Literature screening report

COVID-19 vaccines in the WHO's Emergency Use Listing (EUL) Report (13)

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Abstract

This report provides an in-depth review of the **eight**[1] World Health Organization's (WHO) Emergency Use Listing (EUL) authorized vaccines: BNT162b2/COMIRNATY (Pfizer-BioNTech, USA), Spikevax/Moderna COVID-19 Vaccine/ mRNA-1273 (Moderna, USA), Vaxzevria/ ChAdOx1 nCoV-19/ AZD1222/ Covishield (AstraZeneca/Oxford, UK, India), Janssen Covid-19 vaccine/ Ad26CoV2.S/ Johnson & Johnson (Janssen, USA), Sinopharm/ BBIBP-CorV (China), Sinovac/ CoronaVac (China), COVAXIN/ BBV152 (Bharat Biotech, India), and Novavax/ NXV-CoV2373/ COVAVAX (USA, India)]. The current report summarises the latest data on COVID-19 vaccine-related literature as of 10 February 2022 and presents the information in the form of a synoptic table. This report covers vaccine effectiveness, protection against variants, transmissibility, breakthrough infections, booster doses, COVID-19 vaccines for children, and further important information for each vaccine. The latest changes and additions to the synoptic table are highlighted in yellow.

[1] Since the Covishield vaccine uses the same formulation and platform as Vaxzevria (AstraZeneca's COVID-19 vaccines), we combined both vaccines into one column in the synoptic table. Henceforth, seven vaccines will be referenced as WHO EUL approved (including Covishield)

Content

Preamble

A large number of scientific publications become available on a daily basis, reflecting the rapid development of knowledge and progress of science on COVID-19 related issues. Leading authorities should base decisions or policies on this knowledge; hence they need to master the actual state of this knowledge. Due to the large number of publications shared daily, decision makers heavily depend on accurate summaries of these publications, in the different public health domains. Therefore, the authors of this report were mandated by the Swiss School of Public Health plus (SSPH+), upon request of the Federal Office of Public Health (FOPH), to inform the FOPH on recent findings from the literature.

Background

According to the current global data on vaccinations, 61.6% of the world populations, of which only 10.6% of people in low-income countries, have received at least one dose of a marketed COVID-19 vaccine as of 10 February 2022[2]. Currently, eight vaccines [namely, Comirnaty/BNT162b2 (Pfizer-BioNTech, USA), Spikevax/Moderna COVID-19 Vaccine/mRNA-1273 (Moderna, USA), Vaxzevria/ChAdOx1 nCoV-19/AZD1222/Covishield (AstraZeneca/Oxford, UK, India), Janssen Covid-19 vaccine/ Ad26CoV2.S/Johnson & Johnson (Janssen, USA), Sinopharm/BBIBP-CorV (China), Sinovac/CoronaVac (China), COVAXIN/BBV152 (Bharat Biotech, India), and Novavax/NXV-CoV2373/COVAVAX (USA, India)] were assessed and granted an authorization by WHO as of 23 December 2021[3]. **Articles regarding the latest data on vaccine effectiveness, particularly against the omicron variant, vaccine induced immune response, breakthrough infections and transmission, booster doses, and children vaccination were prioritized during the literature search and are the latest additions to the table. The newest data from clinical trials and observational studies for the eight EUL-accepted vaccines regarding these highlighted topics were summarized and can be found in the synoptic table below. A full version of the synoptic table containing older data on the COVID-19 vaccines can be found under the Annex section.**

[2] https://ourworldindata.org/covid-vaccinations (accessed on 10.02.2022).

[3] Status of COVID-19 vaccines within WHO EUL/ PQ evaluation process. World Health Organization. https://extranet.who.int/pqweb/sites/default/files/documents/Status_COVID_VAX_11Nov2021.pdf [Last updated 23 December 2021; Accessed 10 February 2022]

Methodology

We screened the data for the EUL-accepted vaccines as of 10 February 2022 from PubMed, Embase, medRxiv, bioRxiv, Cochrane, and clinical trials databases such as ClinicalTrials and WHO Trial Registry. The methods used were reported previously and can be found in prior reports[4].

Results

The Omicron Variant (B.1.1.529)

Effectiveness and Duration of Protection

Latest literature regarding vaccine effectiveness (VE) against the variant of concern (VOC), Omicron continues to show evidence of lowered protection against infection compared with other VOCs such as Delta. In a test-negative study conducted in Canada between 06 December 2021 to 26 December 2021 investigating mRNA-based VE against symptomatic infection and severe outcomes; researchers found significantly lower protection against Omicron than Delta. Despite waning immunity, the researchers found high levels of protection against Delta-associated symptomatic infection **[VE of 89% (95% CI, 86.0-92.0) to 80% (95% CI, 74.0-84.0) at ≥240 days after second dose]** compared with **VE against Omicron infection at 36% (95% CI, 24.0-45.0) to 1% (95% CI, -8.0-10.0) at ≥180 after the second dose**.[5] Despite this, the study found that effectiveness of mRNA-based vaccines against severe outcomes

[4] COVID-19 vaccines: efficacy and safety (Literature Review 1). *Swiss School of Public Health*. https://www.bag.admin.ch/dam/bag/de/dokumente/mt/k-und-i/aktuelle-ausbrueche-pandemien/2019-nCoV/Literaturrecherchen/literaturrecherchen_covid-19-impfstoffe_20210209.pdf.download.pdf/20210209_Literaturrecherchen_Covid-19-Impfstoffe_EN.pdf

[5] Effectiveness of COVID-19 vaccines against Omicron or Delta symptomatic infection and severe outcomes. *medRxiv.* https://www.medrxiv.org/content/10.1101/2021.12.30.21268565v2

for Omicron and Delta were comparable and did not show evidence of rapid waning as with VE against symptomatic infection.[6]

Likewise, a study in the United States from August 2021 to January 2022 showed similar results of waning protection and lower VE of mRNA-based vaccines against Omicron compared with Delta. Concerning protection against Emergency Department or Urgent Care encounters, VE against Delta-associated visits was **86% (95% CI, 85.0-87.0) at 14-179 days to 76% (95% CI, 75.0-77.0) ≥180 days after second dose** while VE against Omicron-associated visits was **52% (95% CI, 46.0-58.0) at 14-179 days to 38% (95% CI, 32.0-43.0) ≥180 days after second dose**.[7] Effectiveness against hospitalization was higher for both variants with VE against Delta-associated stays at **90% (95% CI, 89-90) at 14-179 days to 81% (95% CI, 80-82) ≥180 days after second dose** compared with VE against Omicron-associated hospitalization at **81% (95% CI, 65-90) at 14-179 days to 57% (95% CI, 39-70) ≥180 days after second dose**.[8]

Additionally, a study in Qatar specifically examining Pfizer and Moderna effectiveness against Omicron from 23 December 2021 to 02 February 2022 further corroborates results from other studies. In this test-negative, case-control study, the researchers found that Pfizer and Moderna have comparable levels of protection against symptomatic infection while maintaining robust protection against severe, critical, or fatal Omicron-associated disease. Pfizer demonstrated VE against symptomatic Omicron at **61.9% (95% CI, 49.9-71.1%) in the first month after the second dose which gradually declined to 10% (95% CI, -2.3-21.9) and less starting from the 5th month after the second dose**.[9] Moderna exhibited similar VE against

[6] Effectiveness of COVID-19 vaccines against Omicron or Delta symptomatic infection and severe outcomes. *medRxiv.* https://www.medrxiv.org/content/10.1101/2021.12.30.21268565v2

[7] Effectiveness of a Third Dose of mRNA Vaccines Against COVID-19–Associated Emergency Department and Urgent Care Encounters and Hospitalizations Among Adults During Periods of Delta and Omicron Variant Predominance — VISION Network, 10 States, August 2021–January 2022. *Center for Disease Control and Prevention.* https://www.cdc.gov/mmwr/volumes/71/wr/mm7104e3.htm?s_cid=mm7104e3_w

[8] Effectiveness of a Third Dose of mRNA Vaccines Against COVID-19–Associated Emergency Department and Urgent Care Encounters and Hospitalizations Among Adults During Periods of Delta and Omicron Variant Predominance — VISION Network, 10 States, August 2021–January 2022. *Center for Disease Control and Prevention.* https://www.cdc.gov/mmwr/volumes/71/wr/mm7104e3.htm?s_cid=mm7104e3_w

[9] Duration of protection of BNT162b2 and mRNA-1273 COVID-19 vaccines against symptomatic SARS-CoV-2 Omicron infection in Qatar. *medRxiv.* https://www.medrxiv.org/content/10.1101/2022.02.07.22270568v1

symptomatic Omicron which peaked at **44.8% (95% CI, 16.0-63.8) in the first three months after the second dose and declined to negligible levels after**.[10] However, both vaccines demonstrated strong protection against Omicron-related severe disease and outcomes; with Pfizer VE **maintained at >70% after the second dose with no evidence for declining effectiveness** over time and Moderna VE at **>60% after the second dose**.[11]

Despite reports of inadequate VE against Omicron-associated infections, vaccines still offer substantial protection against severe outcomes and highlight the importance of continuing vaccination campaigns. A study in Sweden during the Delta and Omicron periods among vaccinated (Pfizer, Moderna, and AstraZeneca) and unvaccinated individuals showed that the odds of severe COVID-19 requiring hospitalization and extensive medical interventions were **40% lower (95% CI, 18.0-56.0)** among unvaccinated and **71% lower (95% CI, 54.0-82.0)** among those vaccinated during the Omicron period compared to the Delta period.[12] Another study conducted in the United States from 07 November 2021 to 08 January 2022 found similar results wherein incidence and hospitalization rates were higher among unvaccinated persons during the Delta and Omicron predominant periods. During the Delta period, incidence and hospitalization rates among unvaccinated individuals compared with fully vaccinated individuals without a booster were **12.3 times and 83.0 times** higher.[13] While these rate ratios appear to be lower during the Omicron period, when comparing those fully vaccinated without a booster with those who were unvaccinated, the incidence and hospitalization rates were still higher at **2.0 times and 5.3 times**, respectively.[14]

[10] Duration of protection of BNT162b2 and mRNA-1273 COVID-19 vaccines against symptomatic SARS-CoV-2 Omicron infection in Qatar. *medRxiv.* https://www.medrxiv.org/content/10.1101/2022.02.07.22270568v1

[11] Duration of protection of BNT162b2 and mRNA-1273 COVID-19 vaccines against symptomatic SARS-CoV-2 Omicron infection in Qatar. *medRxiv.* https://www.medrxiv.org/content/10.1101/2022.02.07.22270568v1

[12] Risk of severe COVID-19 from the Delta and Omicron variants in relation to vaccination status, sex, age and comorbidities – surveillance results from southern Sweden. *medRxiv.* https://www.medrxiv.org/content/10.1101/2022.02.03.22270389v1

[13] SARS-CoV-2 Infection and Hospitalization Among Adults Aged ≥18 Years, by Vaccination Status, Before and During SARS-CoV-2 B.1.1.529 (Omicron) Variant Predominance — Los Angeles County, California, November 7, 2021–January 8, 2022. *Center for Disease Control and Prevention.* https://www.cdc.gov/mmwr/volumes/71/wr/mm7105e1.htm

[14] SARS-CoV-2 Infection and Hospitalization Among Adults Aged ≥18 Years, by Vaccination Status, Before and During SARS-CoV-2 B.1.1.529 (Omicron) Variant Predominance — Los Angeles County, California, November 7, 2021–January 8, 2022. *Center for Disease Control and Prevention.* https://www.cdc.gov/mmwr/volumes/71/wr/mm7105e1.htm

Transmissibility

Information regarding population-level transmission of the Omicron variant has been published abundantly as public health organizations around the world strive to capture the statistics on this fast-moving variant. Several simultaneous studies from around the world have remarked on the apparent shorter serial interval of Omicron in relation to more ancestral strains. A study from Belgium used contact-tracing data to observe the serial interval of Omicron and Delta variants between 19 November to 31 December 2021. The study found that the mean serial interval of Omicron was **2.75 days (SD 2.53 days)** compared to **3 days (SD 2.48 days)** for Delta variant (p=.019). Primary vaccination did not seem to mitigate this reduced interval, and in comparison to Delta, a large reduction in this period was seen- **2.63 days vs 3.38 days,** respectively. However, booster vaccination did appear to help, as the mean serial interval was longer for boosted people compared to double-vaccinated people- **3.34 vs 2.63 days**.[15] A study from the Netherlands conducted a similarly designed study and found that the mean serial interval for Omicron cases was **0.2-0.6 days** shorter than non-Omicron cases. This study also inferred the incubation period of Omicron to be **2.8 days**, versus 4 days for non-Omicron cases. Additionally, this study demonstrated the speed of Omicron- from one week to the next, the proportion of Omicron-detected positive cases jumped from **9.0% to 28.6%**.[16]

This speed was also demonstrated in a study describing the transmission of Omicron in 3 Massachusetts universities. During the study period, between **8-13 days**, the proportion of positive cases changed from being **90% Delta to 90% Omicron.**[17]

Another study focused on a particular subtype of Omicron, called BA.2, that has dominated transmission in Denmark as measured by data on Danish households. This study estimated a secondary attack rate of **29%** for Omicron BA.1, and **39%** for

[15] Observed serial intervals of SARS-CoV-2 for the Omicron and Delta varaints in Belgium based on contact tracing data, 19 November to 31 December 2021. *medRxiv*. https://doi.org/10.1101/2022.01.28.22269756

[16] Shorter serial intervals in SARS-CoV-2 cases with Omicron BA.1 variant compared to Delta variant in the Netherlands, 13 - 26 December 2021. *medRxiv*. https://doi.org/10.1101/2022.01.18.22269217

[17] Early introduction and rise of the Omicron SARS-CoV-2 variant in highly vaccinated university populations. *medRxiv*. https://doi.org/10.1101/2022.01.27.22269787

Omicron BA.2 within the households in the sample. BA.2 was also seen to be associated with higher odds of infection for unvaccinated, fully vaccinated, and boosted individuals alike, in comparison to BA.1. However, in cases of boosted and double-vaccinated primary cases, vaccination did appear to reduce transmissibility, with BA.2 having an OR below 1.[18]

Another study gave an estimate of the secondary attack rate of Omicron, based on contact-tracing data from Norway. This study estimated the SAR of Omicron as **41%, (95%CI, 38-44)** compared to **35% (95% CI, 31-38)** for Delta variant. This study also stated a higher relative risk of infection in fully vaccinated contacts of households with Omicron, compared to Delta.[19]

Overall, this small collection of studies on Omicron transmission reveals some patterns. Omicron spreads exceedingly well in insular, highly vaccinated communities, and quickly overtakes Delta as the main variant of transmission. However, booster vaccination does appear to confer some protection, especially in the context of secondary case transmission from those who are boosted.

Booster Dose

Although the Omicron variant has, to some extent, lowered the immunity and effectiveness of COVID-19 vaccines, multiple studies have demonstrated that the administration of a booster dose reportedly increases the antibodies and the effectiveness against SARS-CoV-2 infection. Recent studies assessing the performance and effectiveness of COVID-19 booster doses have added to the mounting evidence that booster doses are associated with a higher effectiveness and protection against the Omicron variant. A test-negative case-control study evaluating the association between symptomatic SARS-CoV-2 infections and vaccination among adults 18 years and older found that the receipt of three doses of an mRNA vaccine

[18] Transmission of SARS-CoV-2 Omicron VOC subvariants BA.1 and BA.2: Evidence from Danish Households. *medRxiv*. https://doi.org/10.1101/2022.01.28.22270044

[19] Increased household transmission and immune escape of the SARS-CoV-2 Omicron variant compared to the Delta variant: evidence from Norwegian contact tracing and vaccination data. *medRxiv*. https://doi.org/10.1101/2022.02.07.22270437

was associated with a higher protection against both the Delta and Omicron variants.[20] Based on the results, three doses of mRNA vaccine had an adjusted odds ratio of **0.34 (95% CI, 0.32-0.36) for Omicron** compared to two doses and an adjusted odds ratio of **0.33 (95% CI, 0.31-0.35) for Omicron** compared to unvaccinated individuals. Another study evaluating the effectiveness of a third dose of mRNA vaccines against COVID-19 associated severe cases and hospitalization found similar results. The study reported a vaccine effectiveness of **82% (95% CI, 79-84) against severe cases** and **90% (95% CI, 80-94) against hospitalization** for the Omicron variant.[21]

In addition to an increase in vaccine effectiveness, homologous as well as a heterologous booster doses have demonstrated an increased neutralization against the Omicron variant. For instance, a third dose of the BNT162b2 vaccination has shown to better neutralize SARS-CoV-2 Omicron infections than two vaccine doses. In this study, the geometric mean titers of the Omicron variant was **1.11 GMT** in recipients who received two doses and **107.6 GMT** in recipients who received three doses of the BNT162b2 vaccine.[22] Despite the lower efficiency against other variants of concern compared to the wild-type virus, the third dose of the BNT162b2 efficiently neutralized infections with the Omicron variant. Similar results in neutralizing antibodies against the Omicron variant has been reported in heterologous vaccine schedules. Although the magnitude in the increase of neutralization against the Omicron variant greatly depends on the heterologous vaccine schedule, **boosting with a mRNA vaccine effectively increase the protection against Omicron in all individuals**, regardless of their previous vaccination schedule. These results are highlighted in a study evaluating the neutralizing capacity of the BNT162b2 booster in individuals who received BNT162b2 as their primary vaccination and individuals who

[20] Association Between 3 Doses of mRNA COVID-19 Vaccine and Symptomatic Infection Caused by the SARS-CoV-2 Omicron and Delta Variants. *JAMA.* https://jamanetwork.com/journals/jama/fullarticle/2788485

[21] Effectiveness of a Third Dose of mRNA Vaccines Against COVID-19–Associated Emergency Department and Urgent Care Encounters and Hospitalizations Among Adults During Periods of Delta and Omicron Variant Predominance — VISION Network, 10 States, August 2021–January 2022. *CDC – MMWR.* https://www.cdc.gov/mmwr/volumes/71/wr/mm7104e3.htm?s_cid=mm7104e3_w

[22] Third BNT162b2 Vaccination Neutralization of SARS-CoV-2 Omicron Infection. *NEJM.* https://www.nejm.org/doi/full/10.1056/NEJMc2119358

received ChAdOx1 nCov-19 as their primary vaccination,[23] and in another study evaluating the neutralizing activity against the Omicron variant after a heterologous booster in individuals who received two doses of the CoronaVac vaccination.[24]

Immunogenicity of Booster Doses

As much emphasis has been placed on the dynamics of immunogenicity of vaccines against the Omicron variant, there is a host of studies which add new information to this topic, mainly focusing on booster doses. These studies confirm the continued importance of regular booster doses in bolstering immune response against all variants, but especially against Omicron.

