single dose against symptomatic infection in multiple European countries: 68% (39-83)<sup>43</sup>                      Symptomatic infection in 16-64 years in UK: single dose: 50.2% (40.8-58.2); 2 doses: 78.0% (69.7-84.0)<sup>42</sup>                      Symptomatic infection in Chile: 68.7% (39.8-83.7)<sup>38</sup></p>
<b>Johnson &amp; Johnson</b>	-	<p>USA: Any infection: 76.7% (30.3-95.3)<sup>44</sup></p>
<b>Moderna</b>	<p>Pooled analysis of AstraZeneca, Pfizer/BioNTech and Moderna in Italy: Hospitalisation: 89% (85-91); Death: 93% (89-96)<sup>133</sup>                      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%)<sup>136</sup>                      USA: Hospitalisation: 95.8% (90.7-98.1); Death: 97.9% (66.9-99.9)<sup>45</sup></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)<sup>137</sup>                      Pooled analysis of Moderna and Pfizer/BioNTech vaccines against infection in USA:                      Fully vaccinated: 90% (68-97)                      Two weeks after first dose: 80% (59-90)<sup>138</sup>                      Pooled analysis of AstraZeneca, Pfizer/BioNTech and Moderna vaccines in Italy: Infection: 78% (76-79)<sup>133</sup>                      Single dose against symptomatic disease in the UK: Age 15-39 years: 72% (46-86)<sup>48</sup>                      Minnesota, USA: January to July 2021 (Delta variant &lt;0.7% in May): Infection: 86% (81-91); Hospitalisation: 92% (81-97)                      July (Delta variant &gt;70%): Infection: 76% (58-87); Hospitalisation: 81% (33-96)<sup>46</sup>                      Infection in USA (98% vaccines used Pfizer/BioNTech and Moderna): Pre-Delta variant predominant: 91% (81-96); Delta variant predominant: 66% (26-84)<sup>139</sup>                      Infection in Canada: 1 dose: 72% (63-80); 2 doses: 94% (86-97)<sup>47</sup>                      USA: Any infection: 87.4% (84.8-89.6); Symptomatic infection: 88.3% (86.1-90.2)<sup>45</sup></p>
<b>Pfizer/BioNTech</b>	<p>Severe in Israel: 92% (75-100)<sup>54</sup>                      Severe/critical in Israel: 97.5% (97.1-97.8)<sup>49</sup>                      Single dose against hospitalisation in Scotland: 85% (76-91)<sup>41</sup>                      Risk of death in vaccine failures compared to unvaccinated cases in England reduced by: Single dose: 44% (32-53)                      Fully vaccinated: 69% (31-86)<sup>132</sup> (not peer reviewed)                      Israel:                      Hospitalisation: 97.2% (96.8-97.5); Death: 96.7% (96.0-97.3)<sup>49</sup>                      Hospitalisation in Spain: 94% (60-99)<sup>40</sup>                      Priority groups in Denmark: Hospitalisation: 93% (89-96); Death: 94% (90-96)<sup>50</sup>                      Pooled analysis of AstraZeneca, Pfizer/BioNTech and Moderna vaccines in Italy: Hospitalisation: 89% (85-91); Death: 93% (89-96)<sup>133</sup>                      USA care facility: Hospitalisation: 94.4 (73.9-98.8); Death 94.4 (44.6-99.4)<sup>53</sup>                      Uruguay: Hospitalisation: 97.8% (96.0-98.8); Death: 96.2 (95.4-96.8)<sup>52</sup>                      Israel: Hospitalisation: 93.4% (91.9-94.7); Death: 91.1% (86.5-94.1)<sup>51</sup>                      Chile: Hospitalisation: 97.2% (96.6-97.6); ICU admission: 98.3% (97.6-98.8); Death: 100%<sup>38</sup>                      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%)<sup>136</sup>                      Pooled analysis of Moderna and Pfizer/BioNTech against hospitalisation or death: 98% (83-100)<sup>47</sup></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)<sup>137</sup>                      Pooled analysis of Moderna and Pfizer/BioNTech vaccines in USA: Fully vaccinated: 90% (68-97);                      Two weeks after first dose: 80% (59-90)<sup>138</sup>                      Symptomatic infection in Israel: 94% (87-98)<sup>54</sup>                      Any infection in Israel: 90% (79-95)<sup>56</sup>                      Israel: Any infection: 95.3% (94.9-95.7); Symptomatic infection: 97.0% (96.7-97.2)<sup>49</sup>                      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%<sup>134</sup>                      Documented infection in Israel: incidence decreased from 9.4 infections per 1,000 HCWs in the week following first dose to &lt;1.0 infection per 1,000 HCWs per week from 1 week after the second dose<sup>140</sup>                      Pooled analysis of Pfizer/BioNTech and AstraZeneca vaccines: reduced odds of infection post-second dose: 70% (62-77)<sup>135</sup>                      Spain: Any infection: 65% (56-73); Symptomatic infection: 82% (73-88)<sup>40</sup>                      Infection in priority groups in Denmark: 82% (79-84)<sup>50</sup>                      USA: Symptomatic infection: 84% (75-90)<sup>55</sup>                      Denmark: Infection in care facility residents: &gt;14 days after first dose: 17% (4-28); &gt;7 days after second dose: 64% (14-84)<sup>57</sup>                      USA: Single dose against infection in 2 care facilities: 63% (33-79)<sup>38</sup>                      A care facility in USA: Infection 66% (41-81); Symptomatic illness 87% (66-95)<sup>53</sup>                      Pooled analysis of AstraZeneca, Pfizer/BioNTech and Moderna vaccines in Italy: Infection: 78% (76-79)<sup>133</sup>                      Uruguay: Infection: 78.1% (77.0-79.1)<sup>52</sup>                      Israel: Infection: 93.0% (92.6-93.4)<sup>51</sup>                      Single dose against symptomatic disease in the UK: Age 15-39 years: 61% (56-66)<sup>48</sup>                      Symptomatic infection in multiple European countries: single dose: 61% (39-75); 2 doses: 87% (74-93)<sup>43</sup>                      Symptomatic infection in 16-64 years in UK: single dose: 48.6% (27.9-63.3); 2 doses: 93.3% (85.8-96.8)<sup>42</sup>                      Symptomatic infection in Chile: 87.7% (87.3-88.1)<sup>38</sup>                      Minnesota, USA: January to July 2021 (Delta variant &lt;0.7% in May): Infection: 76% (69-81); Hospitalisation: 85% (73-93)                      July (Delta variant &gt;70%): Infection: 42% (13-62); Hospitalisation: 75% (24-94)<sup>46</sup>                      Infection in USA (98% vaccines used Pfizer/BioNTech and Moderna): Pre-Delta variant predominant: 91% (81-96); Delta variant predominant: 66% (26-84)<sup>139</sup>                      Infection in Canada: 1 dose: 59% (55-62); 2 doses: 91% (88-93)<sup>47</sup></p>
<b>Sinovac</b>	<p>Uruguay: Hospitalisation: 90.9% (88.6-92.7); Death: 94.7% (93.4-95.7)<sup>52</sup>                      Chile: Hospitalisation: 86.0% (85.6-86.5); ICU admission: 89.7% (89.1-90.2); Death: 86.4% (85.6-87.2)<sup>38</sup></p>	<p>Uruguay: Infection: 59.9% (59.1-60.7)<sup>52</sup>                      Symptomatic infection in Chile: 58.5% (58.0-59.0)<sup>38</sup></p>