A report on the serum neutralizing capability of the mRNA-1273 2-dose series and a booster in adults showed that at one month after primary vaccination completion, neutralizing antibodies (NAbs) were below the lower limit of qualification (LLQQ). At 2 weeks post-booster, NAbs increased and showed neutralizing capability, though still at a highly reduced level. This level has been considered sufficient to protect against severe infection.[25] A study from South Africa investigated the roles of Omicron infection and prior vaccination in neutralization of the Delta variant. Participants were both infected with Omicron and vaccinated with either Pfizer or Janssen, and had sera taken from them at intervals. Vaccinated participants showed a **13.7-fold** increase in neutralization of Omicron throughout the 23-day period. Additionally, delta neutralization increased **6.1-fold** in the same period. In these participants, neutralization capability for Delta showed **a 22.5-fold increase**. These findings suggest that though Omicron can cause breakthrough infections in vaccinated people, this extra exposure to SARS-CoV-2 may protect against the deadlier Delta strain.[26]

[23] Omicron Neutralizing and Anti-SARS-CoV-2 S-RBD Antibodies in Naïve and Convalescent Populations After Homologous and Heterologous Boosting With an mRNA Vaccine. *SSRN.* https://dx.doi.org/10.2139/ssrn.4016530

[24] Neutralizing Activities against the Omicron Variant after a Heterologous Booster in Healthy Adults Receiving Two Doses of CoronaVac Vaccination. *medRxiv.* https://www.medrxiv.org/content/10.1101/2022.01.28.22269986v1

[25] Serum Neutralizing Activity of mRNA-1273 Against the SARS-CoV-2 B.1.1.529 (Omicron) Variant: A Preliminary Report. *medRxiv.* doi:10.1101/2022.01.28.21268247

[26] Omicron infection of vaccinated individuals enhances neutralizing immunity against the Delta variant. *medRxiv.* https://doi.org/10.1101/2021.12.27.21268439

Studies which compare the neutralizing activity of vaccines against Omicron versus more ancestral variants put the reduced immunogenicity into stark contrast. A study focusing on the BBV152 (Covaxin) vaccine compared the neutralizing ability of the booster vaccine against Delta, Omicron, and a "wild-type" variant (D614G). The GMT against Omicron was **75**, versus **480** against the Delta variant, and **706** for the D614G variant.[27]

Another study took 38 samples of antisera from both vaccinated participants (Pfizer, Moderna, Janssen) and convalescents and found that there was an average **15-fold reduction** in efficacy against Omicron, relative to the response against an ancestral strain. However, the same study also found that a third dose of the Pfizer vaccine, elicited a detectable level of antibodies in **8 out of 8** subjects, compared to 1 out of 8 without the booster.[28]

A study of people vaccinated with a mix of mRNA vaccines investigated the neutralizing capabilities against Omicron of sera from participants before and after receiving a booster dose of a vaccine. The study found that the 2-dose vaccine series offered very little neutralizing capability, and that neutralizing capacity against any variant strain tested in the study was lost by 8 months since last dose of vaccine. However, the booster offers a significant boost in neutralizing ability. Paired samples pre and post boost showed an increase of more than **15-fold**.[29]

A longitudinal cohort study of 37 elderly individuals determined the SARS-CoV-2 neutralizing activity of sera from this sample against different variants. After a period of 10 months post an initial 2-dose vaccination series of BNT162b2, detectable Omicron neutralizing activity in sera from this elderly cohort was almost entirely absent. After homologous booster immunization, neutralizing activity was seen in **33 out of 37 (89%)** individuals. In a period of 4.5 months after this booster dose, neutralizing titers against several variants showed decline once again in this group,

[27] Covaxin (BBV152) Vaccine Neutralizes SARS-CoV-2 Delta and Omicron variants. *medRxiv*. https://doi.org/10.1101/2022.01.24.22269189

[28] Omicron mutations enhance infectivity and reduce antibody neutralization of SARS-CoV-2 virus-like particles. *medRxiv*. https://doi.org/10.1101/2021.12.20.21268048

[29] Comparison of total and neutralizing SARS-CoV-2 spike antibodies against omicron and other variants in paired samples after two or three doses of mRNA vaccine. *medRxiv*. https://doi.org/10.1101/2022.01.26.22269819

emphasizing the importance of continued booster immunization, especially for at-risk groups.[30]

A study focusing on various evasive capabilities of the Omicron spike mutations also collected data on sera neutralization capability of BNT162b2-vaccinated people against Omicron. Samples taken within 3 months after completion of BNT162b2 immunization series showed 34-fold lower efficiency in protecting against Omicron infection as compared to the Alpha (B.1) variant. This same study also demonstrated that heterologous vaccinations with a first dose of ChAdO1-nCoV-19 (AstraZeneca) and a second dose of BNT162b2 (Pfizer) showed a **14-fold reduction** in neutralization efficiency as compared to the Alpha variant, but only a **3-fold reduction** when compared against Delta. The study also asserted the importance of booster immunization, as a third immunization of BNT162b2 improved the protection of people already double-vaccinated with BNT162b2 by **10-fold**.[31] Current literature on vaccine immunogenicity lends further credibility to the important and effectiveness of booster doses, irrespective of vaccine type.

Booster Doses

With the reported waning immunity and the decreased effectiveness of COVID-19 vaccines against new variants of concerns such as Omicron, booster doses have become essential in protecting against all COVID-19 infection, severe disease, and death risk as they have shown to reduce the risk of infection from **88%** to **92%**.[32] Recently, data on the efficacy and safety of the Ad26.COV2.S booster dose[33] and the

[30] Durability of Omicron-neutralizing serum activity following mRNA booster immunization in elderly individuals. *medRxiv*. https://doi.org/10.1101/2022.02.02.22270302

[31] The Omicron variant is highly resistant against antibody-mediated neutralization - Implications for control of the COVID-19 pandemic. *BioRxiv*. https://www.biorxiv.org/content/10.1101/2021.12.12.472286v1.full

[32] Third Dose of SARS-CoV-2 Vaccine: A Systematic Review of 30 Published Studies. *Journal of Medical Virology*. https://onlinelibrary.wiley.com/doi/10.1002/jmv.27644

[33] Efficacy and Safety of a Booster Regimen of Ad26.COV2.S Vaccine against Covid-19. *medRxiv*. https://www.medrxiv.org/content/10.1101/2022.01.28.22270043v1

immunogenicity of inactivated booster vaccines[34] continue to demonstrate the benefits of booster doses.

Heterologous Boosters

A reduction in the risk of infection has also been reported in the administration of heterologous booster doses. In a study analysing the effectiveness of homologous and heterologous COVID-19 booster doses in veterans, the results showed that in Ad26.COV2.S-primed vaccine individuals, the incidence of infection after heterologous boosting was **approximately 50% lower** than in homologous boosted individuals (adjusted rate ratio: 0.49 [95% CI, 0.40-0.60]) while no material difference was noted in heterologous or homologous boosting among mRNA-primed individuals (adjusted rate ratio: 1.10 [95% CI, 0.90-1.35]).[35] As for differences in the immune response of heterologous and homologous booster dose recipients, heterologous boosting with an mRNA vaccine following CoronaVac or ChAdOx1 reported to confer more immunogenic responses than homologous boosted individuals.[36,37]

Fourth Dose

While the number of countries offering a booster dose to the general continues to increase over time, countries such as Israel have decided to start vaccinating their health-care workers, people older than 60 years, and immunocompromised groups with a fourth dose of the BNT162b2 vaccine. The effects and the protection this fourth dose offers are relatively unknown, making multiple scientists question the necessity of such measures. Recently, scientists in Israel published preliminary results on the protection of the fourth dose of BNT162b2 against the Omicron variant in Israel. Based

[34] Evaluation of Immunogenicity by Pseudovirus Neutralization Assays for Coronavirus Disease 2019 (COVID-19) Variants after Primary and Booster Immunization. *International Journal of Infectious Diseases.* https://www.ijidonline.com/article/S1201-9712(22)00075-3/fulltext

[35] Effectiveness of Homologous or Heterologous Covid-19 Boosters in Veterans. *NEJM.* https://www.nejm.org/doi/full/10.1056/NEJMc2200415

[36] The immunogenicity and reactogenicity of four COVID-19 booster vaccinations against SARS-CoV-2 variants of concerns (Delta, Beta, and Omicron) following CoronaVac or ChAdOx1 nCoV-19 primary series. *medRxiv.* https://www.medrxiv.org/content/10.1101/2021.11.29.21266947v3

[37] Anti-spike antibody trajectories in individuals previously immunised with BNT162b2 or ChAdOx1 following a BNT162b2 booster dose. medRxiv. https://www.medrxiv.org/content/10.1101/2022.02.07.22270451v1

on the results, the rate of confirmed infection was lower in people who received the fourth dose 12 days or more than people who only received three doses of the BNT162b2 vaccine by a factor of **2.0 (95% CI, 2.0-2.1)** while the rate against severe illness was lowered by a factor of **4.3 (95% CI, 2.4-7.6)**.[38]

Children Vaccination

As the Omicron variant continues to dominate the global landscape of novel COVID-19 infection, the relatively new demographic of child vaccinees must also be considered regarding the concerning evasive capabilities of Omicron. This area of the field currently shows a dearth of literature, though this will likely change in the upcoming weeks and months. One study from Hong Kong on a small cohort of adolescent vaccine recipients assessed serum neutralization against the Omicron variant. In this study, only **38.2%** of adolescents vaccinated with the BNT162b2 vaccine showed serum neutralization at or above detectable levels. Additionally, the geometric mean titre (GMT) in this group against Omicron was **7.2 (95%CI, 6.8-6)**, versus the GMT against a wild-type lineage, which was **150.5(95%CI, 109.6-206.7)**. This study reiterates what we already know about Omicron, but in the context of child vaccination. It appears that Omicron is incredibly efficient in evading neutralization from vaccination.[39]

New reports of adverse events in pediatric, adolescent, and young adult age groups have been published. Though no novel adverse events were found, and no causal association has yet been offered, these studies have value in further characterizing the potential clinical safety concerns of child vaccination. A study of hospitalized patients ages 12 and up examined the role of exposure to either the BNT162b2 or CoronaVac vaccine in incidence rates of carditis, using hospitalized patients without carditis as controls. The study found that the incidence of carditis per 100,000 doses

[38] Protection by 4th dose of BNT162b2 against Omicron in Israel. *medRxiv.* https://www.medrxiv.org/content/10.1101/2022.02.01.22270232v1

[39] Omicron variant susceptibility to neutralizing antibodies induced in children by natural SARS-CoV-2 infection or COVID-19 vaccine. *Emerging microbes & infections*. https://doi.org/10.1080/22221751.2022.2035195

of CoronaVac was **0.31 (95%CI, 0.13-0.66)**, and for BNT162b2 it was **0.57 (95% CI, 0.36-0.90)**. However, it is worth noting that the sample size for CoronaVac recipients was much smaller than that of BNT162b2. BNT162b2 recipients were also shown to have higher odds of being a carditis patient than unvaccinated controls. Additionally, males had higher odds than females, and adolescents had higher odds than adults, which are both trends that have been seen repeatedly in the literature. Additionally, this study found that 75% of cases occurred in the first week after vaccination, and out of 160 cases of carditis/myocarditis, 14 unvaccinated patients were admitted to the ICU, and 12 unvaccinated patients died during the observation period.[40] Another report from the US Vaccine safety agency, VAERS, looked at stratified rates of myocarditis in vaccinated people over the age of 12 as of September 2021. Among 192,405,448 people who received 1 or more doses of an mRNA-based vaccine, there were 1626 verified reports of myocarditis. The median age of the report subject was 21 years old (IQR, 16-31), and the median time to symptom onset was 2 days (IQR, 1-3 days). 90% of myocarditis events occurred within a week of vaccination. This study showed that the rates of myocarditis in adolescent males aged 16-17 was 105.9 (95%CI, 91.65-122.27) per million doses, the highest of all age groups surveyed.[41]

A case study also regarding myocarditis relayed the case of a previously healthy 14-year-old male who was admitted to the ER due to chest pain 3 days after receiving the BNT162b2 vaccine. Though his vitals were stable, electrocardiographs and cardiac enzyme levels showed clinical signs of some sort of pathology. After testing negative for SARS-CoV-2, and inconclusive angiography, the patient was treated with NSAIDs and his symptoms and cardiac enzymes began to return to baseline. After one week, the patient's cardiac enzymes were in normal range, and the patient was discharged.[42] Another case study from Japan presented a 26 year old man who went to the hospital with chest pain 4 days after receiving the second dose of the BNT162b2 vaccine

[40] Carditis After COVID-19 Vaccination With a Messenger RNA Vaccine and an Inactivated Virus Vaccine: a Case-Control Study. *Annals of internal medicine.* https://doi.org/10.7326/M21-3700

[41] Myocarditis Cases Reported After mRNA-Based COVID-19 Vaccination in the US From December 2020 to August 2021. *JAMA.* doi:10.1001/jama.2021.24110

[42] A Pediatric Case of Myopericarditis Post COVID-19 mRNA Vaccine.*Cardiology in the young*. https://doi.org/10.1017/S1047951122000312

series. The patient tested negative for SARS-CoV-2 and a battery of other viruses, and showed clinical signs of myocarditis through imaging and lab results. The patient was treated with oral acetaminophen and was discharged after 4 days. Though he had no decrease in cardiac dysfunction, the patient eventually returned to an outpatient clinic complaining of malaise, where he was diagnosed with post-vaccination syndrome.[43] Combined, the cohort studies and case studies in this report serve to further define the instances of myocarditis after vaccination as being more common in young males, occurring with 7 days of vaccination, and being mostly rare and easily resolved.

Another potential adverse event associated with child vaccination is multisystem inflammatory syndrome (MIS-C). A case study relayed the case of a 12-year-old male who presented to the hospital with headache and vomiting, 2 days after vaccination with the BNT162b2 series. Encephalopathy and elevated troponin levels alone were indicative of MIS-C, however upon the patient's movement to PEDS ICU, a brain MRI showed a cytotoxic lesion of the corpus callosum (CLOCC), a temporary brain lesion associated with MIS-C. All workups for other possible explanations were negative, and his cardiac MRI was normal. After 5 days, the patient was discharged and showing normal neurological exam results.[44]

Due to the timing of the current vaccine rollout and the limited number of vaccines that have been approved for widespread use in adolescents and children, amount of information available about other, less used vaccines in children is currently scarce. However, this is rapidly changing, and a clinical trial has been announced to test the efficacy and safety of the CoronaVac vaccine in children and adolescents.[45] We will likely see more trials and studies on the use of a wider range of vaccines in children in the coming months.

[43] Case report of acute myocarditis after administration of coronavirus disease 2019 vaccine in Japan. *European heart journal case reports*. https://doi.org/10.1093/ehjcr/ytab534

[44] Multisystem Inflammatory-like Syndrome in a Child Following COVID-19 mRNA Vaccination. *Vaccines*. https://doi.org/10.3390/vaccines10010043

[45] Efficacy, Immunogenicity and Safety of Inactivated Vaccine (Coronavac) Against SARS-COV2 in Children and Adolescents. *ClinicalTrialsgov*. 2022;Nct05225285. NCT05225285.

Further (biweekly) updated data on the eight WHO EUL vaccines are synthesized in the synoptic table.

Synoptic Table

Synoptic table about SARS-CoV-2 vaccines accepted in the WHO's Emergency Use Listing containing ONLY the newest information (as of 14 February 2022)

	BNT162b2/ COMIRNATY (Pfizer-BioNTech, USA)	Spikevax/ Moderna COVID-19 Vaccine/ mRNA-1273 (Moderna, USA)	Vaxzevria/ ChAdOx1 nCoV-19/ AZD1222/ Covishield (AstraZeneca/Oxford, UK, India)	Janssen COVID-19 vaccine/Johnson & Johnson (Janssen, USA)	BBIBP-CorV/ Covilo (Sinopharm, China)	CoronaVac (Sinovac, China)	COVAXIN / BBV152 (Bharat Biotech, India)	NVX-CoV2373/ Covovax/ Nuvaxovid (Novavax, Czech Republic, India)
EFFICACY								
Two doses	No new data	No new data	No new data	No new data	No new data	No new data	No new data	*Against SARS-CoV-2 Infection:* **90.4% (95% CI, 82.9-94.6)** ≥7 days after 2nd dose [Phase 3 Trial: USA & Mexico][1] *Against moderate-severe disease:* **100% (95% CI, 87.0-100)** ≥7 days after 2nd dose [Phase 3 Trial: USA & Mexico][1]
Efficacy against variants	No new data	No new data	No new data	No new data	No new data	No new data	No new data	*Against any variant of concern:* **92.6% (95% CI, 83.6-96.7)** ≥7 days

								after 2nd dose [Phase 3 Trial: USA & Mexico][1] *Alpha (B.1.1.7):* **93.6% (95% CI, 81.7-97.8)** ≥7 days after 2nd dose [Phase 3 Trial: USA & Mexico][1]
EFFECTIVENESS AGAINST ANY SARS-COV-2 INFECTION								
Effectiveness of Single Dose	No new data	No new data	No new data	*Against Severe Disease -* **>60%** against infection, severe infection, and infection requiring hospitalization[average from systematic review][2] *Age 80+:* **94.4 (95% CI, 92.1-96.1)** waned to **86.0 (95% CI, 83.1-88.4)** after 6 months[Greece; January 2021 to December 2021;	No new data	*Against any SARS-CoV-2 Infection -* **14.5% (95% CI, 11.0-34.2)** 0-13 days after first dose[Indonesia; 13 January 2021 to 30 June 2021][4]	No new data	No new data

				pooled effectiveness][3i] *Age 60-79:* **96.9 (95% CI, 96.1-97.6)**[Greece; January 2021 to December 2021; pooled effectiveness][3ii] *Age 15-59:* **98.3 (95% CI, 97.6-98.7)**[Greece; January 2021 to December 2021; pooled effectiveness][3iii] *Against Death - Age 80+* **91.0 (95% CI, 87.8-93.0)** waned to **84.1 (95% CI, 81.9-86.0)** after 6 months[Greece; January 2021 to December 2021;				

[i] Study investigated BNT162b2, mRNA-1273, ChAdOx-1 nCoV-19, and Ad26.COV2.S.
[ii] Study investigated BNT162b2, mRNA-1273, ChAdOx-1 nCoV-19, and Ad26.COV2.S.
[iii] Study investigated BNT162b2, mRNA-1273, ChAdOx-1 nCoV-19, and Ad26.COV2.S.

				pooled effectiveness][3iv] *Age 60-79:* **94.6 (95% CI, 93.1-95.8)**[Greece; January 2021 to December 2021; pooled effectiveness][3v] *Age 15-59:* **96.9 (95% CI, 95.0-98.0)**[Greece; January 2021 to December 2021; pooled effectiveness][3vi]				
Effectiveness of Two Doses	*Against any SARS-CoV-2 Infection -* **62.8% (95% CI, 49.3–72.7)** for all vaccines combined[England][5vii]	*Against any SARS-CoV-2 Infection -* **62.8% (95% CI, 49.3–72.7)** for all vaccines combined[England][5xiv]	*Against any SARS-CoV-2 Infection -* **62.8% (95% CI, 49.3–72.7)** for all vaccines	Not Applicable (One Dose Schedule)	No new data	*Against any SARS-CoV-2 Infection -* **66.7% (58.1 to 73.5%)** at ≥14 days[Indonesia; 13 January 2021 to 30 June 2021] [4]	No new data	No new data

[iv] Study investigated BNT162b2, mRNA-1273, ChAdOx-1 nCoV-19, and Ad26.COV2.S.
[v] Study investigated BNT162b2, mRNA-1273, ChAdOx-1 nCoV-19, and Ad26.COV2.S.
[vi] Study investigated BNT162b2, mRNA-1273, ChAdOx-1 nCoV-19, and Ad26.COV2.S.
[vii] Study included BNT162b2, mRNA-1273, and ChAdOx-1 nCoV-19.
[xiv] Study included BNT162b2, mRNA-1273, and ChAdOx-1 nCoV-19.

	Against Severe Disease - **>90%** against infection, severe infection, infection requiring hospitalization, and mortality[average from systematic review][2] *Age 80+:* **94.4 (95% CI, 92.1-96.1)** waned to **86.0 (95% CI, 83.1-88.4)** after 6 months[Greece; January 2021 to December 2021; pooled effectiveness][3viii] *Age 60-79:* **96.9 (95% CI, 96.1-97.6)**[Greece; January 2021 to December 2021;	*Against Severe Disease -* **>80%** against infection, severe infection, and infection requiring hospitalization[average from systematic review][2] *Age 80+:* **94.4 (95% CI, 92.1-96.1)** waned to **86.0 (95% CI, 83.1-88.4)** after 6 months[Greece; January 2021 to December 2021; pooled effectiveness][3xv] *Age 60-79:* **96.9 (95% CI, 96.1-97.6)**[Greece; January 2021 to December 2021;	combined[England][5xxi] *Age 80+:* **94.4 (95% CI, 92.1-96.1)** waned to **86.0 (95% CI, 83.1-88.4)** after 6 months[Greece; January 2021 to December 2021; pooled effectiveness][3xxii] *Age 60-79:* **96.9 (95% CI, 96.1-97.6)**[Greece; January 2021 to December 2021; pooled effectiveness][3xxiii] *Age 15-59:* **98.3 (95% CI, 97.6-98.7)**[Greece; January 2021 to December 2021;			*Against Death –* **87.4% (95% CI, 65.1-95.4)** ≥14 days[Indonesia; 13 January 2021 to 30 June 2021][4]		

[viii] Study investigated BNT162b2, mRNA-1273, ChAdOx-1 nCoV-19, and Ad26.COV2.S.
[xv] Study investigated BNT162b2, mRNA-1273, ChAdOx-1 nCoV-19, and Ad26.COV2.S.
[xxi] Study included BNT162b2, mRNA-1273, and ChAdOx-1 nCoV-19.
[xxii] Study investigated BNT162b2, mRNA-1273, ChAdOx-1 nCoV-19, and Ad26.COV2.S.
[xxiii] Study investigated BNT162b2, mRNA-1273, ChAdOx-1 nCoV-19, and Ad26.COV2.S.

	pooled effectiveness][3ix] *Age 15-59:* **98.3 (95% CI, 97.6-98.7)**[Greece; January 2021 to December 2021; pooled effectiveness][3x] *Against Death - Age 80+* **91.0 (95% CI, 87.8-93.0)** waned to **84.1 (95% CI, 81.9-86.0)** after 6 months[Greece; January 2021 to December 2021; pooled effectiveness][3xi] *Age 60-79:*	pooled effectiveness][3xvi] *Age 15-59:* **98.3 (95% CI, 97.6-98.7)**[Greece; January 2021 to December 2021; pooled effectiveness][3xvii] *Against Death - Age 80+* **91.0 (95% CI, 87.8-93.0)** waned to **84.1 (95% CI, 81.9-86.0)** after 6 months[Greece; January 2021 to December 2021; pooled effectiveness][3xviii] *Age 60-79:*	pooled effectiveness][3xxiv] *Against Death - Age 80+* **91.0 (95% CI, 87.8-93.0)** waned to **84.1 (95% CI, 81.9-86.0)** after 6 months[Greece; January 2021 to December 2021; pooled effectiveness][3xxv] *Age 60-79:* **94.6 (95% CI, 93.1-95.8)**[Greece; January 2021 to December 2021; pooled effectiveness][3xxvi] *Age 15-59:*					

[ix] Study investigated BNT162b2, mRNA-1273, ChAdOx-1 nCoV-19, and Ad26.COV2.S.
[x] Study investigated BNT162b2, mRNA-1273, ChAdOx-1 nCoV-19, and Ad26.COV2.S.
[xi] Study investigated BNT162b2, mRNA-1273, ChAdOx-1 nCoV-19, and Ad26.COV2.S.
[xvi] Study investigated BNT162b2, mRNA-1273, ChAdOx-1 nCoV-19, and Ad26.COV2.S.
[xvii] Study investigated BNT162b2, mRNA-1273, ChAdOx-1 nCoV-19, and Ad26.COV2.S.
[xviii] Study investigated BNT162b2, mRNA-1273, ChAdOx-1 nCoV-19, and Ad26.COV2.S.
[xxiv] Study investigated BNT162b2, mRNA-1273, ChAdOx-1 nCoV-19, and Ad26.COV2.S.
[xxv] Study investigated BNT162b2, mRNA-1273, ChAdOx-1 nCoV-19, and Ad26.COV2.S.
[xxvi] Study investigated BNT162b2, mRNA-1273, ChAdOx-1 nCoV-19, and Ad26.COV2.S.

	94.6 (95% CI, 93.1-95.8)[Greece; January 2021 to December 2021; pooled effectiveness][3xii] *Age 15-59:* **96.9 (95% CI, 95.0-98.0)**[Greece; January 2021 to December 2021; pooled effectiveness][3xiii]	**94.6 (95% CI, 93.1-95.8)**[Greece; January 2021 to December 2021; pooled effectiveness][3xix] *Age 15-59:* **96.9 (95% CI, 95.0-98.0)**[Greece; January 2021 to December 2021; pooled effectiveness][3xx]	**96.9 (95% CI, 95.0-98.0)**[Greece; January 2021 to December 2021; pooled effectiveness][3xxvii]					
EFFECTIVENESS AGAINST VARIANTS								
Delta (1.617.2)	No new data	No new data	*Against Infection (Two Doses):* **83% (95% CI, 70.0-90.0)**[Thailand; 25 July 2021 to 23 October 2021][6]	No new data	*Against Infection (One Dose):* **10.7% (95% CI, −41.2-62.6)**[China][7xxviii]	*Against Infection (One Dose):* **10.7% (95% CI, −41.2-62.6)**[China][7xxxvi]	No new data	No new data

[xii] Study investigated BNT162b2, mRNA-1273, ChAdOx-1 nCoV-19, and Ad26.COV2.S.
[xiii] Study investigated BNT162b2, mRNA-1273, ChAdOx-1 nCoV-19, and Ad26.COV2.S.
[xix] Study investigated BNT162b2, mRNA-1273, ChAdOx-1 nCoV-19, and Ad26.COV2.S.
[xx] Study investigated BNT162b2, mRNA-1273, ChAdOx-1 nCoV-19, and Ad26.COV2.S.
[xxvii] Study investigated BNT162b2, mRNA-1273, ChAdOx-1 nCoV-19, and Ad26.COV2.S.
[xxviii] Study does not differentiate between inactivated vaccines, Sinopharm or CoronaVac.
[xxxvi] Study does not differentiate between inactivated vaccines, Sinopharm or CoronaVac.

					Against Symptomatic Infection (One Dose): **6.8% (95% CI, −47.4-61.0)**[China][7xxix] *Against Pneumonia (One Dose):* **11.6% (95% CI, −42.6-65.8)**[China][7xxx] *Against Infection (Two Doses):* **51.8% (95% CI, 20.3-83.2)**[China][7xxxi] *Against Symptomatic Infection (Two Doses):* **60.4% (95% CI, 31.8-88.9)**[China][7xxxii]	*Against Symptomatic Infection (One Dose):* **6.8% (95% CI, −47.4-61.0)**[China][7xxxvii] *Against Pneumonia (One Dose):* **11.6% (95% CI, −42.6-65.8)**[China][7xxxviii] *Against Infection (Two Doses):* **51.8% (95% CI, 20.3-83.2)**[China][7xxxix] **60% (95% CI, 49.0-69.0)** [Thailand; 25 July 2021 to 23 October 2021][6] *Against Symptomatic*		

[xxix]Study does not differentiate between inactivated vaccines, Sinopharm or CoronaVac.
[xxx]Study does not differentiate between inactivated vaccines, Sinopharm or CoronaVac.
[xxxi]Study does not differentiate between inactivated vaccines, Sinopharm or CoronaVac.
[xxxii]Study does not differentiate between inactivated vaccines, Sinopharm or CoronaVac.
[xxxvii]Study does not differentiate between inactivated vaccines, Sinopharm or CoronaVac.
[xxxviii]Study does not differentiate between inactivated vaccines, Sinopharm or CoronaVac.
[xxxix]Study does not differentiate between inactivated vaccines, Sinopharm or CoronaVac.

					Against Pneumonia (Two Doses): **78.4% (95% CI, 56.9-99.9)**[China][7xxxiii] *Against Severe or Critical Illness (Two Doses):* **100% (95% CI, 98.4-100.0)**[China][7xxxiv] **88% (95% CI, 0.02-0.45)**[China][8xxxv]	*Infection (Two Doses):* **60.4% (95% CI, 31.8-88.9)**[China][7xl] *Against Pneumonia (Two Doses):* **78.4% (95% CI, 56.9-99.9)**[China][7xli] *Against Severe or Critical Illness (Two Doses):* **100% (95% CI, 98.4-100.0)**[China][7xlii] **88% (95% CI, 0.02-0.45)**[China][8xliii]		
EFFECTIVENESS AGAINST HOSPITALIZATION								

[xxxiii]Study does not differentiate between inactivated vaccines, Sinopharm or CoronaVac.
[xxxiv]Study does not differentiate between inactivated vaccines, Sinopharm or CoronaVac.
[xxxv] Study does not differentiate between the inactivated vaccines, CoronaVac or BBIBP-CoRV.
[xl]Study does not differentiate between inactivated vaccines, Sinopharm or CoronaVac.
[xli]Study does not differentiate between inactivated vaccines, Sinopharm or CoronaVac.
[xlii]Study does not differentiate between inactivated vaccines, Sinopharm or CoronaVac.
[xliii] Study does not differentiate between the inactivated vaccines CoronaVac or BBIBP-CoRV.

Any SARS-CoV-2 Infection	Risk divided by 3.1 for mortality, 2.8 for ICU admission, and by 1.8 for hospitalization[France;18 January 2021 to 13 August 2021][9xliv]	Risk divided by 3.1 for mortality, 2.8 for ICU admission, and by 1.8 for hospitalization[France;18 January 2021 to 13 August 2021][9xlv]	Risk divided by 3.1 for mortality, 2.8 for ICU admission, and by 1.8 for hospitalization[France;18 January 2021 to 13 August 2021][9xlvi]	Risk divided by 3.1 for mortality, 2.8 for ICU admission, and by 1.8 for hospitalization[France;18 January 2021 to 13 August 2021][9xlvii]	No new data	*Two Doses:* **71.1% (95% CI, 62.9-77.6)** ≥14 days[Indonesia; 13 January 2021 to 30 June 2021][4]	No new data	No new data
Alpha	*One Dose:* **84.0% (95% CI, 72.6-90.6)** [France; January to June 2021][10xlviii] *Two Doses:* **96.2% (95% CI, 86.8-98.9**)[France; January to June 2021][10xlix]	*One Dose:* **84.0% (95% CI, 72.6-90.6)** [France; January to June 2021][10l] *Two Doses:* **96.2% (95% CI, 86.8-98.9**)[France; January to June 2021][10li]	*One Dose:* **84.0% (95% CI, 72.6-90.6)** [France; January to June 2021][10lii] *Two Doses:* **96.2% (95% CI, 86.8-98.9**)[France; January to June 2021][10liii]	**84.0% (95% CI, 72.6-90.6)** [France; January to June 2021][10liv]	No new data	No new data	No new data	No new data

[xliv] Study does not differentiate between Pfizer-BioNTech, AstraZeneca, Moderna, and Johnson & Johnson.
[xlv] Study does not differentiate between Pfizer-BioNTech, AstraZeneca, Moderna, and Johnson & Johnson.
[xlvi] Study does not differentiate between Pfizer-BioNTech, AstraZeneca, Moderna, and Johnson & Johnson.
[xlvii] Study does not differentiate between Pfizer-BioNTech, AstraZeneca, Moderna, and Johnson & Johnson.
[xlviii] Study does not differentiate between BNT162b2, mRNA-1273, ChAdOx1 nCoV-19, and Ad26.COV2-S.
[xlix] Study does not differentiate between BNT162b2, mRNA-1273, ChAdOx1 nCoV-19, and Ad26.COV2-S.
[l] Study does not differentiate between BNT162b2, mRNA-1273, ChAdOx1 nCoV-19, and Ad26.COV2-S.
[li] Study does not differentiate between BNT162b2, mRNA-1273, ChAdOx1 nCoV-19, and Ad26.COV2-S.
[lii] Study does not differentiate between BNT162b2, mRNA-1273, ChAdOx1 nCoV-19, and Ad26.COV2-S.
[liii] Study does not differentiate between BNT162b2, mRNA-1273, ChAdOx1 nCoV-19, and Ad26.COV2-S.
[liv] Study does not differentiate between BNT162b2, mRNA-1273, ChAdOx1 nCoV-19, and Ad26.COV2-S.

DURATION OF PROTECTION, TRANSMISSION & BREAKTHROUGH INFECTIONS								
Duration of Protection (Antibodies)	Abs elevated at 3 weeks (15,443.5 ± 9,655.2 AU/mL in Alinity RBD-IgG, 406.0 ± 242.7 SU/mL in HISCL S-IgG, and 23.6 ± 14.1 U/mL in STACIA Neut-Ab), but **waned after 6 months (1,576.8 ± 5080.2 AU/mL in Alinity RBD-IgG, 63.9 ± 195.9 SU/mL in HISCL S-IgG, and 3.3 ± 4.9 U/mL in STACIA Neut-Ab)**[Japan][11] *Neutralizing activity of Anti-Spike IgG:* **78.37%** for vaccinated HCWs and **88.82%** for HCWs vaccinated after infection[Romania; January 2021 to August 2021][12]	Highest antibody response was 41-45 days after first dose. Serum samples at 69-75 days, 130-135 days, and 221-229 days after vaccination showed positive, but waning levels of anti-SARS-CoV-2 Abs. [United States][13]	No new data	No new data	No new data	No new data	No new data	No new data

Duration of Protection (Vaccine Effectiveness)	*Against Any SARS-CoV-2 Infection:* Declined to **45% (aHR 0.55, 95% CI 0.49-0.61)** 26 weeks after second dose. [Wales; 07 December 2020 to 20 September 2021][14] *Against Severe Disease:* **Stable around 90%** across the entire follow up period irrespectively of which VOC that dominated. [Sweden; December 2020 to January 2022][15lv] **Maintained at >70%** after second dose with no evidence for declining effectiveness over	*Against Severe Disease:* **Stable around 90%** across the entire follow up period irrespectively of which VOC that dominated. [Sweden; December 2020 to January 2022][15lxiii] **High at >60%** after the second dose [Qatar; 23 December 2021 to 02 February 2022][16] *Against Infection with Variants:* **67%** during the Delta period, and showed a declining trend. By end of follow up when Omicron dominated, **no vaccine protection**	*Against Severe Disease:* **Stable around 90%** across the entire follow up period irrespectively of which VOC that dominated. [Sweden; December 2020 to January 2022][15lxxi] *Against Infection with Variants:* **67%** during the Delta period, and showed a declining trend. By end of follow up when Omicron dominated, **no vaccine protection** against infection remained. [Sweden; December 2020 to January 2022][15lxxii]	No new data	*Against Hospitalization:* **64% (95% CI, 59.0-69.0)** beyond the sixth month. [Morocco; February 2021 to October 2021][19]	No new data	No new data	No new data

[lv] Study does not differentiate between Pfizer, Moderna, and AstraZeneca
[lxiii] Study does not differentiate between Pfizer, Moderna, and AstraZeneca
[lxxi] Study does not differentiate between Pfizer, Moderna, and AstraZeneca
[lxxii] Study does not differentiate between Pfizer, Moderna, and AstraZeneca

	time.[Qatar; 23 December 2021 to 02 February 2022][16] *Against Infection with Variants:* **67%** during the Delta period, and showed a declining trend. By end of follow up when Omicron dominated, **no vaccine protection** against infection remained. [Sweden; December 2020 to January 2022][15lvi] *Against Symptomatic Infection (DELTA):* **Declined to 80% (95% CI, 74.0-84.0)** after ≥240 days.[Canada; 06	against infection remained. [Sweden; December 2020 to January 2022][15lxiv] *Against Symptomatic Infection (DELTA):* **Declined to 80% (95% CI, 74.0-84.0)** after ≥240 days.[Canada; 06 December 2021 to 26 December 2021][17lxv] *Against Symptomatic Infection (OMICRON):* **Declined to 1% (95% CI, -8.0-10.0)** 180-239 days after second dose.[Canada; 06 December 2021 to 26 December 2021][17lxvi] Peaked at **44.8% (95% CI, 16.0-**						

[lvi] Study does not differentiate between Pfizer, Moderna, and AstraZeneca.
[lxiv] Study does not differentiate between Pfizer, Moderna, and AstraZeneca
[lxv] Study does not differentiate between mRNA-based vaccines.
[lxvi] Study does not differentiate between mRNA-based vaccines.

	December 2021 to 26 December 2021][17lvii] *Against Symptomatic Infection (OMICRON):* **Declined to 1% (95% CI, -8.0-10.0)** 180-239 days after second dose.[Canada; 06 December 2021 to 26 December 2021][17lviii] **61.9% (95% CI: 49.9-71.1%)** in the first month after the second dose and **declined** to **10% (95% CI; -2.3-21.9) or less** starting from the 5th month after the second dose.[Qatar; 23 December 2021 to 02 February 2022][16]	**63.8)** in the first three months after the second dose and **declined to negligible levels**.[Qatar; 23 December 2021 to 02 February 2022][16] *Against Emergency Department or Urgent Care (DELTA):* From **86% (95% CI, 85.0-87.0)** at 14-179 days to **76% (95% CI, 75.0-77.0)** ≥180 days after 2nd dose[USA; August 2021 to January 2022][18lxvii] *Against Emergency Department or Urgent Care (OMICRON):* From **52% (95% CI, 46.0-58.0)** at						

[lvii] Study does not differentiate between mRNA-based vaccines.
[lviii] Study does not differentiate between mRNA-based vaccines.
[lxvii] Study does not differentiate between mRNA-based vaccines.

	Against Emergency Department or Urgent Care (DELTA): From **86% (95% CI, 85.0-87.0)** at 14-179 days to **76% (95% CI, 75.0-77.0)** ≥180 days after 2nd dose[USA; August 2021 to January 2022][18lix] *Against Emergency Department or Urgent Care (OMICRON):* From **52% (95% CI, 46.0-58.0)** at 14-179 days to **38% (95% CI, 32.0-43.0)** ≥180 days after 2nd dose[USA; August 2021 to January 2022][18lx]	14-179 days to **38% (95% CI, 32.0-43.0)** ≥180 days after 2nd dose[USA; August 2021 to January 2022][18lxviii] *Against Hospitalization (DELTA):* From **90% (95% CI, 89-90)** at 14-179 days to **81% (95% CI, 80-82)** ≥180 days after 2nd dose[USA; August 2021 to January 2022][18lxix] *Against Hospitalization (OMICRON):* From **81% (95% CI, 65-90)** at 14-179 days after to **57% (95% CI, 39-70)** ≥180 days after 2nd dose[USA; August						

[lix] Study does not differentiate between mRNA-based vaccines.
[lx] Study does not differentiate between mRNA-based vaccines.
[lxviii] Study does not differentiate between mRNA-based vaccines.
[lxix] Study does not differentiate between mRNA-based vaccines.

	Against Hospitalization (DELTA): From **90% (95% CI, 89-90)** at 14-179 days to **81% (95% CI, 80-82)** ≥180 days after 2nd dose[USA; August 2021 to January 2022][18lxi] *Against Hospitalization (OMICRON):* From **81% (95% CI, 65-90)** at 14-179 days after to **57% (95% CI, 39-70)** ≥180 days after 2nd dose[USA; August 2021 to January 2022][18lxii]	2021 to January 2022][18lxx]						
Breakthrough Infections	**0.011 to 0.0001 (per 100 individuals)** incidence of BTIs among	**0.011 to 0.0001 (per 100 individuals)** incidence of BTIs among	*BTI with Delta:* Of 164 fully vaccinated people, 162 (99%) were infected. **Case-fatality ratio was 1.2%**	No new data	No new data	No new data	No new data	No new data

[lxi] Study does not differentiate between mRNA-based vaccines.
[lxii] Study does not differentiate between mRNA-based vaccines.
[lxx] Study does not differentiate between mRNA-based vaccines.