<b>Sinopharm</b>	-	<p>Symptomatic infection in Bahrain: 90% (88-91)<sup>34</sup></p>

# 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.<sup>141</sup> The WHO recommends labelling SARS-CoV-2 variants with letters of the Greek alphabet, as in the table below.<sup>142</sup>

VACCINE	VACCINE EFFICACY/EFFECTIVENESS								
	B.1.1.7 (ALPHA) VARIANT		B.1.351 (BETA) VARIANT		P.1 (GAMMA) VARIANT		B.1.617.2 (DELTA) VARIANT		
	ANY INFECTION	SEVERE	ANY INFECTION	SEVERE	ANY INFECTION	SEVERE	ANY INFECTION	SEVERE	
AstraZeneca	UK: 70.4% (43.6-84.5) (vs. 81.5% (67.9-89.4) against wild variant) <sup>143</sup> Effectiveness: ≥21 days after one dose: 48.7% (45.2-51.9); ≥14 days after two doses: 74.5% (68.4-79.4) <sup>59</sup> Scotland: 73% (66-78) <sup>60</sup> Effectiveness in Canada: Single dose: 64% (60-68) <sup>62</sup> Effectiveness in UK: Single dose: 63% (55-69); 2 doses: 79% (56-90) <sup>61</sup>	Effectiveness in Canada: Single dose: 85% (81-88) <sup>62</sup>	10.4% (-76.8 to 54.8) <sup>144</sup>	Study underway <sup>24</sup>	-	-	Effectiveness: ≥21 days after one dose: 30.0% (24.3-35.3); ≥14 days after second dose: 67.0% (61.3-71.8) <sup>59</sup> Scotland: 60% (53-66) <sup>60</sup> Effectiveness in Canada: Single dose: 67% (44-80) <sup>62</sup> Effectiveness in UK: Single dose: 46% (35-55); 2 doses: 67% (62-71) <sup>61</sup> Symptomatic infection in England: 66.7% (66.3-67.0) <sup>58</sup>	Hospitalisation in England: 1 dose: 71% (51-83); 2 doses: 92% (75-97) <sup>63</sup> ; 93.9% (91.3-95.7) <sup>58</sup> Death in England: 94.1% (91.9-95.8) <sup>58</sup> Effectiveness in Canada: Single dose: 88% (60-96) <sup>62</sup>	
Johnson & Johnson	-	-	-	Moderate to severe/critical: 64.0% (41.2-78.7) Severe/critical: 81.7% (46.2-95.4) <sup>24</sup> Efficacy in South Africa: Hospitalisation: 67% <sup>26</sup>	-	-	Moderate to severe/critical: 68.1% (48.8-80.7); Severe/critical: 87.6% (7.8-99.7) <sup>24</sup>	Efficacy in South Africa: Hospitalisation: 71% <sup>26</sup>	
Moderna	Effectiveness in Canada: Single dose: 83% (80-86); 2 doses: 92% (86-96) <sup>62</sup>	Effectiveness in Canada: Single dose: 79% (74-83); 2 doses: 94% (89-97) <sup>62</sup>	-	-	-	-	Effectiveness in Canada: Single dose: 72% (57-82) <sup>62</sup> Minnesota, USA: 76% (58-87) <sup>45</sup> Symptomatic infection in England: 95.2% (94.4-95.9) <sup>39</sup>	Effectiveness in Canada: Single dose: 96% (72-99) <sup>62</sup> Minnesota: 81% (33-96) <sup>45</sup> Hospitalisation in England: 97.5% (82.3-99.7) <sup>39</sup>	
Novavax	86.3% (71.3-93.5) (vs. 96.4% (73.8-99.5) against wild variant in UK) <sup>60</sup>	-	South Africa: 51.0% (-0.6 to 76.2) <sup>145</sup>	-	-	-	-	-	
Pfizer/BioNTech	Case-control study in Israel: After one dose, vaccinees were disproportionately infected with B.1.1.7 (OR: 26:10) <sup>146</sup> Effectiveness in Qatar: 89.5% (85.9-92.3) <sup>147</sup> Effectiveness: ≥21 days after one dose: 47.5% (41.6 to 52.8) ≥14 days after second dose: 93.7% (91.6-95.3) <sup>59</sup> Scotland: 92% (90-93) <sup>60</sup> Effectiveness in Canada: Single dose: 66% (64-68); 2 doses: 89% (86-91) <sup>62</sup> Effectiveness in UK: Single dose: 59% (52-65); 2 doses: 78% (68-84) <sup>61</sup>	Effectiveness in Qatar: 100% (81.7-100) <sup>147</sup> Effectiveness