	HCWs(systematic review)[20lxxiii] *BTI with Delta:* Incidence rate was **2.8 cases per 1000 person-days (P<0.001)** 60-day **hospitalization risk was 13.3%** (2489/18737)[United States][21]	HCWs(systematic review)[20lxxiv] *BTI with Delta:* BTI incidence rate was **1.6 cases per 1000 person-days (P<0.001)** and 60-day **hospitalization risk was 12.7%** (392/3078)[United States][21]	(2/162; lower compared to outbreak prior to vaccination at 6.9%) with **prolonged hospitalization** also less prevalent **at 8.5%** (compared to 25.0% of unvaccinated). [Korea][22]					
SAFETY AND ADVERSE EVENTS								
Rare adverse events	Acquired haemophilia A (AHA)[23,24], transient lymphedema[25], anti-LGI1 encephalitis[26], eosinophilic granulomatosis[27], pyoderma gangrenosum[28], transverse myelitis[29],	Acute vertigo[31]	Macular neuroretinopathy[33] ,takotsubo cardiomyopathy[34], Kawasaki[35], chilblain-like lesions[36], cytomegalovirus reactivation[37]	Acute vertigo[31]	Eosinophilic panniculitis[38]	No new data	No new data	No new data

[lxxiii] Study does not differentiate between mRNA-based vaccines.
[lxxiv] Study does not differentiate between mRNA-based vaccines.

	hepatotoxicity[30], hepatotoxicity[30], acute vertigo[31], leukocytoclastic vasculitis[32]							
Potential associated adverse events (Causal links not yet proven)	Lupus nephritis[39]	No new data	No new data	No new data	No new data	No new data	No new data	No new data
IMMUNOGENICITY								
General	*Anti-RBD-IgG:* 3-weeks post series: **15,443.5 ± 9,655.2 AU/mL** 6 mo post series: **1,576.8 ± 5080.2 AU/mL[11]** *IgG and IgA :* IgG: **679.0 (95% CI,626.1 – 733.7)** IgA: **5.3 (95% CI 3.9 – 7.1**)[40]	*IgG and IgA:* IgG: **618.6(95% CI 492.4 – 672.9)** IgA: **3.9 (95% CI 0.9 – 6.0)** [40]	*IgG and IgA:* IgG: **259.5 (95% CI 181.3 – 337.9)** IgA: **0.7 (95% CI 0.6 – 1.4 [40]**	No new data	**5.6-fold** decrease in seropositivity rate at 6-months post- 2 doses[41lxxv] *Anti-RBD-IgG:* 42 days post 1st : **376.5 (95% CI, 290.9-526.4**); p<0,001) BAU/ml 6 mo post 1st: **608.7 (95% CI, 574.6-647.1)** BAU/ml[42]	median antibody titer :**63.58 U/ml**[43] *anti-S IgG:* after 1 dose: **723.4 AU/ml (IQR, 109.6–1873)** after 2 doses: **1208 AU/ml (IQR, 706.1–2236) (p < 0.001)** 6 mo after 2 doses: **470.1 AU/ml (IQR, 191.3–1140)** [44]	*Against Delta:* GMT of **480**[45] **5.6-fold** decrease in seropositivity rate at 6-months post- 2 doses[41]	No new data

[lxxv] Study does not distinguish between Covishield and Covaxin

Omicron (B.1.1.529)	**15-fold** reduction in neutralization[lxxvi] 46 **34-fold** reduction in efficiency of neutralization compared to B.1. **12-fold** lower efficiency compared to Delta[47] **27-fold** reduction in efficiency of neutralization compared to wild type[lxxvii]48	Nabs below LLQQ against Omicron at 1 month post-primary series[49] **15-fold** reduction in neutralization[lxxviii] 46 **27-fold** reduction in efficiency of neutralization compared to wild type[lxxix]48	No new data	**15-fold** reduction in neutralization[lxxx] 46	*Hybrid immunity:* GMT: **52 (95% CI, 36-75) (p = 0.0011)** [50]	No new data	GMT of **75** compared to 706 for D614G (wild-type)[45]	No new data
CHILDREN VACCINATION								
Effectiveness	No new data	No new data	No new data	No new data	No new data	No new data	No new data	No new data
Safety and adverse events	*Myocarditis:* Incidence of **0.57 (95% CI, 0.36-0.90)** per 100,000 doses. Adjusted OR of **3.57 (95%**	*Myocarditis, Males 18-24:* **56.31 (95%CI, 47.08-67.34)** cases per million doses[54]	No new data	No new data	No new data	*Myocarditis:* Incidence of 0.31 **(95% CI, 0.13-0.66)** per 100,000 doses[51]	No new data	no new data

[lxxvi] Study does not distinguish between Pfizer, Moderna, or Janssen.
[lxxvii] Study does not distinguish between Pfizer and Moderna
[lxxviii] Study does not distinguish between Pfizer, Moderna, or Janssen.
[lxxix] Study does not distinguish between Pfizer and Moderna
[lxxx] Study does not distinguish between Pfizer, Moderna, or Janssen.

	CI, 1.93-6.6) compared to unvaccinated.[51] Rare risk of myocarditis, especially in young males[51,52] *CASES PER MILLION DOSES* *Myocarditis, Males 12-15:* **70.7 (95% CI, 61.68-81.11)** *Myocarditis, Males 16-17 :* **105.9 (95% CI, 91.65-122.27)** *Myocarditis, Males 18-24 :* **52.43 (95% CI, 45.56-60.33)** Oster Me, 2022 #14599} Rare risk of multi-system inflammatory syndrome (MIS-C)[53]							
Immunogenicity	*AGAINST OMICRON:*	No new data	No new data	No new data	No new data	Clinical trial pending[56]	No new data	No new data

	38.2% of BNT162b2 vaccine recipients showed serum neutralization titer at or above detection threshold GMT: **7.2 (95% CI, 6-8.6)**[55]							
				BOOSTER DOSES				
Efficacy	No new data	No new data	No new data	*Against Moderate to Severe/critical Infection:* **75.2% (95% CI, 54.6-87.3)**[57] *Against Asymptomatic Infections:* **75.6% (95% CI, 55.5-99.9)**[57] *Against Severe/Critical Infection:* **100% (95% CI, 32.6-100)**[57]	No new data	No new data	No new data	No new data
Effectiveness against variants	**Delta (B.1.617):** *Against Symptomatic Infection:*	**Delta (B.1.617):** *Against Symptomatic Infection:*	No new data	No new data	No new data	No new data	No new data	No new data

	92.3% (95% CI, 91-93) compared to unvaccinated [USA; December 2021-January 2022][58] **83% (95% CI, 81-84)** compared to 2 doses [USA; December 2021-January 2022][58] *Against Emergency Department and Urgent Care:* **94% (95% CI, 93-94)** [USA; August 2021-January 2022][18lxxxi] *Against Hospitalization:* **94% (95% CI, 93-95)** [USA; August 2021-January 2022][18lxxxii] **Omicron (B.1.1.529):**	**95.5% (95% CI, 95-96)** compared to unvaccinated [USA; December 2021-January 2022][58] **87% (95% CI, 85-89)** compared to 2 doses [USA; December 2021-January 2022][58] *Against Emergency Department and Urgent Care:* **94% (95% CI, 93-94)** [USA; August 2021-January 2022][18lxxxv] *Against Hospitalization:* **94% (95% CI, 93-95)** [USA; August 2021-January 2022][18lxxxvi] **Omicron (B.1.1.529):**							

[lxxxi] Study does not differentiate between mRNA-based vaccines.
[lxxxii] Study does not differentiate between mRNA-based vaccines.
[lxxxv] Study does not differentiate between mRNA-based vaccines.
[lxxxvi] Study does not differentiate between mRNA-based vaccines.

	Against Symptomatic Infection: **65% (95% CI, 62-68)** compared to unvaccinated [USA; December 2021-January 2022][58] **65% (95% CI, 63-68)** compared to 2 doses [USA; December 2021-January 2022][58] *Against Emergency Department and Urgent Care:* **82% (95% CI, 79-84)** [USA; August 2021-January 2022][18lxxxiii] *Against Hospitalization:* **90% (95% CI, 80-94)** [USA; August 2021-January 2022][18lxxxiv]	*Against Symptomatic Infection:* **72% (95% CI, 69-74)** compared to unvaccinated [USA; December 2021-January 2022][58] **69% (95% CI, 66-72)** compared to 2 doses [USA; December 2021-January 2022][58] *Against Emergency Department and Urgent Care:* **82% (95% CI, 79-84)** [USA; August 2021-January 2022][18lxxxvii] *Against Hospitalization:* **90% (95% CI, 80-94)** [USA; August 2021-January 2022][18lxxxviii]						

[lxxxiii] Study does not differentiate between mRNA-based vaccines.
[lxxxiv] Study does not differentiate between mRNA-based vaccines.
[lxxxvii] Study does not differentiate between mRNA-based vaccines.
[lxxxviii] Study does not differentiate between mRNA-based vaccines.

Immunogenicity	*Neutralizing Antibodies (FRNT50):* **1704 GMT**[59] **891.4 GMT**[60] *Anti-S Spike IgG:* **22185 U/mL (95% CI, 21406-22990)** 14 days after booster[61]	No new data	*Anti-RBD IgG:* **246.4 GMT (95% CI, 92.11-259.47)**[62]	No new data	*Neutralizing Antibodies:* **263.9 GMT (95% CI, 223.7-311.3)**[63lxxxix]	*Neutralizing Antibodies:* **263.9 GMT (95% CI, 223.7-311.3)** 63xc	No new data	No new data
Immunogenicity against variants	**Beta (B.1.351):** *Neutralizing Antibodies (FRNT50):* **651 GMT**[59] **152.2 GMT**[60] **Delta (B.1.617):** *Neutralizing Antibodies (FRNT50):* **881 GMT**[59] **430.5 GMT**[60]	**Omicron (B.1.1.529):** *Neutralizing Antibodies:* **38-fold** increase in neutralization compared to 2 doses[xcii48]	No new data	No new data	**Alpha (B.1.1.7):** *Neutralizing Antibodies:* **319.1 GMT (95% CI, 274.1-371.5)** **10.8x higher** than 2 doses[63xciii] **Beta (B.1.351):** *Neutralizing Antibodies:* **194.9 GMT (95% CI, 160.9-236.1)** **17.9x higher** than 2 doses[63xciv]	**Alpha (B.1.1.7):** *Neutralizing Antibodies:* **319.1 GMT (95% CI, 274.1-371.5)** **10.8x higher** than 2 doses[63xcvi] **Beta (B.1.351):** *Neutralizing Antibodies:* **194.9 GMT (95% CI, 160.9-236.1)**	No new data	No new data

[lxxxix] Study does not differentiate between inactivated vaccines.
[xc] Study does not differentiate between inactivated vaccines.
[xcii] Study does not differentiate between Pfizer and Moderna
[xciii] Study does not differentiate between inactivated vaccines.
[xciv] Study does not differentiate between inactivated vaccines.
[xcvi] Study does not differentiate between inactivated vaccines.

	Omicron (B.1.1.529): Neutralizing Antibodies *(FRNT50):* **200 GMT** **9.9-fold decrease** compared to Delta[59] **107.6 GMT**[60] **38-fold** increase in neutralization compared to 2 doses[xci48]				**Delta (B.1.617.2):** *Neutralizing Antibodies:* **202.1 GMT (95% CI, 171.3-238.4)** **7.7x higher** than 2 doses[63xcv]	**17.9x higher** than 2 doses[63xcvii] **Delta (B.1.617.2):** *Neutralizing Antibodies:* **202.1 GMT (95% CI, 171.3-238.4)** **7.7x higher** than 2 doses[63xcviii]		
Duration of Protection	*Half-life:* **44 days** (steeper than 2 doses [54 days])[61]							
4th Dose	*Confirmed Infections:* **2.0 lower rate (95% CI, 2.0-2.1)** than 3 doses[64] *Severe Illness:* **4.3 lower rate** than 3 doses[64]	No new data	No new data	No new data	No new data	No new data	No new data	No new data

[xci] Study does not differentiate between Pfizer and Moderna
[xcv] Study does not differentiate between inactivated vaccines.
[xcvii] Study does not differentiate between inactivated vaccines.
[xcviii] Study does not differentiate between inactivated vaccines.

HETEROLOGOUS BOOSTER DOSES								
Vaccine Schedule	*Heterologous 1:* **mRNA1273/BNT162b2** *Heterologous 2:* **Ad26.CoV.2.S/BNT162b2** *Heterologous 3:* **ChAdOx1/BNT162b2** *****Received BNT162b2 as booster dose	*Heterologous 1:* **BNT162b2/mRNA1273** *Heterologous 2:* **Ad26.CoV.2.S/mRNA1273** *Heterologous 3:* **ChAdOx1/mRNA1273** *****Received mRNA1273 as booster dose	*Heterologous 1:* **BNT162b2/ChAdOx1*** *****Received ChAdOx1 as booster dose	*Heterologous 1:* **BNT162b2/Ad26.CoV.2.S** *Heterologous 2:* **mRNA1273/Ad26.CoV.2.S** *Heterologous 3:* **ChAdOx1/Ad26.CoV.2.S.** *****Received Ad26.CoV.2 as booster dose	*Heterologous 1:* **SinoPharm/BNT162b2** *Heterologous 2:* **ChAdOx1/SinoPharm*** *Received SinoPharm as booster dose	*Heterologous 1:* **CoronaVac/ChAdOx1** *Heterologous 2 :* **CoronaVac/BNT162b2** *Heterologous 3 :* **CoronaVac/SinoPharm** *Heterologous 4:* **CoronaVac/mRNA1273** *****Received CoronaVac as initial regimen	No available data	*Heterologous 1:* **BNT162b2/NVX-CoV2373** *Heterologous 2:* **ChAdOx1/NVX-CoV2373** *****Received NVX-CoV2373 as booster dose
Effectiveness	**Heterologous 1:** *Incidence of Infection:* **15% higher** than mRNA1273 homologous booster (Adjusted rate ratio: **1.15** [95% CI, 0.87-1.52])*[65] **Heterologous 2:**	**Heterologous 1:** *Incidence of Infection:* **14% lower** than BNT162b2 homologous booster (Adjusted rate ratio: **0.86** [95% CI, 0.63-1.17])*[65] **Heterologous 2:**	No new data	**Heterologous 1:** *Incidence of Infection:* **146% higher** than BNT162b2 homologous booster (Adjusted rate ratio: **2.46** [95% CI, 1.07-5.66])*[65] **Heterologous 2:**	No new data	*Heterologous 1:* **86% (95% CI, 74.0-93.0)** [Thailand; July-October 2021][6] *Heterologous 2:* **98% (95% CI, 87.0-100.0)** [Thailand; July-October 2021][6]	No new data	No new data

	Incidence of Infection: **42% lower** than Ad26.COV2.S homologous booster (Adjusted rate ratio: **0.58** [95% CI, 0.43-0.78])[65] *Results not statically significant	*Incidence of Infection:* **55% lower** than Ad26.COV2.S homologous booster (Adjusted rate ratio: **0.45** [95% CI, 0.35-0.57])[65] *Results not statically significant		*Incidence of Infection:* **22% lower** than mRNA1273 homologous booster (Adjusted rate ratio: **0.78** [95% CI, 0.32-1.90])*[65] *Results not statically significant				
Immunogenicity	**Heterologous 3:** *Neutralizing Antibodies (FRNT50):* **1543 GMT**[59] *Anti-RBD IgG:* **2363 GMT (95% CI, 2005.6-2786.1)** 14 days after booster[62] *Anti-S Spike IgG:* **19203 U/mL (95% CI, 18094-20377)** 14 days after booster[61]	No new data	No new data	No new data	**Heterologous 2:** *Anti-RBD IgG:* **128.1 GMT (95% CI, 93.5-175.4)** 14 days after booster[62]	**Heterologous 1:** *Anti-RBD IgG:* **1358.0 GMT (95% CI, 1141.8-1615.1)** 14 days after booster[62] *Total RBD Ig:* **12111 U/mL** 28 days after booster[66] *T Cell (IFN-y CD4+/IFN-y CD4+ and CD8+):* **86%/93% seropositivity** 28 days after booster[66] **Heterologous 2:** *Anti-RBD IgG:* **5152.2 GMT (95% CI, 4491.7-**	No new data	No new data

						5909.8) 14 days after booster[62] *Total RBD Ig:* **21053 U/mL** 28 days after booster[66] *T Cell (IFN-γ CD4+/IFN-γ CD4+ and CD8+):* **96%/100% seropositivity** (95% CI, 190-402) 28 days after booster[66] **Heterologous 3:** *Anti-RBD IgG:* **154.1 GMT (95% CI, 92.11-259.47)** 14 days after booster[62] *Total RBD Ig:* **1295 U/mL** 28 days after booster[66] *T Cell (IFN-γ CD4+/IFN-γ CD4+ and CD8+):* **43%/47% seropositivity**[66] **Heterologous 4:** *Total RBD Ig:*		

						33519 U/mL 28 days after booster[66] *T Cell (IFN-γ CD4+/IFN-γ CD4+ and CD8+):* **90%/93% seropositivity**[66]		
Immunogenicity against variant	**BETA (B.1.351):** **Heterologous 3:** *Neutralizing Antibodies (FRNT50):* **651 GMT**[59] **DELTA (B.1.617):** **Heterologous 3:** *Neutralizing Antibodies (FRNT50):* **881 GMT**[59] **OMICRON (B.1.1.529):** **Heterologous 3:** *Neutralizing Antibodies (FRNT50):* **200 GMT**	No new data	No new data	No new data	No new data	**OMICRON (B.1.1.529):** **Heterologous 1:** *NAbs titers:* **250 GMT** (95% CI, 169-368) 28 days after booster **4.0-fold decrease** compared to **Delta**[66] **Heterologous 2:** *NAbs titers:* **277 GMT** (95% CI, 190-402) 28 days after booster **4.6-fold decrease** compared to **Delta**[66] **Heterologous 3:** *NAbs titers:*	No new data	No new data

	9.9-fold decrease compared to Delta[59]					**24.6 GMT** (95% CI, 18.1-33.5) 28 days after booster **2.8-fold decrease** compared to **Delta**[66] **<u>Heterologous 4:</u>** *<u>NAbs titers:</u>* **512 GMT** (95% CI, 359-732) 28 days after booster **4.2-fold decrease** compared to **Delta**[66]		
Duration of protection	*<u>Half-life:</u>* **40 days** (steeper than 2 doses [80 days])[61]	No new data	No new data	No new data	No new data	No new data	No new data	No new data

ANNEXES

Full Synoptic Table

Full Synoptic table about SARS-CoV-2 vaccines accepted in the WHO's Emergency Use Listing containing old information (as of 14 February 2022)

	BNT162b2/ COMIRNATY (Pfizer-BioNTech, USA)	Spikevax/ Moderna COVID-19 Vaccine/ mRNA-1273 (Moderna, USA)	Vaxzevria/ ChAdOx1 nCoV-19/ AZD1222/ Covishield (AstraZeneca/Oxford, UK, India)	Janssen COVID-19 vaccine/Johnson & Johnson (Janssen, USA)	Covilo/ BBIBP-CorV (Sinopharm, China)	CoronaVac (Sinovac, China)	COVAXIN / BBV152 (Bharat Biotech, India)	Nuvaxovid/ NVX-CoV2373/ Covovax (Novavax, Czech Republic, India)
GENERAL VACCINE INFORMATION								
Platform	mRNA-based vaccine	mRNA-based vaccine	Non-replicating vector-based vaccine	Non-replicating vector-based vaccine	Inactivated virus (Vero cell)	Inactivated virus (Vero cell)	Whole-virion inactivated Vero cell	Recombinant protein (nanoparticle) vaccine with Matrix-M adjuvant
Dose and frequency	2 doses, 21 days apart	2 doses, 28 days apart	2 doses, 4-12 weeks apart	1 dose, once [Phase III trials currently testing 2-dose regime, 56 days apart][xcix]	2 doses, 21 days apart	2 doses, 14 days apart	2 doses, 28 days apart	2 doses, 21 days apart

[xcix] Johnson & Johnson Announces Real-World Evidence and Phase 3 Data Confirming Strong and Long-Lasting Protection of Single-Shot COVID-19 Vaccine in the U.S. *Johnson & Johnson*. https://www.jnj.com/johnson-johnson-announces-real-world-evidence-and-phase-3-data-confirming-strong-and-long-lasting-protection-of-single-shot-covid-19-vaccine-in-the-u-s

Target population	12 years old and over	12 years old and over	18 years old and over	18 years old and over	18 years old and over	18 years old and over	18 years old and over	18 years old and over
Storage conditions	2°C to 8 °C (for 1 month)	2°C to 8 °C (for 1 month)	2°C until 8 °C	2°C to 8 °C (for 3 months)	2°C until 8 °C	2°C until 8 °C	2°C until 8 °C	2°C to 8 °C
Approving authorities	FDA (11.12.20)[c]; EMA (21.12.20); WHO EUL (31.12.20); and list of 137 countries (including Switzerland – approved on 20.12.20)	FDA (18.12.20); EMA (06.01.21); WHO EUL (30.04.21); and list of 85 countries (including Switzerland – approved 12.01.21)	FDA (awaiting on approval); EMA (29.01.21); WHO EUL (15.02.21); and list of 137 (Vaxzevria) and 47 (Covishield) countries (Switzerland awaiting on approval)	FDA (27.02.21); EMA (11.03.21), WHO EUL (12.03.21), and list of 106 countries (including Switzerland – approved 22.03.21)	WHO EUL (07.05.21); and list of 88 countries (e.g., Argentina, Bahrain, Brazil, China, Indonesia, United Arab Emirates, Zimbabwe)	WHO EUL (01.06.21), and list of 53 countries (e.g., Albania, Chile, Egypt, Hong Kong, Malaysia, Tunisia, Turkey, Ukraine)	WHO EUL (03.11.21) and list of 13 countries (Guyana, Inidia, Iran, Mauritius, Mexico, Nepal, Paraguay, Philippines & Zimbabwe)	WHO EUL (17-20.12.21) and list of 32 countries (Nuvaxovid) and 3 countries (Covovax)
Booster shot approving authorities	EMA approved booster for those aged 18 and above, 6 months after the 2nd dose FDA approved booster for those ages 16 and above, 6 months after the 2nd dose[ci]	EMA authorised booster dose for people aged 18 years and above[ciii] FDA approved third booster dose for individuals >65 and high-risk individuals, 6	-	EMA authorised	-	-	-	-

[c] Pfizer-BioNTech's Comirnaty Vaccine received full FDA approval on 23 August 2021 for people age 16 and above, moving it beyond emergency use status. https://www.fda.gov/news-events/press-announcements/fda-approves-first-covid-19-vaccine

[ci] FDA authorizes booster dose of Pfizer-BioNTech COVID-19 vaccine for certain populations. *FDA News Release*. https://www.fda.gov/news-events/press-announcements/fda-authorizes-booster-dose-pfizer-biontech-covid-19-vaccine-certain-populations

[ciii] Comirnaty and Spikevax: EMA recommendations on extra doses and boosters. *European Medicines Agency*. https://www.ema.europa.eu/en/news/comirnaty-spikevax-ema-recommendations-extra-doses-boosters

	Swissmedic approves booster dose for everyone aged 16 and over[cii]	months after the 2nd dose[civ] Swissmedic approves booster dose for adults aged 18 and over[cv]						
EFFECTIVENESS AGAINST ANY SARS-COV-2 INFECTION								
	BNT162b2/ COMIRNATY	**Spikevax/ Moderna COVID-19 Vaccine/ mRNA-1273**	**Vaxzevria/ ChAdOx1 nCoV-19/ AZD1222/ Covishield**	**Janssen COVID-19 vaccine/Johnson & Johnson**	**Covilo/ BBIBP-CorV**	**CoronaVac**	**COVAXIN / BBV152**	**Nuvaxovid/ NVX-CoV2373/ Covovax**
Effectiveness single dose	*Against any SARS-CoV-2 infection:* **70%**. **77.6%** (95% CI, 70.9-82.7) **36.8%** (95% CI, 33.2-40.2) [3 weeks after first dose] **57%** (95% CI, 52-61; Spain) [Apr-Aug]	*Against SARS-CoV-2 infection:* **60%** (95% CI, 57-64; >2 weeks after dose).[cvii] **88.9%** (95% CI, 78.7-94.2) **66%** (95% CI, 56-73; Spain) [Apr-Aug] **69%** (pooled meta-analysis) **64%** (95% CI, 59%-68%; United	*Against SARS-CoV-2 infection:* **31.4%** (95% CI, 25.7-36.7; Norway) [Jan-Sep] *Symptomatic disease:* **67%** **49%** (95% CI, 32.0-62.0; India) [Apr-Jun]	*Against SARS-CoV-2 infection:* **50.6%** (95% CI, 14.0-74.0) [<2 weeks after dose]; **76.7%** (95% CI, 30.3-95.3) [>2 weeks after dose]; **79%** (95% CI, 77-80) (when corrected for under-recording, VE was estimated	Partial protection.[cxiv]	**15.5%** for preventing COVID-19; **37.4%** for preventing hospitalization; **44.7%** for preventing admission to the ICU; and **45.7%** for preventing of COVID-19 related death.	*Against symptomatic disease*: **45%** (95% CI,6.0-68.0; India) [Apr-Jun] **40%** (95% CI, -21-71; India) less than 7 days after first dose [April-May]	Ongoing studies in South Africa and the United Kingdom

[cii] COVID-19 vaccine from Pfizer/BioNTech: Swissmedic approves the extension of the booster dose to everyone aged 16 years and over. *Swissmedic*. https://www.swissmedic.ch/swissmedic/en/home/news/coronavirus-covid-19/covid-19-impfstoff-pfizer-biontech-boosterdosis.html

[civ] F.D.A. Panel recommends booster for many Moderna vaccine recipients. *The New York Times*. https://www.nytimes.com/2021/10/14/us/politics/fda-moderna-vaccine-boosters.html

[cv] Swissmedic approves booster dose of the Moderna COVID-19 vaccine for adults aged 18 and over. *Swissmedic*. https://www.swissmedic.ch/swissmedic/en/home/news/coronavirus-covid-19/auffrischimpfung-boosterdosis-impfstoff-moderna-ab-18-jahren.html

[cvii] mRNA-aggregated data (results do not disaggregate between BNT162b2 and mRNA-1273).

[cxiv] Study did not report numerical data on vaccine effectiveness. Further studies are required to validate results.

	72% (pooled meta-analysis) **64%** (95% CI, 59%-68%; United States) [May to July 2021][cvi] **19.6%** (95% CI, 17.3-21.9; Norway) [Jan-Sep] *Against symptomatic disease*: **66%** (95% CI, 60-71; Spain) [Apr-Aug] *Individuals ≥70:* Symptomatic disease: **58%**.	States) [May to July 2021][cviii] **39.6%** (95% CI, 36.3-42.8; Norway) [Jan-Sep] *Against symptomatic disease*: **71%** (95% CI, 61-79; Spain) [Apr-Aug] *Individuals ≥70:* Symptomatic disease: **64%** (95% CI, 46-78; >2 weeks after dose).[cix]	**41%** (95% CI, 34-48; Spain) [Apr-Aug] **51%** (pooled meta-analysis) **46%** (95% CI, 37-54; Spain) [Apr-Aug] *Individuals ≥70:* Symptomatic disease: **58%**.	to be **69%** (95% CI, 67-71). **71%** (95% CI, 56-81) [11 March – 15 August]. **61%** (95% CI, 29-84) [January-June] **50.9%** (95% CI, 35.1-63.0) [June-September; Brazil] **50.0%** (95% CI, 42.0-57.0; Spain) [Apr-Aug] **73.6%** (95% CI, 65.9-79.9; US) [Feb-Jul] **82.3%** (95% CI, 75.1-87.4%; USA) [16 Dec 2020 to 30 Sep 2021][cx] Among individuals with history of infection, VE against symptomatic infection ≥ 14 days from vaccine series completion was 44.0% (95%		**18.6%** (95% CI, 17.6-19.6) against SARS-CoV-2 infection, **28.1%** (95% CI, 26.3-29.9) against hospitalization, **28.5%** (95% CI, 25.4-31.4) against ICU admission, and **29.4%** (95% CI, 26.7.3-31.9) against death [January-April]	**1%** (95% CI, -30-25); India) at least 7 days after first dose [April-May] **-1%** (95% CI, -51-33; India) at least 21 days after first dose [April-May]	

[cvi] Results do not disaggregate between mRNA vaccines, BNT162b2 and mRNA-1273.
[cviii] Results do not disaggregate between mRNA vaccines, BNT162b2 and mRNA-1273.
[cix] mRNA-aggregated data (results do not disaggregate between BNT162b2 and mRNA-1273).
[cx] Study does not differentiate between Pfizer, Moderna, and Janssen.

				CI, 31.5-54.2) for Ad26.COV2.S. [Brazil] *Symptomatic disease*: **54%** (95% CI, 45-62; Spain) [Apr-Aug] **81%** (95% CI, 79-84) for preventing hospitalization when corrected for under-recording, VE was estimated to be **73%** (95% CI, 69-76). **75%** (95% CI, 65-82) against severe critical COVID-19 **66.1%** against moderate to severe-critical COVID-19 cases after 28 days [ENSEMBLE study; Sep 2020-Nov 2021) **85.4%** against severe COVID-19 cases after 28 days [ENSEMBLE					

				study; Sep 2020-Nov 2021) *<u>Individuals ≥50:</u>* 68% (95% CI, 50-79). VE against severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) infection was 89.1% (95% CI 85.6–92.6%), VE against COVID-19-related hospitalization was 97.2% (95% CI 96.1–98.3%), and VE against admission to the intensive care unit 97.4% (95% CI 96.0–98.8%), and against death was 99.0% (95% CI 98.5–99.6%). [Overall average from literature review and meta-analysis][cxi]				

[cxi] Study does not differentiate between Pfizer-BioNTech, Moderna, Oxford-AstraZeneca, CoronaVac, and Janssen.

				VE against infection in the general population aged ≥16 years was 86.1% (95% CI 77.8–94.4%), for the elderly VE was 83.8% (95% CI 77.1–90.6%), and for healthcare workers VE was 95.3% (95% CI 92.0–98.6%).[Overall average from literature review and meta-analysis][cxii] Adjusted VE was 71% (95% confidence interval, 49%-83%) among fully vaccinated participants reporting contact with persons with COVID-19 versus 80% (95% CI, 72%-86%) among those without contact.[United States; February				

[cxii] Study does not differentiate between Pfizer-BioNTech, Moderna, Oxford-AstraZeneca, CoronaVac, and Janssen.

				2021 to September 2021][cxiii]				
Effectiveness of two doses	*SARS-Cov-2 infection:* **85%**. **94.6%**. **94.5%**. **76%** (95% CI, 69-81) [Jan-Jul]. **88.8%** (95% CI, 84.6-91.8) [Dec 2020-May] **74%** (95% CI, 72-76) [Jan-Jun] **77.5%** (95% CI, 76.4-78.6) [first month after second dose] **47%** (95% CI, 43-51) [5 months after second dose] **56%** (95% CI, 53-59) [4 months after second dose] **69%** (95% CI, 66-72; Spain) [Apr-Aug] **88%** (pooled meta-analysis) **84%** (95% CI, 40-96; Italy) [27 Dec	*SARS-Cov-2 infection:* **100%**. **86%** (95% CI, 81-90.6) [January-July]. **96.3%** (95% CI, 91.3-98.4) [December-May] **85%** (95% CI, 80-90) [January-June] **71%** (95% CI, 68-74) [4 months after second dose] **63%** (95% CI, 44-76) [June-August] **82%** (95% CI, 78-86; Spain) [Apr-Aug] **80%** (pooled meta-analysis)	*Asymptomatic efficacy:* 61.9% *SARS-CoV-2 infection*: **53%** (95% CI, 12-84) [January-June] **27%** (95% CI, 17-37) [4 months after second dose] **88%** (95% CI, 79.0-94.0; India) [Apr-Jun] **54.0%** (95% CI, 48-60; Spain) [Apr-Aug] **43.4%** (95% CI, 4.4-66.5; Norway) [Jan-Sep] **80%** (95% CI; 73-86; India) [May - July 2021]	Not Applicable (one dose schedule)	Partial protection.[cxxxix]	**65.9%** for preventing COVID-19; **87.5%** for preventing hospitalization; **90.3%** for preventing ICU admission; and **86.3%** for preventing COVID-19 related death. **52.7%** (95% CI, 52.1-53.4) against SARS-CoV-2 infection, **72.8%** (95% CI, 71.8-73.7) against hospitalization, **73.8%** (95% CI, 72.2-75.2) against ICU admission, and **73.7%** (95% CI, 72.3-75.0) against death [January-April]	*Against symptomatic disease*: **71%** (95% CI, 41-85; India) [Apr-Jun] VE against symptomatic COVID-19 (second dose administered at least 14 days before RT-PCR testing) **50%** (95%CI 33.0-62.0; India)[April 15 to May 15 2021] *Effectiveness of full vaccination:* **69%** (95% CI; 54-79; India) [May - July 2021] **50%** (95% CI, 33-62; India) 14 days after second dose [April-May]	Ongoing studies in South Africa and the United Kingdom **89.7%** protection against SARS-CoV-2 infection (95% CI, 80.2-94.6; United Kingdom)

[cxiii] Study does not differentiate between Pfizer, Moderna, and Janssen

[cxxxix] Study did not report numerical data on vaccine effectiveness. Further studies are required to validate results. Death reports on fully vaccinated doctors (10 cases during June 2021 in Indonesia). It may be related to new variants [media report]. Indonesian Covid deaths add to questions over Sinovac vaccine. *The Guardian* [press release]. https://www.theguardian.com/world/2021/jun/28/indonesian-covid-deaths-add-to-questions-over-sinovac-vaccine

	2020 – 24 Mar 2021] 14-21 days from the first dose and **95%** (95% CI, 62-99; Italy) [27 Dec 2020 – 24 Mar 2021] at least 7 days from the second dose **95%** (95% CI, 93%-96%; United States) [May to July 2021][cxv] **69.7%** (95% CI, 68.6-70.8; Norway) [Jan-Sep] **82.3%** (95% CI, 75.1-87.4%; USA) [16 Dec 2020 to 30 Sep 2021][cxvi] **75%** (95% CI, 73-77; Sweden) [27 Dec 2020-2 Nov 2021] VE was 49% (95% CI 22.0%-67.0%)[England]	**95%** (95% CI, 93%-96%; United States) [May to July 2021][cxxv] **78.2%** (95% CI, 76.7-79.6; Norway) [Jan-Sep] **82.3%** (95% CI, 75.1-87.4%; USA) [16 Dec 2020 to 30 Sep 2021][cxxvi] **85%** (95% CI, 82-87; Sweden) [27 Dec 2020-2 Nov 2021] For those fully vaccinated the observed effectiveness of the Moderna vaccine was 98.1%. [Overall average from literature review and meta-analysis]	**60%** (95% CI, 50-67; Sweden) [27 Dec 2020-2 Nov 2021] For BNT162b2 and AZD1222, VE was higher across all age-groups from 14 days after dose two compared to one dose, but the magnitude varied with dose interval. [England] VE was approximately **96.7%** (95% CI, 87.9-99.9) 7 days after the second dose [France; December 2020 to June 2021][cxxxiv] VE against severe acute respiratory syndrome			Among individuals with history of infection, VE against symptomatic infection ≥ 14 days from vaccine series completion was 39.4% (95% CI, 36.1-42.6) for CoronaVac. [Brazil] For those fully vaccinated the observed effectiveness of the CoronaVac vaccine was found to be 65.7%.[Overall average from literature review and meta-analysis] VE against infection in the general population	**47%** (95% CI, 29-61; India) 14 days after second dose – excluding participants with previous SARS-CoV-2 infections [April-May] **46%** (95% CI, 22-62; India) 28 days after second dose [April-May] **57%** (95% CI, 21-76; India) 42 days after second dose [April-May]	

[cxv] Results do not disaggregate between mRNA vaccines, BNT162b2 and mRNA-1273.
[cxvi] Study does not differentiate between Pfizer, Moderna, and Janssen.
[cxxv] Results do not disaggregate between mRNA vaccines, BNT162b2 and mRNA-1273.
[cxxvi] Study does not differentiate between Pfizer, Moderna, and Janssen.
[cxxxiv] Study does not differentiate between Comirnaty and Vaxrevria

	Higher dose two VE was observed with >6 week interval between BNT162b2 doses compared to the standard schedule. Specifically, antibody levels 14–35 days after dose two are higher in BNT162b2 recipients with an extended vaccine interval (65–84 days) compared with those vaccinated with a standard (19–29 days) interval. Following the extended schedule, antibody levels were 6-fold higher at 14–35 days post dose 2 for BNT162b2 than AZD1222. [England]	VE against symptomatic SARS-CoV-2 infection was estimated at 94% (95% CI, 86–97%) for mRNA-1273.[Based on estimations from a Rapid Review] VE greater than 26 weeks from a second dose was 65% (95% CI, 65.0-66.0) and VE against SARS-CoV-2 related hospitalizations for individuals greater than 26 weeks from a second dose was 73% (95% CI, 71.0-75.0) for Moderna.[United States] VE was 69% (95% CI, 67.0% to 70.0%) against SARS-CoV-2	coronavirus 2 (SARS-CoV-2) infection was 89.1% (95% CI 85.6–92.6%), VE against COVID-19-related hospitalization was 97.2% (95% CI 96.1–98.3%), and VE against admission to the intensive care unit 97.4% (95% CI 96.0–98.8%), and against death was 99.0% (95% CI 98.5–99.6%). [Overall average from literature review and meta-analysis][cxxxv] VE against infection in the general population aged ≥16 years was 86.1% (95% CI 77.8–94.4%), for the elderly VE was 83.8% (95% CI 77.1–90.6%), and for healthcare			aged ≥16 years was 86.1% (95% CI 77.8–94.4%), for the elderly VE was 83.8% (95% CI 77.1–90.6%), and for healthcare workers VE was 95.3% (95% CI 92.0–98.6%).[Overall average from literature review and meta-analysis][cxl] VE against severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) infection was 89.1% (95% CI 85.6–92.6%), VE against COVID-19-related hospitalization was 97.2% (95% CI 96.1–98.3%), and VE against admission to the intensive care unit 97.4% (95%		

[cxxxv] Study does not differentiate between Pfizer-BioNTech, Moderna, Oxford-AstraZeneca, CoronaVac, and Janssen.
[cxl] Study does not differentiate between Pfizer-BioNTech, Moderna, Oxford-AstraZeneca, CoronaVac, and Janssen.

	For BNT162b2 and AZD1222, VE was higher across all age-groups from 14 days after dose two compared to one dose, but the magnitude varied with dose interval. [England] VE greater than 26 weeks from a second dose was 45% (95% CI, 44.0-47.0) for Pfizer.[United States] For those fully vaccinated the observed effectiveness of the Pfizer-BioNTech vaccine was 91.2%. [Overall average	infection and 86% (95% CI, 82.0% to 89.0%) against SARS-CoV-2–related death or more days after the second vaccine dose and was similar when follow-up period was extended. VE against infection decreased with increasing age and comorbidity burden. [United States, December 2020 to March 2021][cxxvii] VE against severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) infection was 89.1% (95% CI 85.6–92.6%), VE	workers VE was 95.3% (95% CI 92.0–98.6%).[Overall average from literature review and meta-analysis][cxxxvi] *Symptomatic disease*: **90%**. **56%** (95% CI, 48-63; Spain) [Apr-Aug] For two doses, VE against symptomatic SARS-CoV-2 infection was 73.9% (95% CI, 26.2%–90.8%) [Portugal; December 2020 to November 2021][cxxxvii]			CI 96.0–98.8%), and against death was 99.0% (95% CI 98.5–99.6%). [Overall average from literature review and meta-analysis[cxli] VE was 94.3% against mild disease and 99.9% against severe infection[Colombia, 24 February 2021 to 10 August 2021][cxlii] *In pregnant women*: **41%** (95% CI, 27.1-52.2%; Brazil) against symptomatic COVID-19, **85%** (95% CI, 59.5-		

[cxxvii] Study does not differentiate between Moderna or Pfizer-BioNTech.