in Canada: Single dose: 80% (78-82); 2 doses: 95% (92-97) <sup>62</sup>	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) <sup>146</sup> Effectiveness in Qatar: 75.0% (70.5-78.9) <sup>147</sup> South Africa: 100% (53.5-100) <sup>33</sup>	Effectiveness in Qatar: 100% (73.7-100) <sup>147</sup>	-	-	Effectiveness: ≥21 days after one dose: 35.6% (22.7-46.4); ≥14 days after second dose: 88.0% (85.3-90.1) <sup>59</sup> Scotland: 79% (75-82) <sup>60</sup> Effectiveness in Canada: Single dose: 56% (45-64); 2 doses: 87% (64-95) <sup>62</sup> Effectiveness in Israel: Infection: 64%; Symptomatic illness: 64% <sup>148</sup> Israel 6m after roll out: 39.0% (9.0-59.0) <sup>64</sup> Minnesota, USA: 42% (13-62) Effectiveness in UK: Single dose: 57% (50-63); 2 doses: 80% (77-83) <sup>61</sup> Symptomatic infection in England: 89.8% (89.6-90.0) <sup>39</sup>	Hospitalisation in England: 1 dose: 94% (46-99); 2 doses: 96% (86-99) <sup>63</sup> ; 99.7% (97.6-100.0) <sup>39</sup> Death in England: 98.2% (95.9-99.2) <sup>39</sup> Canada: Single dose: 78% (65-86) <sup>62</sup> Effectiveness against hospitalisation in Israel: 93% <sup>148</sup> Severe disease in Israel: 91.4% (82.5-95.7) <sup>64</sup> Minnesota: 75% (24-94) <sup>45</sup>	
Sinovac	Chile: 67% (65-69) <sup>34</sup>	-	-	-	-	Brazil: vaccine effectiveness 1 or 2 doses: 37.9% (-46.4-73.6) <sup>149</sup> Chile: 67% (65-69) <sup>34</sup> Brazil: ≥70 years: 41.6% (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) <sup>150</sup>	-	China (combined Sinovac and Sinopharm): Single dose: 13.8% (-60.2-54.8); 2 doses: 59.0% (16.0-81.6) <sup>151</sup>	China (combined Sinovac and Sinopharm): 100% <sup>151</sup>
Sinopharm	-	-	-	-	-	-	China (combined Sinovac and Sinopharm): Single dose: 13.8% (-60.2-54.8); 2 doses: 59.0% (16.0-81.6) <sup>151</sup>	China (combined Sinovac and Sinopharm): 100% <sup>151</sup>	
Bharat Biotech	-	-	-	-	-	-	Efficacy against infection in India: 65.2% (33.1-83.0) <sup>37</sup>	-	

\* 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



# Appendix 3: Vaccine Efficacy/Effectiveness in High-Risk Groups

VACCINE	VACCINE EFFICACY UNLESS OTHERWISE STATED			
	DIABETES	OBESITY	AT RISK FOR SEVERE COVID-19	ELDERLY
<b>AstraZeneca</b>	-	-	76% against symptomatic infection in a sample where 60% had comorbidities, including diabetes, severe obesity or cardiac disease <sup>21</sup> (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) <sup>42</sup>	In ≥65 years: 85% <sup>21</sup> (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) <sup>41</sup> Effectiveness of single dose against hospitalisation in England: ≥80 years: 73% (60-81) <sup>67</sup> Effectiveness in England: Symptomatic infection ≥70 years: 73% (27-90); Hospitalisation ≥80 years: 37% (3-59) <sup>66</sup> Hospitalisation following single dose in the UK: ≥80 years: 80.4% (36.4-94.5) <sup>65</sup> Single dose in Spain: ≥60 years: 53% (19-72) vs. 18-59 years: 50% (34-62) <sup>40</sup> Effectiveness against death in the UK: ≥65 years: Single dose: 83% (78-86); Two doses: 94% (80-98) <sup>48</sup> 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) <sup>42</sup>
<b>Gamaleya</b>	-	-	-	Against symptomatic infection in >60 years: 91.8% (67.1-98.3) <sup>22</sup>