[cxxxvi] Study does not differentiate between Pfizer-BioNTech, Moderna, Oxford-AstraZeneca, CoronaVac, and Janssen.

[cxxxvii] Study does not differentiate between Pfizer and AstraZeneca.

[cxli] Study does not differentiate between Pfizer-BioNTech, Moderna, Oxford-AstraZeneca, CoronaVac, and Janssen.

[cxlii] 95% CI were not reported by authors.

	from literature review and meta-analysis] VE was 69% (95% CI, 67.0% to 70.0%) against SARS-CoV-2 infection and 86% (95% CI, 82.0% to 89.0%) against SARS-CoV-2–related death or more days after the second vaccine dose and was similar when follow-up period was extended. VE against infection decreased with increasing age and comorbidity burden. [United States, December 2020 to March 2021][cxvii] VE was approximately **96.7%** (95% CI, 87.9-99.9) 7 days after the second	against COVID-19-related hospitalization was 97.2% (95% CI 96.1–98.3%), and VE against admission to the intensive care unit 97.4% (95% CI 96.0–98.8%), and against death was 99.0% (95% CI 98.5–99.6%). [Overall average from literature review and meta-analysis][cxxviii] VE against infection in the general population aged ≥16 years was 86.1% (95% CI 77.8–94.4%), for the elderly VE was 83.8% (95% CI 77.1–90.6%), and for healthcare workers VE was 95.3% (95% CI 92.0–98.6%).[Overall	VE against symptomatic SARS-CoV-2 infection was estimated at 92% (95% CI, 78–97%) for ChAdOx.[Based on estimations from a Rapid Review] Among individuals with history of infection, VE against symptomatic infection ≥ 14 days from vaccine series completion was 56.0% (95% CI, 51.4-60.2) for ChAdOx1. [Brazil] VE was approximately 96.7% (95% CI, 87.9-99.9) 7 days after the second dose [France;			94.8; Brazil) against severe COVID-19, and **75%** (95% CI 27.9-91.2; Brazil)		

[cxvii] Study does not differentiate between Moderna or Pfizer-BioNTech.
[cxxviii] Study does not differentiate between Pfizer-BioNTech, Moderna, Oxford-AstraZeneca, CoronaVac, and Janssen.

	dose [France; December 2020 to June 2021][cxviii] VE against severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) infection was 89.1% (95% CI 85.6–92.6%), VE against COVID-19-related hospitalization was 97.2% (95% CI 96.1–98.3%), and VE against admission to the intensive care unit 97.4% (95% CI 96.0–98.8%), and against death was 99.0% (95% CI 98.5–99.6%). [Overall average from literature	average from literature review and meta-analysis][cxxix] Adjusted VE was 71% (95% confidence interval, 49%-83%) among fully vaccinated participants reporting contact with persons with COVID-19 versus 80% (95% CI, 72%-86%) among those without contact.[United States; February 2021 to September 2021][cxxx] *Symptomatic disease*: **91%** (95% CI, 89-93;	December 2020 to June 2021][cxxxviii]						

[cxviii] Study does not differentiate between Comirnaty and Vaxrevria.
[cxxix] Study does not differentiate between Pfizer-BioNTech, Moderna, Oxford-AstraZeneca, CoronaVac, and Janssen.
[cxxx] Study does not differentiate between Pfizer, Moderna, and Janssen.
[cxxxviii] Study does not differentiate between Comirnaty and Vaxrevria.

	review and meta-analysis][cxix] VE against infection in the general population aged ≥16 years was 86.1% (95% CI 77.8–94.4%), for the elderly VE was 83.8% (95% CI 77.1–90.6%), and for healthcare workers VE was 95.3% (95% CI 92.0–98.6%).[Overall average from literature review and meta-analysis][cxx] Adjusted VE was 71% (95% confidence interval, 49%-83%) among fully vaccinated participants	>2 weeks after dose).[cxxxi] **85%** (95% CI, 80-89; Spain) [Apr-Aug] *Asymptomatic SARS-CoV-2 infection:* **90.6%**.[cxxxii] **71%** (95% CI, 61-78) [January-August] *Hospitalization:* **91.6%** (95% CI, 81-97) [January-July]. **93%** (95% CI, 91-95) [11 March – 15 August). **89%** (95% CI, 87-91) for individuals ≥50 years [1 January-22 June.[cxxxiii]							

[cxix] Study does not differentiate between Pfizer-BioNTech, Moderna, Oxford-AstraZeneca, CoronaVac, and Janssen.
[cxx] Study does not differentiate between Pfizer-BioNTech, Moderna, Oxford-AstraZeneca, CoronaVac, and Janssen.
[cxxxi] Results do not disaggregate between BNT162b2 and mRNA-1273.
[cxxxii] Results do not disaggregate between BNT162b2 and mRNA-1273
[cxxxiii] mRNA-aggregated data (results do not disaggregate between BNT162b2 and mRNA-1273).

	reporting contact with persons with COVID-19 versus 80% (95% CI, 72%-86%) among those without contact.[United States; February 2021 to September 2021][cxxi] Adjusted VE against infection was **93·0%** (CI:92·6–93·4%) [Israel] VE against infection among older population was **34.5%** (95% CI, 18.5-47.3)[France] VE against any infection during predominance of alpha variant was **94.5%** (95% CI, 82.6%-98.2%)[Israel]									

[cxxi] Study does not differentiate between Pfizer, Moderna, and Janssen.

	VE against severe disease among older population was **58.6%** (95% CI, 43.8-69.6). [France] *Symptomatic disease*: **72%** (95% CI, 69-75; Spain) [Apr-Aug] Adjusted VE was 59% (95% CI 23.0%-78.0%)[England] VE against symptomatic SARS-CoV-2 infection was estimated at 89–97% BNT162b2.[Based on estimations from a Rapid Review] Among individuals with history of infection, VE against symptomatic infection ≥ 14 days from vaccine series completion									

	was 64.8% (95% CI, 54.9-72.4) for BNT162b2. [Brazil] For two doses, VE against symptomatic SARS-CoV-2 infection was 73.9% (95% CI, 26.2%–90.8%) [Portugal; December 2020 to November 2021][cxxii] *<u>Asymptomatic SARS-CoV-2 infection:</u>* **90.6%**.[cxxiii] **73.1** (95% CI, 70.3-75.5) *<u>Hospitalization:</u>* **85%** (95% CI, 73-93) [January-July]. **88%** (95% CI, 85-91) [11 March – 15 August].								

[cxxii] Study does not differentiate between Pfizer and AstraZeneca
[cxxiii] Results do not disaggregate between BNT162b2 and mRNA-1273

	89% (95% CI, 87-91) for individuals ≥50 years [1 January-22 June.[cxxiv] **90%** (95% CI, 89-92) [Dec 2020 – Aug 2021] VE against SARS-CoV-2 related hospitalizations for individuals greater than 26 weeks from a second dose was 67% (95% CI, 65.0-69.0) for Pfizer.[United States] VE against hospitalization or death ≥ 14 days from vaccine series completion was 89.7% (95% CI, 54.3-97.7) for BNT162b2. [Brazil] VE against hospitalization 14–								

[cxxiv] mRNA-aggregated data (results do not disaggregate between BNT162b2 and mRNA-1273).

	119 days following second Pfizer-BioNTech dose was 86.0% (95% CI = 77.6%–91.3%); at ≥120 days VE was 75.1% (95% CI = 64.6%–82.4%).[United States; February 2021 to September 2021] *Individuals ≥65:* **61%** (95% CI, 57-65) against SARS-CoV-2 infection and **86%** (95% CI, 82-88) against hospitalizations *Individuals ≥ 80:* VE of **68.3%** (95% CI, 65.5-70.9) for infections, **73.2%** (95% CI, 65.3-79.3) for hospitalization, **85.1%** (95% CI, 80.0-89.0) for mortality [Germany, 09 Jan – 11 Apr 2021]								

EFFECTIVENESS AGAINST VARIANTS[cxliii]

	BNT162b2/ COMIRNATY	Spikevax/ Moderna COVID-19 Vaccine/ mRNA-1273	Vaxzevria/ ChAdOx1 nCoV-19/ AZD1222/ Covishield	Janssen COVID-19 vaccine/Johnson & Johnson	Covilo/ BBIBP-CorV	CoronaVac	COVAXIN / BBV152	Nuvaxovid/ NVX-CoV2373/ Covovax
Alpha (B.1.1.7)	*Single dose:* **48.7%** (95% CI, 45.5 to 51.7) **66%** (95% CI,64-68). **54.5%** (95 CI, 50.4-58.3) *Two doses:* **93.7%** (95% CI, 91.6 to 95.3) **92%** (95% CI, 90-93). **89%** (95% CI, 86-91). **78%** (95% CI, 68-84) **84.4%** (95 CI, 81.8-86.5)	*Single dose:* **88.1%** (95% CI, 83.7 to 91.5) **83%** (95% CI, 80-86). *Two doses:* **100%** (95% CI, 91.8 to 100) **92%** (95% CI, 86-96). **98.4%** (95% CI, 96.9-99.1)	*Single dose:* **48.7%** (95% CI 45.5 to 51.7) 6**4%** (95% CI, 60-68). *Two doses:* **74.5%** (95% CI, 68.4 to 79.4) **73%** (95% CI, 66-78). 79% (95% CI, 56-90).	-	No published data	*Two doses:* Equally effective **(~76%**) in neutralizing D614G, B.1.1.7 and B.1.429 as the wild-type strain.	No available data	Ongoing studies in South Africa and the United Kingdom Post hoc analysis showed efficacy of **86.3%** (95% CI, 71.3-93.5; United Kingdom) **against B.1.1.7 variants** and **96.4%** (95% CI, 73.8-99.5; United Kingdom) **against non-B.1.1.7 variants.**
Beta (1.351)	*Against SARS-CoV-2 infection:* *Single dose:* **60%** (95% CI, 52-67).	*Single dose:* **61.3%** (95% CI, 56.5 to 65.5) **77%** (95% CI, 69-92). *Two doses:*	*Single dose:* **48%** (95% CI, 28-63).	-	No published data	Neutralization capacity was decreased by factor **5.27**.	No available data	No available data

[cxliii] Effectiveness data against the latest variant of interest (Mu) will be included in upcoming reports based on data availability.

	Two doses: **84%** (95% CI, 69-92) **72%** (95% CI, -5-97; Israel) [Dec 2020-Mar 2021] *Against symptomatic infection:* **100%** (95% CI, 19-100; Israel) [Dec 2020-Mar 2021]	**96.4%** (95% CI, 91.9 to 98.7)						
Gamma (P.1)	Neutralization activity reduced by **3.3-fold**.	No available data	No available data	No available data	No published data	Demonstrated **42%** vaccine effectiveness in a setting with high P.1 transmission, in individuals aged 70 and above. **50.2%** against P.1 (>14 days after 2nd dose). Neutralization was decreased by factor **3.92**. *Against symptomatic COVID-19:* **80.5%** (95% CI, 75.1-84.7)	No available data	No available data

Delta (1.617.2)	*Single dose:* **30.7%** (95% CI, 25.2 to 35.7); **57%** (95% CI, 50-63) **22.5%** (95 CI, 17.0-27.4) **22%** (95% CI, 10-32; France) [May-August 2021] *Two doses:* **88.0%** (95% CI, 85.3 to 90.1); **80%** (95% CI, 77-83) **79%** (95% CI,75-82). **80%** (95% CI, 77-83) **40.5%** (95% CI, 8.7-61.2). **42%** (95% CI, 13-62). **89.8%** (95% CI, 89.6-90.0) [2-9 weeks after second dose]. **69.7%** (95% CI, 68.7-70.5) [≥20	*Single dose:* **72%** effective against symptomatic SARS-Cov-2 infection. *≥14 days after second dose:* **76%** (95% CI, 58-87). **94.5%** (95% CI, 94.1-95) [2-9 weeks after second dose]. **50.6%** (95% CI, 45.0-55.7) [among nursing home residents]. **86.7%** (95% CI, 84.3-88.7) **56.6%** (95% CI, 42.0-67.5) *against infection* **84.2%** (95% CI, 56.4-94.3) *against symptomatic infection* **64%** (95% CI, 62-66) [August;	*Single dose:* **30.7%** (95% CI 25.2 to 35.7) **73%** (95% CI, 64-80; India) [May – July 2021] *Two doses:* **67.0%** (95% CI, 61.3 to 71.8) **67%** (95% CI, 62-71). **60%** (95% CI, 53-66). **66.7%** (95% CI, 45-49.6) [2-9 weeks after second dose]. **47.3%** (95% CI, 66.3-67.0) [≥20 weeks after second dose]. **81%** (95% CI, 71-88; India) [May – July 2021] Odds ratio of **5.45** (95% CI, 1.39-21.4) to become infected with	**78%** (95% CI, 73-82) against SARS-CoV-2 infection. **3%** (95% CI, -7-12) [August] **76.5%** (95% CI, 40.9-90.6; USA) [01 Jul 2021 to 30 Sep 2021][clviii] Prior to the predominance of the delta variant (delta comprising 1.8% of circulating variants), median VE against infection was **86.6%** (95% CI, 77.8 to 89.7) for Ad26.COV2.S and **continuously declined in all cohorts** (BNT162b2, mRNA-1273, Ad26.COV2.S) from a median of **93.4%** (95% CI, 77.8- 98.0) when	No available data	*Single dose:* **13.8%** (95% CI, -60.2-54.8). *Two doses:* **59%** (95% CI, 16-81.6) against SARS-CoV-2 infection and **70.2%** (95% CI, 29.6-89.3) against moderate COVID-19 infection.	*Single dose*: **44%** (95% CI, 0-71; India) [May – July 2021] *Two doses:* **64%** (95% CI, 40-79; India) [May – July 2021] VE was **44%** (95% CI, 37.0-51.0) against symptomatic infection and **61%** (95% CI, 37.0-76.0) against hospitalization or death 2 weeks after second dose during the delta dominant period. [India]	No available data

[clviii] Study does not differentiate between Pfizer, Moderna, and Janssen.

	weeks after second dose]. **64.6%** (95 CI, 60.6-68.2) **52.4%** (95% CI, 48.0-56.4) [among nursing home residents]. **53%** (95% CI, 39-65) [4 months after second dose] **50%** (95% CI, 47-52) [August; elderly Veteran population] **76.5%** (95% CI, 40.9-90.6; USA) [01 Jul 2021 to 30 Sep 2021][cxliv] **67%** (95% CI, 63-71; France) [May-August 2021] VE against Delta variant-related symptomatic infection was 88% (95% CI, 85.3–90.1%) by BNT162b2 after full vaccination. [Based on	elderly Veteran population] **76.5%** (95% CI, 40.9-90.6; USA) [01 Jul 2021 to 30 Sep 2021][cl] *<u>10-14 weeks after second dose:</u>* **90.3%** (95% CI, 67.2-97.1). VE against Delta variant-related symptomatic infection was 67.0% (95% CI, 61.3–71.8%) ChAdOx1 after full vaccination.[Based on estimations from a Rapid Review] Among early recipients of mRNA-1273, VE decreased an estimated 10 percentage when	B.1.167.2 compared to non-B.1.167.2. Among individuals who received 2 doses of vaccines (with at least 1mRNA vaccine) VE against Delta declined steadily over time from 84% (95%CI, 81-86%) 7-59 days after the second dose to 71% (95%CI, 66-75%) ≥240 days after the second dose, but recovered to 93% (95%CI, 92-94%) ≥7 days after receiving an mRNA vaccine for the third dose.[Canada; November 2021 to December 2021] [clvi]	the prevalence of delta was at 1.8% to **73.5%** (95% CI, 13.8-90.0) when delta prevalence was **85.3%,** and 74.2% (95% CI, 63.4-86.8) when the prevalence of delta was 99.6%.[United States] VE against severe COVID-19 was **86%** (95% CI, 79.0–90.0) for ages 18-49, **89%** (95% CI, 85.0–91.0) for 50-64, **77%** (95% CI, 74.0–81.0) for ≥ 65 year-olds. Among ≥ 65 year-olds fully vaccinated with mRNA vaccines, **VE decreased from 93%** (95% CI: 88–96) in those				

[cxliv] Study does not differentiate between Pfizer, Moderna, and Janssen.
[cl] Study does not differentiate between Pfizer, Moderna, and Janssen.
[clvi] Study does not differentiate between Pfizer, Moderna, or AstraZeneca.

	estimations from a Rapid Review] VE against hospitalization was 93% (95% CI, 90.0-94.0); South Africa)[September 2021 to October 2021] Among early recipients of BNT162b2, VE decreased an estimated 15 percentage when the Delta variant became dominant. Among individuals who received 2 doses of vaccines (with at least 1mRNA vaccine) VE against Delta declined steadily over time from 84% (95%CI, 81-86%) 7-59 days after the second	the Delta variant became dominant. Among individuals who received 2 doses of vaccines (with at least 1mRNA vaccine) VE against Delta declined steadily over time from 84% (95%CI, 81-86%) 7-59 days after the second dose to 71% (95%CI, 66-75%) ≥240 days after the second dose, but recovered to 93% (95%CI, 92-94%) ≥7 days after receiving an mRNA vaccine for the third dose.[Canada; November 2021 to December 2021] [cli] VE was 62.0% (95% CI, 45.6-73.5) in the first month after	VE against severe COVID-19 was **86%** (95% CI, 79.0–90.0) for ages 18-49, **89%** (95% CI, 85.0–91.0) for 50-64, **77%** (95% CI, 74.0–81.0) for ≥ 65 year-olds. Among ≥ 65 year-olds fully vaccinated with mRNA vaccines, **VE decreased from 93%** (95% CI: 88–96) in those vaccinated ≤ 3 months ago to **43%** (95% CI: 30–54) in those vaccinated ≥ 6 months ago. [Slovenia][clvii]	vaccinated ≤ 3 months ago to **43%** (95% CI: 30–54) in those vaccinated ≥ 6 months ago. [Slovenia][clix] *Individuals ≥50:* **83% (**95% CI, 81-85)				

[cli] Study does not differentiate between Pfizer, Moderna, or AstraZeneca.
[clvii] Study does not differentiate between Pfizer, Moderna, Oxford-AstraZeneca, or Janssen.
[clix] Study does not differentiate between Pfizer, Moderna, Oxford-AstraZeneca, or Janssen.

	dose to 71% (95%CI, 66-75%) ≥240 days after the second dose, but recovered to 93% (95%CI, 92-94%) ≥7 days after receiving an mRNA vaccine for the third dose.[Canada; November 2021 to December 2021][cxlv] VE was 62.0% (95% CI, 45.6-73.5) in the first month after complete vaccination and decreased to 57.8% (95%CI, 52.5-62.5) by month 3, similar to to results from pre-Delta period.[cxlvi] Prior to the predominance of	complete vaccination and decreased to 57.8% (95%CI, 52.5-62.5) by month 3, similar to to results from pre-Delta period.[cliii] One dose VE was 77.0% (95% CI, 60.7-86.5%). Two dose VE was 86.7% (95% CI 84.3%-88.7%). VE against hospitalization was 97.5% (95% CI 92.7%-99.2%). VE against infection declined from 94.1% (95% CI 90.5%-96.3%) 14-60 days after vaccination to 80.0%(95% CI, 70.2-86.6%) 151-180 days after.							