<b>Johnson &amp; Johnson</b>	Against moderate to severe/critical: 23.0% (-90.1-69.8) <sup>24</sup>	Against moderate to severe/critical: 65.9% (47.8-78.3) <sup>24</sup>	Against moderate to severe/critical: With any comorbidity: 58.6% (40.6-71.6) <sup>24</sup> No comorbidity: 68.8% (59.0-76.6) <sup>24</sup>	Against moderate-severe/critical disease ≥28 post vaccination: 18-59 years: 66.1% (53.3-75.8) 60+ years: 66.2% (36.7-83.0) <sup>24</sup>
<b>Moderna</b>	-	-	Against 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) <sup>27</sup>	Against symptomatic infection: 18-64 years: 95.6% (90.6-97.9) ≥65 years: 86.4% (61.4-95.2) <sup>27</sup> Pooled Moderna and Pfizer vaccines against hospitalisation ≥65 years: 94% (49-99) <sup>152</sup> Infection in Canada: 1 dose ≥70 years: 54% (31-69); 2 doses ≥70 years: 95% (83-98) <sup>47</sup>
<b>Pfizer/BioNTech</b>	Effectiveness in Israel: Diabetes or cardiovascular disease: 82% (62-92) <sup>56</sup> Effectiveness against infection in Israel: (88.9% (87.3-90.2) <sup>51</sup>	Effectiveness against infection in Israel: (89.7% (88.6-90.7) <sup>51</sup>	Against symptomatic infection: With any comorbidity or obesity: 95.3% With no comorbidity: 94.7% <sup>32</sup> Denmark: Infection: 71% (58-80); Hospitalisation: 81% (49-93) <sup>50</sup> Effectiveness against infection in Israel: Hypertension: (89.7% (88.6-91.7) <sup>51</sup> 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) <sup>42</sup>	Against symptomatic infection: >55 years: 93.7% (80.6-98.8); >65 years: 94.7% (66.7-99.9); >75 years: 100% (-13.1-100) <sup>32</sup> 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) <sup>41</sup> England 80-83 years: Documented infection: 70.1% (55.1-80.1) Hospital attendance: 78.9% (60.0-89.9); Hospital admission: 75.6% (52.8-87.6) <sup>68</sup> 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% <sup>153</sup> Pooled Moderna and Pfizer vaccines against hospitalisation ≥65 years: 94% (49-99) <sup>152</sup> 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) <sup>66</sup> Effectiveness against hospitalisation in England ≥80 years: Single dose: 81% (76-85) Fully vaccinated: 93% (89-95) <sup>67</sup> (not peer reviewed) Effectiveness in Israel: 65-74 years: 82% (63-92); ≥75 years: 82% (61-91) <sup>56</sup> Hospitalisation following single dose in the UK: ≥80 years: 71.4% (43.1-86.2) <sup>65</sup> Single dose in Spain: ≥60 years: 76% (55-87) vs. 18-59 years: 85% (74-91) <sup>40</sup> Effectiveness against infection in Denmark: ≥80 years: 77% (50-89) <sup>50</sup> Effectiveness against infection in Israel: ≥70 years: 89.1% (83-93) <sup>51</sup> Effectiveness against death in the UK: ≥65 years: Single dose: 77% (72-81); Two doses: 98% (94-99) <sup>48</sup> 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) <sup>42</sup> Infection in Canada: 1 dose ≥70 years: 40% (29-50); 2 doses ≥70 years: 93% (82-98) <sup>47</sup>
<b>Novavax</b>	-	-	Against any infection with comorbidity, age ≥65 years or frequent COVID-19 exposure in USA and Mexico: 91.0% (83.6-95.0) <sup>31</sup>	-
<b>Sinovac</b>	-	74.9% (53.7-86.4) <sup>34</sup>	Any comorbidity: 48.9% (26.6-64.5) <sup>34</sup>	-
<b>Sinopharm</b>	-	80.7% (56.7-91.4) <sup>34</sup>	-	Effectiveness against symptomatic infection in Bahrain: ≥60 years: 91% (87-94) <sup>34</sup>
<b>Bharat Biotech</b>	-	-	Efficacy against any infection with comorbidity: 66.2% (33.8-84.0) <sup>37</sup>	Efficacy against symptomatic infection in India: ≥60 years: 67.8% (8.0-90.0) vs 18-59 years: 79.4% (66.0-88.2) <sup>37</sup>