[cxlv] Study does not differentiate between Pfizer, Moderna, or AstraZeneca.
[cxlvi] Study does not differentiate between mRNA vaccines, Pfizer and Moderna.
[cliii] Study does not differentiate between mRNA vaccines, Pfizer and Moderna.

	the delta variant (delta comprising 1.8% of circulating variants), median VE against infection was **91.3%** (95% CI, 84.1-97.0) for BNT162b2, and **continuously declined in all cohorts** (BNT162b2, mRNA-1273, Ad26.COV2.S) from a median of **93.4% (**95% CI, 77.8- 98.0) when the prevalence of delta was at 1.8% to **73.5%** (95% CI, 13.8-90.0) when delta prevalence was 85.3%, and **74.2%** (95% CI, 63.4-86.8) when the prevalence of delta was 99.6%.[United States] For those who have received 2 doses of mRNA vaccines, VE is 41% (95% CI,	VE against infection was lower for ≥ 65 years at 75.2% (95% CI 59.6%-84.8) than those 18-64 years at 87.9%(95% CI, 85.5%-89.9%). Prior to the predominance of the delta variant (delta comprising 1.8% of circulating variants), median VE against infection was **96.9%** (95% CI, 93.7-98.0) for mRNA-1273 and **continuously declined in all cohorts** (BNT162b2, mRNA-1273, Ad26.COV2.S) from a median of **93.4%** (95% CI, 77.8- 98.0) when the prevalence of delta was at 1.8% to **73.5%** (95% CI, 13.8-90.0) when delta prevalence

	37.0-44.0) against Delta.[United States; 01 December 2021 to 31 December 2021][cxlvii] VE against symptomatic infection was **88.7%** (95% CI], 78.8-93.9) among patients aged 16 to 64 and **90.3%** (95% CI, 73.6-96.4) among patients aged ≥65.[Japan, 01 July to 30 September 2021][cxlviii] *<u>Against severe COVID-19:</u>* **91.4%** (95% CI, 82.5-95.7). **86%** (95% CI, 79.0–90.0) for ages 18-49, **89%** (95% CI, 85.0–91.0) for 50-64,	was 85.3%, and **74.2%** (95% CI, 63.4-86.8) when the prevalence of delta was 99.6%.[United States] For those who have received 2 doses of mRNA vaccines, VE is 41% (95% CI, 37.0-44.0) against Delta.[United States; 01 December 2021 to 31 December 2021][cliii] VE against severe COVID-19 was **86%** (95% CI, 79.0–90.0) for ages 18-49, **89%** (95% CI, 85.0–91.0) for 50-64, **77%** (95% CI, 74.0–81.0) for ≥ 65 year-olds. Among ≥ 65 year-							

[cxlvii] Study does not differentiate between mRNA vaccines.
[cxlviii] Study does not differentiate between BNT162b2 or mRNA-1273.
[cliii] Study does not differentiate between mRNA vaccines.

	77% (95% CI, 74.0–81.0) for ≥ 65 year-olds. Among ≥ 65 year-olds fully vaccinated with mRNA vaccines, **VE decreased from 93%** (95% CI: 88–96) in those vaccinated ≤ 3 months ago to **43%** (95% CI: 30–54) in those vaccinated ≥ 6 months ago. [Slovenia][cxlix]	olds fully vaccinated with mRNA vaccines, **VE decreased from 93%** (95% CI: 88–96) in those vaccinated ≤ 3 months ago to **43%** (95% CI: 30–54) in those vaccinated ≥ 6 months ago. [Slovenia][cliv] VE against symptomatic infection was **88.7%** (95% CI], 78.8-93.9) among patients aged 16 to 64 and **90.3%** (95% CI, 73.6-96.4) among patients aged ≥65.[Japan, 01 July to 30 September 2021][clv]							

[cxlix] Study does not differentiate between Pfizer, Moderna, Oxford-AstraZeneca, or Janssen.
[cliv] Study does not differentiate between Pfizer, Moderna, Oxford-AstraZeneca, or Janssen.
[clv] Study does not differentiate between BNT162b2 or mRNA-1273.

		Pooled VE was **66%** (95% CI, 65.0-67.0) ≥ 21 days after the first dose and **91%** (95% CI, 84.0-95.0) ≥14 days after the second dose.						
Mu (B.1.621)	Mu variant is 9.1 times more resistant than the wild type strain when vaccinated with BNT162b2	*Two doses:* **90.4%** (95% CI, 73.9-96.5) (demonstrated similar protective measures as against the Alpha variant)	No available data	No available data	No available data	No available data	No available data	No available data
Omicron (B.1.1.529)	**88.0%** (95% CI, 65.9-95.8) after 2-9 weeks following second dose, **48.5%** (95% CI, 24.3-65.0) after 10-14 weeks following second dose, **34-37%** from 15 weeks after second dose[67] If assuming a 25-fold decrease in	2-dose VE against omicron infection was 30.4% (95% CI, 5.0%-49.0%) at 14-90 days after vaccination and declined quickly thereafter. [United States; December 6 2021 to December 23 2021][72] VE against the Omicron variant was 36.7% (95%	No protective effect of vaccination against symptomatic disease with Omicron from 15 weeks after the second dose[67] 2 doses of COVID-19 vaccines was not protective against Omicron infection at any point in					

	pseudovirus neutralization **66%** (95% CI, 42-86)[68] VE against the Omicron variant was 55.2% (95% CI, 23.5 to 73.7%) for BNT162b2 in the first month after primary vaccination. However, the VE is significantly lower than that against Delta infection and declines rapidly over just a few months. [Denmark, November 2021 to December 2021][69] 2 doses of COVID-19 vaccines was not protective against Omicron infection at any point in time, and VE was –38% (95%CI, –61%, –18%) 120-	CI: -69.9 to 76.4%) for mRNA-1273 in the first month after primary vaccination. [Denmark, November 2021 to December 2021][69] 2 doses of COVID-19 vaccines was not protective against Omicron infection at any point in time, and VE was –38% (95%CI, –61%, –18%) 120-179 days and –42% (95%CI, –69%, –19%) 180-239 days after the second dose. VE against Omicron was 37% (95%CI, 19-50%) ≥7 days after receiving an mRNA vaccine for the third dose.[Canada; November 2021 to	time, and VE was –38% (95%CI, –61%, –18%) 120-179 days and –42% (95%CI, –69%, –19%) 180-239 days after the second dose. VE against Omicron was 37% (95%CI, 19-50%) ≥7 days after receiving an mRNA vaccine for the third dose.[Canada; November 2021 to December 2021] 70 clxiv						

[clxiv] Study does not differentiate between Pfizer, Moderna, or AstraZeneca.

	179 days and –42% (95%CI, –69%, –19%) 180-239 days after the second dose. VE against Omicron was 37% (95%CI, 19-50%) ≥7 days after receiving an mRNA vaccine for the third dose.[Canada; November 2021 to December 2021] [70] clx VE was 25% (95% CI, 20.0-30.0) against Omicron infection. [United States; 01 December 2021 to 31 December 2021] [71] clxi	December 2021] [70] clxii VE was **30.4% (95% CI, 5.0%-49.0%)** 14-90 days after vaccination and declined thereafter.[72] VE was 25% (95% CI, 20.0-30.0) against Omicron infection. [United States; 01 December 2021 to 31 December 2021] [71]clxiii							

[clx] Study does not differentiate between Pfizer, Moderna, or AstraZeneca.

[clxi] Study does not differentiate between mRNA vaccines.

[clxii] Study does not differentiate between Pfizer, Moderna, or AstraZeneca.

[clxiii] Study does not differentiate between mRNA vaccines.

	EFFECTIVENESS AGAINST HOSPITALIZATION							
	BNT162b2/ COMIRNATY	**Spikevax/ Moderna COVID-19 Vaccine/ mRNA-1273**	**Vaxzevria/ ChAdOx1 nCoV-19/ AZD1222/ Covishield**	**Janssen COVID-19 vaccine/Johnson & Johnson**	**Covilo/ BBIBP-CorV**	**CoronaVac**	**COVAXIN / BBV152**	**Nuvaxovid/ NVX-CoV2373/ Covovax**
Any SARS-CoV-2 infection	*Single dose:* **85%** (pooled meta-analysis) Hospitalization risk reduced by 35-**45%**. Risk of death reduced by **54%**. *Individuals ≥50:* ≥14 days after first dose: **54%** (95% CI, 47-61) [1 Jan-22 Jun. [clxv] *Two doses:* **91%** (pooled meta-analysis) **91%** (95% CI, 93%-96%; United	*Single dose:* **73%** (pooled meta-analysis) *Individuals ≥50:* ≥14 days after first dose: **54%** (95% CI, 47-61) [1 Jan-22 Jun.[clxxi] *Two doses:* **88%** (pooled meta-analysis) **91%** (95% CI, 93%-96%; United States) [May to July 2021][clxxii] **79%** (95% CI, 60-89; Sweden) [27 Dec 2020-2 Nov 2021]	*Single dose:* **56%** (pooled meta-analysis) Hospitalization risk reduced by **35-45%**. *Two doses:* **91%** (pooled meta-analysis) **92%** (95% CI, 80-97; Sweden) [27 Dec 2020-2 Nov 2021] VE against hospitalization or death ≥ 14 days from vaccine series completion	VE against hospitalization or death ≥ 14 days from vaccine series completion was 57.7% (95% CI, −2.6-82.5) for Ad26.COV2.S. [Brazil]	*Two doses:* VE against hospitalization was **71.9%** [95% CI: 70.7-73.1%] for those who received the full vaccination schedule of BBIBP-CorV.[Iran]	*Against hospitalization:* **71.2%** (95%CI, 70.0-72.4)[Brazil, 18 January 2021 to July 2021] *Against ICU admission*: **72.0%** (95% CI, 69.9-73.9; Malaysia) [Apr-Sep 2021] **72.2%** (95%CI, 70.2-74.0)[Brazil, 18 January 2021 to July 2021] *Against death:*	No available data	No available data

[clxv] mRNA-aggregated data (results do not disaggregate between BNT162b2 and mRNA-1273).

[clxxi] mRNA-aggregated data (results do not disaggregate between BNT162b2 and mRNA-1273).

[clxxii] Results do not disaggregate between mRNA vaccines, BNT162b2 and mRNA-1273.

	States) [May to July 2021][clxvi] **89%** (95% CI, 84-93; Sweden) [27 Dec 2020-2 Nov 2021] *Against ICU admission*: **90.3%** (95% CI, 88.8-91.6; Malaysia) [Apr-Sep 2021] *Against death:* **92.7%** (95% CI, 91.7-93.6; Malaysia) [Apr-Sep 2021] Adjusted Hazard Ratio for COVID-19 hospitalization from day 7 after the second dose was estimated at 0.14 (95% CI, 0.11–0.17), for an estimated 86% (95% CI, 83.0%-88.0%) risk	Adjusted Hazard Ratio for COVID-19 hospitalization from day 7 after the second dose was estimated at 0.14 (95% CI, 0.11–0.17), for an estimated 86% (95% CI, 83.0%-88.0%) risk reduction in people aged 75 and older [France] [clxxiii] Fully vaccinated patients had a shorter overall length of stay in hospitals (aHR for discharge: 1.61, 95%CI: 1.24–2.08), shorter LoS without ICU (aHR: 1.27, 95%CI: 1.07–1.52), and lower risk of ICU admission (aHR: 0.50, 95%CI: 0.37–0.69) compared to	was 89.9% (95% CI, 83.5-93.8) for ChAdOx1. [Brazil] VE against hospitalization, **91.4%** (95%C, 90.1-92.5). VE against hospitalization was **81.5%** [95% CI: 79.5-83.4%] for those who received the full vaccination schedule of ChAdOx1-S/nCoV-19. [Iran] *Against ICU admission*: **95.6%** (95% CI, 88.3-98.4; Malaysia) [Apr-Sep 2021] **91.1%** (95%CI, 88·9-92.9). *Against death:*			**82.4%** (95% CI, 81.0-83.7; Malaysia) [Apr-Sep 2021] VE against hospitalization or death ≥ 14 days from vaccine series completion was 81.3% (95% CI, 75.3-85.8) for CoronaVac. [Brazil] Adjusted odds ratios of COVID hospitalisation or death were significantly increased from 98 days since series completion, compared to individuals vaccinated 14-41 days previously: 1.40 (95% CI, 1.09 to 1.79) from 98-125 days, 1.55 (1.16 to 2.07) from 126-153 days, 1.56 (1.12 to 2.18)		

[clxvi] Results do not disaggregate between mRNA vaccines, BNT162b2 and mRNA-1273.

[clxxiii] Study does not differentiate between Pfizer/BioNTech and Moderna.

	reduction in people aged 75 and older [France] [clxvii] Fully vaccinated patients had a shorter overall length of stay in hospitals (aHR for discharge: 1.61, 95%CI: 1.24–2.08), shorter LoS without ICU (aHR: 1.27, 95%CI: 1.07–1.52), and lower risk of ICU admission (aHR: 0.50, 95%CI: 0.37–0.69) compared to unvaccinated patients. We observed no difference in the LoS in ICU, nor risk of in-hospital death between fully vaccinated and unvaccinated patients. [Norway,	unvaccinated patients. We observed no difference in the LoS in ICU, nor risk of in-hospital death between fully vaccinated and unvaccinated patients. [Norway, February 2021 to November 2021] [clxxiv] VE was observed to increase after the first dose of mRNA vaccines with week 6 effectiveness approximating 84% (95% CI 72.0-91.0) for COVID-19 infection and 86% (95% CI, 69.0-95.0) for COVID-19-associated hospitalization.[United States] [clxxv]	**95.3%** (95% CI, 91.3-97.4; Malaysia) [Apr-Sep 2021] **92.3%** (95%CI, 90.5-93.7)[Brazil, 18 January 2021 to July 2021] <60 years VE against death was **96.5%** (95%CI, 82.1–99.3) versus **68·5%** (95%CI, 40.0–83.4) in those ≥90 years.[Brazil, 18 January 2021 to July 2021]			from 154-181 days, and 2.12 (1.39-3.22) from 182 days. [Brazil; January 2021 to September 2021] **73.7%** (95%CI, 72.1–75.2)[Brazil, 18 January 2021 to July 2021] **84.8%** (95%CI:77.1–89.9) in those <60 years compared to **63.5** (95%CI 58.7–67.7) for those aged 80–89 years and **48.6%**; (95%CI:35.0–59.3) for individuals aged ≥90 years. [Brazil, 18 January 2021 to July 2021]		

[clxvii] Study does not differentiate between Pfizer/BioNTech and Moderna.

[clxxiv] Study does not differentiate between mRNA vaccines Pfizer and Moderna.

[clxxv] Study does not differentiate between Pfizer and Moderna.

	February 2021 to November 2021] [clxviii] VE was observed to increase after the first dose of mRNA vaccines with week 6 effectiveness approximating 84% (95% CI 72.0-91.0) for COVID-19 infection and 86% (95% CI, 69.0-95.0) for COVID-19-associated hospitalization.[United States] [clxix] Adjusted VE against hospitalization was 93·4% (CI:91·9–94·7%) and 91·1% (CI:86·5–94·1%) against death.[Israel]	VE against hospitalization 14–119 days following second Moderna vaccine dose was 89.6% (95% CI = 80.1%–94.5%) at ≥120 days VE was 86.1% (95% CI = 77.7%–91.3%).[United States; February 2021 to September 2021] Adjusted Hazard Ratio was 0.14% (95% CI, 0.11-0.17) against hospitalization 7 days after second dose among people aged 75 and older; which is an **estimated 86% risk reduction**. [France] [clxxvi]							

[clxviii] Study does not differentiate between mRNA vaccines Pfizer and Moderna.

[clxix] Study does not differentiate between Pfizer and Moderna.

[clxxvi] Study does not differentiate between mRNA-based vaccines.

	Adjusted Hazard Ratio was 0.14% (95% CI, 0.11-0.17) against hospitalization 7 days after second dose among people aged 75 and older; which is an **estimated 86% risk reduction**. [France] [clxx] VE against death among older population was **75.2%** (95% CI, 54.6-86.4). [France] VE was **82%** (95% CI, 69.0-90.0) against hospitalization after full vaccination and **53%** (95% CI, 23.0-71.0) for partially vaccinated.[Leban								

[clxx] Study does not differentiate between mRNA-based vaccines.

	on; April to May 2021]							
Alpha	Single dose: **83%** (95% CI, 62-93) **53%** (95% CI, 7-83; England) [Feb-Sep 2021] Two doses: **95%** (95% CI, 78-99) **71%** (95% CI, 12-95; England) [Feb-Sep 2021] *Against death:* **98.2%** (95% CI, 95.9-99.2) [2-9 weeks] **90.4%** (95% CI, 85.1-93.8) [≥20 weeks]	No available data	Single dose: **76%** (95% CI, 61-85) **3%** (95% CI, -38 – 39; England) [Feb-Sep 2021] Two doses: **86%** (95% CI, 53-96) **26%** (95% CI, -39 – 73; England) [Feb-Sep 2021] *Against death:* **94.1%** (95% CI, 91.8-95.8) [2-9 weeks] **78.7%** (95% CI, 52.1-90.4) [≥20 weeks]	***Beta*** **67%** effective at preventing hospitalizations *Against death:* 96% effective at preventing death	No available data	No available data	No available data	No available data
Gamma	No available data	No available data	No available data	**72.9%** (95% CI, 35.1-91.1) *Against ICU admission:* **92.5%** (95% CI, 54.9-99.6) *Against death:* **90.5%** (95% CI, 31.5-99.6)	No available data	*Against hospitalization:* **95%** (95% CI, 86.9-98.1) *Against death:* **94.9%** (95% CI, 76.4-98.9)	No available data	No available data

Delta	*Single dose:* **94%** (95% CI, 46-99) **91%** (95% CI, 90-93) **4%** (95% CI, -21 – 44; England) [Feb-Sep 2021] *Two doses*: **96%** (95% CI, 86-99) **88%** (95% CI, 78.9-93.2) **75%** (95% CI, 24-93.9) **84%** (95% CI, 79-89) **98.4%** (95% CI, 97.9-98.8) [2-9 weeks] **92.7%** (95% CI, 90.3-94.6) [≥20 weeks] **96%** (95% CI, 95-96) **80%** (95% CI, 73-85) [June-August]	*Single dose:* **81%** (95% CI, 81-90.6) *Two doses:* **84%** (95% CI, 80-87) **95%** (95% CI, 92-97) [Jun-Aug 2021] **96.7%** (95% CI, 93.9-98.2) **97.3%** (95% CI, 95.9-98.4; New York) [Aug 2021] *Individuals ≥65:* **93.7%** (95% CI, 92.9-94.4; New York) [Aug 2021] *Against ICU admission:* **86%** (95% CI, 79-90)	*Single dose*: **71%** (95% CI, 51-83) **88%** (95% CI, 83-91) **2%** (95% CI, -19 – 31; England) [Feb-Sep 2021] *Two doses*: **92%** (95% CI, 75-97) **95.2%** (95% CI, 94.6-95.6) [2-9 weeks] **77.0%** (95% CI, 70.3-82.3) [≥20 weeks] **94%** (95% CI, 92-95) **14%** (95% CI, -5 – 46; England) [Feb-Sep 2021] **63.1%** (95% CI, 51.5-72.1; India) (Apr – May 2021)	**71%** **85%** (95% CI, 73-91) **91%** (95% CI, 88-94) **93.5%** (95% CI, 89.6-96.1; New York) [Aug 2021] **85%** effective at preventing severe disease and hospitalization *Individuals ≥50:* **84% (**95% CI, 81-85) *Individuals ≥65:* **81.8%** (95% CI, 77.8-85.3; New York) [Aug 2021] *Against ICU admission:*	*Single dose:* Does not offer clinically meaningful protection against severe illness[clxxvii] *Two doses:* **88%** (95% CI, 55-98) adjusted risk reduction in developing severe illness[clxxviii]	*Single dose:* Does not offer clinically meaningful protection against severe illness[clxxix] *Two doses:* **88%** (95% CI, 55-98) adjusted risk reduction in developing severe illness[clxxx]	No available data	No available data

[clxxvii] Study does not differentiate between the two inactivated vaccines, BBIBP-CorV and CoronaVac.

[clxxviii] Study does not differentiate between the two inactivated vaccines, BBIBP-CorV and CoronaVac.

[clxxix] Study does not differentiate between the two inactivated vaccines, BBIBP-CorV and CoronaVac.

[clxxx] Study does not differentiate between the two inactivated vaccines, BBIBP-CorV and CoronaVac.

	93% (95% CI, 84-96) **96.8%** (95% CI, 93.9-98.3)[2 months after the second dose] **93%** (95% CI, 84-96) **91.5%** (95% CI, 89.5-93.2) **24%** (95% CI, -2 – 64; England) [Feb-Sep 2021] **95.2%** (95% CI, 93.6-96.5; New York) [Aug 2021] *Individuals ≥65:* **88.6%** (95% CI, 87.4-89.6; New York) [Aug 2021] *Against death:* **90%** (95% CI, 83-94) [≥2 weeks after second dose] *All ages:* **90%** (95% CI, 83-94) *40-59*: **95%** (95% CI, 79-99) *60+:* **87%** (95% CI, 77-93) Estimated risk of SARS-CoV-2	**96%** against severe COVID-19 infection Estimated risk of SARS-CoV-2 infection is **4.52 events per 1000** persons (95% CI, 4.17-4.84)	*Against moderate to severe disease:* **81.5%** (95% CI, 9.9-99.0; India) (Apr – May 2021) *Against ICU admission:* *Single dose:* **92%** (95% CI, 84-96) *Two doses*: **96%** (95% CI, 94-98) *Against death:* **91%** (95% CI, 86-94) [≥2 weeks after second dose] *All ages:* **91%** (95% CI, 86-94) *40-59*: **88%** (95% CI, 76-93) *60+:* **90%** (95% CI, 84-94)	**94%** (95% CI, 88-98)				

	infection is **5.75 events per 1000** persons (95% CI, 5.39-6.23) VE against ED admission waned from **80%** (95% CI, 69.0-87.0) at <3 months to **63%** (95% CI, 57.0-69.0) at ≥6 months after two doses. [United States, 01 Dec 2021 to 11 Jan 2022] VE against hospital admission waned from **88%** (95% CI, 71.0−95.0) at <3 months to **74%** (95% CI, 65.0−80.0) at ≥6 months after two doses.[United States, 01 Dec 2021 to 11 Jan 2022]							
Omicron	Estimated VE against	Estimated VE against hospitalization **4**	Length hospital stay was significantly					

	hospitalization **4 to 5-fold increased** compared to Delta[73]* **84.9%** (95% CI, 83.0-86.6) against Omicron variant for recently vaccinated Pfizer[73] *No differention between mRNA vaccines VE against hospitalization was 70% (95% CI, 62.0-76.0; South Africa)[November 2021 to December 2021][74] VE against ED admission waned from **60%** (95% CI, 43.0−72.0) at <3 months to **41%** (95% CI, 32.0−50.0) at ≥6	**to 5-fold increased** compared to Delta[73]* *No differention between mRNA vaccines Length hospital stay was significantly shorter than for Delta (**confounding-adjusted difference -4.0 days** (95%CI -7.2 to -0.8).[Portugal, 01 December 2021 to 29 December 2021][76clxxxiii] Odds of death were **0.14** (95% CI, 0.0011-1.12), representing a reduction in the risk of death of 86% when	shorter than for Delta (**confounding-adjusted difference -4.0 days** (95%CI -7.2 to -0.8).[Portugal, 01 December 2021 to 29 December 2021][76clxxxv] Odds of death were **0.14** (95% CI, 0.0011-1.12), representing a reduction in the risk of death of 86% when infected with Omicron (BA.1) compared with Delta (B.1.617.2). [Portugal, 01 December 2021 to 29 December 2021][76clxxxvi]						

[clxxxiii] Study does not differentiate between ChAdOx1, BNT162b2, or mRNA-1273.

[clxxxv] Study does not differentiate between ChAdOx1, BNT162b2, or mRNA-1273.

[clxxxvi] Study does not differentiate between ChAdOx1, BNT162b2, or mRNA-1273.

	months after two doses.[United States, 01 Dec 2021 to 11 Jan 2022] [75] VE against hospital admission was **68%** (95% CI, 58.0−75.0) after two doses with no waning of effectiveness observed.[United States, 01 Dec 2021 to 11 Jan 2022] [75] Length hospital stay was significantly shorter than for Delta (**confounding-adjusted difference -4.0 days** (95%CI -7.2 to -0.8).[Portugal, 01 December 2021 to 29 December 2021] [76clxxxi]	infected with Omicron (BA.1) compared with Delta (B.1.617.2). [Portugal, 01 December 2021 to 29 December 2021][76clxxxiv]							

[clxxxi] Study does not differentiate between ChAdOx1, BNT162b2, or mRNA-1273.
[clxxxiv] Study does not differentiate between ChAdOx1, BNT162b2, or mRNA-1273.

	Odds of death were **0.14** (95% CI, 0.0011-1.12), representing a reduction in the risk of death of 86% when infected with Omicron (BA.1) compared with Delta (B.1.617.2). [Portugal, 01 December 2021 to 29 December 2021][76clxxxii]							
	DURATION OF PROTECTION & BREAKTHROUGH INFECTIONS							
	BNT162b2/ COMIRNATY	**Spikevax/ Moderna COVID-19 Vaccine/ mRNA-1273**	**Vaxzevria/ ChAdOx1 nCoV-19/ AZD1222/ Covishield**	**Janssen COVID-19 vaccine/Johnson & Johnson**	**Covilo/ BBIBP-CorV**	**CoronaVac**	**COVAXIN / BBV152**	**Novavax/ NVX-CoV2373**
Duration of protection (antibodies)	Median time between second dose and infection: **146 days (IQR, 121-167)**	*Preliminary phase I results:* Antibody activity remained high in all age groups at **day 209**	*Antibody Response:* After single dose, antibody response declined within one year, but remained above	*Neutralizing antibodies:* Remained largely stable for **8-9 months**	*Antibody Response:* **Unexposed subjects:** After 1st dose: **43.6 IU/mL** (95% CI, 30.3-62.8)	A phase I/II clinical trial found that NAbs titres dropped below the seropositive cut-off of 8, **6 months** after the	Median anti-S IgG was **342.7 AU/mL** (IQ: 76.1-892.8) which was found to be significantly lower than the Covidshield-induced antibody	No available data

[clxxxii] Study does not differentiate between ChAdOx1, BNT162b2, or mRNA-1273.

	Anti-SARS-CoV-2 Antibodies: 1 month after 2nd dose: **1762 KU/L (IQR: 933-3761)** 3 months after 2nd dose: **1086 KU/L (IQR: 629-2155)** 6 months after 2nd dose: **802 KU/L (IQR, 447-1487)** No health worker had antibodies BELOW method-dependent cut-off (0.8 KU/L) *Anti-S antibody titre* 694.6 AU/mL after 8.4 months *Neutralizing antibodies:* At peak immunity, NAb titre was **1,789**, after 8 months titre was **53**	(approximately 6 months) GMT were lower in ≥56 years old *Anti-S antibody titre* 1500.8 AU/mL after 8.4 months[78] *Neutralizing antibodies:* At peak immunity, NAb titre was **5,848**, after 8 months titre was **133** VLP neutralization titers were **reduced 2.7-fold** to Delta and **reduced 15.4-fold** to Omicron.[77clxxxviii] *Pseudovirus neutralizing antibodies:* At peak immunity, pseudovirus NAb titre was **1,569**,	baseline levels. Antibody levels after **day 180**: 0.54 GMR (CI, 0.47-0.61). Antibody levels after **day 320**: 0.30 GMR (CI, 0.24-0.39) *Cellular Immune Response:* **Day 182** after first dose: median of **237 SFUx10^6 PBMC (IQR, 109-520)** **6 months** after second dose: **(median 1240, IQR 432-2002**) in groups with 15-25 week interval between doses *Anti-spike Protein RBD IgG Antibodies:* **Younger age groups (<60):**	Remained **stable for 8 months**; At 4 weespoks after immunization NAb titre was **146**, after 8 months titre was **629** VLP neutralization titers were **reduced 2.7-fold** to Delta and **reduced 15.4-fold** to Omicron.[77clxxxix] *Pseudovirus neutralizing antibodies:* Remained **stable for 8 months**; At 4 weeks after immunization pseudovirus NAb titre was **391**, after 8 months titre was **185** *Binding antibodies:* Remained stable **6 months**	After 2nd dose: **377.0 IU/mL** (95% CI: 324.3-438.3) 3 months after 2nd dose: **125.4 IU/mL** (95% CI: 88.2-178.4) **Exposed subjects:** Before 1st dose: **203.2 UI/mL** (95% CI: 42.9-962.4) After 1st dose: **761.7 UI/mL** (95% CI: 381.1-1522) After 2nd dose: **719.9 UI/mL** (95% CI : 264.6-1959) 3 months after 2nd dose: **484.4 IU/mL** (95% CI: 147.3-1593) *Anti-RBD IgG*: Decreased up to **41.8%** 2 months after second dose and dropped to **42.9%** decrease after 7 months	administration of the first dose **80-90%** of anti-S IgG and Nab titers against wild type waned **6 months** after second vaccination *Anti-spike Protein RBD IgG Antibodies:* **Younger age groups (<60):** 1 month after 2nd dose: 97% seropositivity, **11.3** (IQR, 6.2-20.7) 3 months after 2nd dose: 76% seropositivity, **2.4** (IQR, 1.0-5.0) **Older age groups (≥60)**: 1 month after 2nd dose: 88% seropositivity, **6.4** (IQR, 2.5-13.6) 3 months after 2nd dose: 60%	concentration of **1,299.5 AU/mL** (IQ: 517.9-5,019.07). [India; January to July 2021]	

[clxxxviii] Study does not differentiate between BNT162b2, mRNA-1273, or Ad26.COV2.S
[clxxxix] Study does not differentiate between BNT162b2, mRNA-1273, or Ad26.COV2.S

	Pseudovirus neutralizing antibodies: At peak immunity, pseudovirus NAb titre was **700**, after 8 months titre was **160** *Anti-spike Protein RBD IgG Antibodies:* At peak immunity, RBD titre was **21,564**, after 8 months titre was **755** **Younger age groups (<60):** 1 month after 2nd dose: 100% seropositivity, **35.3** (IQR, 27.6-40.0) 3 months after 2nd dose: 100% seropositivity, **19.2** (IQR, 8.2-23.1) **Older age groups (≥60)**: 1 month after 2nd dose: 100% seropositivity, **29.4** (IQR, 22.5-33.3)	after 8 months titre was **273** *Anti-spike Protein RBD IgG Antibodies:* At peak immunity, RBD titre was **25,677**, after 8 months titre was **1,546** *Humoral & Cellular Immune Response:* CD8+ T cell response was **0.017%** 8 months after full vaccination	1 month after 2nd dose: 100% seropositivity, **17.1** (IQR, 9.9-23.6) 3 months after 2nd dose: 97% seropositivity, **6.5** (IQR, 3.5-9.3) **Older age groups (≥60)**: 1 month after 2nd dose: 96% seropositivity, **13.3** (IQR, 6.9-27.7) 3 months after 2nd dose: 90% seropositivity, **3.9** (IQR, 1.9-8.4) Median anti-S IgG was **1,299.5 AU/mL (IQ: 517.9-5,019.07)** which is approximately **4-fold higher than the Covaxin**-induced antibody concentration of 342.7 AU/mL (IQ: 76.1-892.8). [India; January to July 2021]	irrespective of age group *Humoral & Cellular Immune Response:* Antibody responses were detected in all vaccine recipients on **day 239** (stable response for at least 8 months) CD8+ T cell response was **0.12%** 8 months after vaccination *Anti-spike Protein RBD IgG Antibodies:* Remained **stable for 8 months**; At 4 weeks after immunization titre was **1,361**, after 8 months titre was **843**	*Binding Antibodies:* Decreased **82.1%** 7 months after second dose	seropositivity, **1.3** (IQR, 0.5-3.3) *Neutralizing Antibody:* Decay from **95.08%** 42 days after 2nd dose to **19.7%**160 days after 2nd dose *Anti-RBD Antibody:* Decay from **100%** 42 days after 2nd dose to **54.10%** 160 days after 2nd dose *Anti-spike IgG:* Decay from **100.0%** 42 days after 2nd dose to **50.82%** 160 days after 2nd dose *Anti-spike IgM:* Decay from **59.02%** 42 days after 2nd dose to **3.28%** 160 days after 2nd dose *Anti-spike IgA:* Decay **31.15%** 42 days after 2nd		

	3 months after 2nd dose: 100% seropositivity, **14.8** (IQR, 7.4-18.7) *Sub-populations:* **Older age (≥65): 38%** to **42%** decrease of humoral antibodies compared to 18- to 45-year-old **Older age (≥65) AND men: 37%** to **46%** decrease compared to 18- to 45-year-old women **Immunosuppression: 65% to 70%** decrease compared to non-immunosuppressed **Obesity (BMI ≥30): 31%** increase in neutralizing antibody					dose to **0.00%** 160 days after 2nd dose Of 329 participants, 18.5% (61 of 329) results were positive with a 64.47 BAU/mL anti –RDB IgG median quantitative titer (IQR 42.87-125.5) obtained. The negative group comprised of 80% of the group (268 of 329) with a 8.55 anti –RDB IgG median quantitative titer (IQR 5.5-13.92) and the maximum titer was 29.92 BAU/mL (p <0.001).[Brazil]		

	compared with nonobese While the mean values of anti-RBD-IgG showed a marked decline at 6 months, high neutralizing bioactivity was maintained at least 6 months after vaccination in almost all study participants (N=57 HCWs) *<u>Humoral & Cellular Immune Response:</u>* CD8+ T cell response was **0.016%** 8 months after full vaccination Decline in Serum Nucleocapsid and RBD Abs from 632.5 U/mL (IQR: 170-1848 U/mL) at 5-weeks post vaccination to 133 U/mL (IQR: 54-337 U/mL) at 6-								

	months post vaccination. IgG levels steadily decreased over the 6-month period in the total tested population and in all age groups. An inverse relationship was found between IgG titer and subsequent PCR-positive infection. Persons vaccinated during the first 2 months of the campaign were more likely to become infected than those subsequently vaccinated.[Israel] VLP neutralization titers were **reduced 2.7-fold** to Delta and **reduced 15.4-fold** to Omicron.[77clxxxvii]								

[clxxxvii] Study does not differentiate between BNT162b2, mRNA-1273, or Ad26.COV2.S

Duration of protection (vaccine effectiveness)	*Against any SARS-CoV-2 Infection:* After reaching peak VE (77.5%) 1 month after 2nd dose, VE dropped to **20%** in **months 5-7** after 2nd dose VE reduced from **87%** (95% CI, 85-89) to **56%** (95% CI, 53-59) after 4 months VE reduced from **91%** (95% CI, 91-92) in March to **50%** (95% CI, 47-52) in August VE reduced from **89.0%** (95% CI, 84.6-92.1; United States) [May to August] to **62.7%** (95% CI, 62.4-63.1; United States) [May to August][cxc]	**36.4** (95% CI, 17.1-51.5) reduction of observed incidence rate (SARS-CoV-2 infection) if vaccinated from Dec 2020 – Apr 2021 than Jul 2021 – Dec 2020. **46.0** (95% CI, -52.4-83.2) reduction of observed incidence rate (**severe** SARS-CoV-2 infection) if vaccinated from Dec 2020 – Apr 2021 than Jul 2021 – Dec 2020. VE against the Delta variant declined from **94.1%** (95% CI, 90.5-96.3) 14-60 days after vaccination to **80.0%** (95% CI,	VE reduced by 7% (95% CI, -18 - 2) for every 30 days from the second dose for those aged 18 to 64 years. VE reduced from **58%** (95% CI, 51-65) to **27%** (95% CI, 17-37) after 4 months. VE reduced from **88%** (95% CI, 87-89) in March to **3%** (95% CI, -7-12) in August VE decreased by **18.5% points** (95% CI 8.4-33.4) among all ages and **19.9% points** among older individuals (95% CI; 9.2-36.7) [Overall average from Systematic Review and Meta-Regression][ccx]	A study observed sustained and stable vaccine effectiveness starting 14 days post vaccination to a maximum of **152** days after vaccination. VE decreased from **89.4%** in May to **51.7%** in July VE decreased from **86.4%** (95% CI, 85.2-87.6) in March 2021 to **13.1%** (95% CI, 9.2-16.8) in September 2021 VE decreased by **18.5% points** (95% CI 8.4-33.4) among all ages and **19.9% points** among older individuals (95% CI; 9.2-36.7) [Overall average	No available data	*Against COVID-19 infections:* VE waned from **74.4%** (95% CI 209 70.4, 77.8) to **30.0%** (95% CI 18.4, 39.9) [Malaysia] *Against ICU admissions:* VE declined from **56.1%** (95% CI 51.4, 60.2) to **29.9%** (95% CI 13.9, 43.0) [Malaysia] *Against deaths:* Did not wane after three to five months of full vaccination. [Malaysia]	No available data	No available data

[cxc] Study does not differentiate between the two mRNA vaccines, Pfizer and Moderna.
[ccx] Study does not differentiate between Pfizer/BioNTech-Comirnaty, Moderna-mRNA-1273, Janssen-Ad26.COV2.S and AstraZeneca-Vaxrevria.

	VE decreased by **18.5% points** (95% CI 8.4-33.4) among all ages and **19.9% points** among older individuals (95% CI; 9.2-36.7) [Overall average from Systematic Review and Meta-Regression][cxci] VE reduced from **91.3%** (range, 84.1-97) for the week of 1 May 2021 to **72.3%** (range, 63.7-77.5) by the week of August 28 2021. **VE decreased to 66.3% (95% CI, 65.7-66.9)** by 20 weeks after the second dose. Protection **against hospitalization decreased less with a VE of 91.7% (95% CI**	70.2-86.6) 151-180 days after vaccination. **91%** [January-March] **71%** (95% CI, 53-83) [April-May] **63%** (95% CI, 44-76) VE reduced from **90%** (95% CI, 88-91) to **71%** (95% CI, 68-74) after 4 months VE reduced from **91%** (95% CI, 72-98) in January-March to **71%** (95% CI, 53-83) in April-May to **63%** (95% CI, 44-76) in June-August VE reduced from **92%** (95% CI, 92-93) in March to **64%** (95% CI, 62-66) in August	VE reduced from **96.9%** (range, 93.7-98.0) for the week of 1 May 2021 to **77.8%** (range, 70.1-86.8) by the week of August 28 2021 Estimated results show that vaccine effectiveness significantly wanes from 60 days after the second dose [Japan; February 2020 to December 2021] [ccxi] VE of first dose 68% (95% CI 67.0.% - 69.%; Canada) and 88% (95% CI 87.0% - 88.0%; Canada) [December 2020 to October 2021] Risk of infection decreased 4-6 months after the second vaccine	from Systematic Review and Meta-Regression][ccxvi] VE reduced from **86.6%** (range, 77.8-89.7) for the week of 1 May 2021 to **69.4%** (range, 63.4-77.3) by the week of August 28 2021. VE was 74.8% (95% CI, 72.5-76.9) at 1 months and decreased to 59.4% (95% CI, 57.2-61.5) at 5 months. [United States; December 2020 to September 2021] Waning protection against infections started in month 4 for Ad26.COV2.S (OR [95% CI] in month 5+, 1.31 [1.18, 1.47]). No				

[cxci] Study does not differentiate between Pfizer/BioNTech-Comirnaty, Moderna-mRNA-1273, Janssen-Ad26.COV2.S and AstraZeneca-Vaxrevria.

[ccxi] Study does not differentiate between Pfizer Moderna, and AstraZeneca.

[ccxvi] Study does not differentiate between Pfizer/BioNTech-Comirnaty, Moderna-mRNA-1273, Janssen-Ad26.COV2.S and AstraZeneca-Vaxrevria.

	90.2-93.0) and a **VE against death of 91.9% (95% CI, 88.5-94.3)** [England] VE was **94.5% (95% CI, 94.1 to 94.9)** 2 months after the first dose and **decreased to 66.6% (95% CI 65.2-67.8)** at 7 months. [United States; December 2020 to September 2021] Waning protection against infections started in month 2 for BNT162b2 (OR [95% CI] in month 6+, 2.93 [2.72, 3.15]). No waning of protection was observed at any time for ICU admissions. [United States, January 2021 to September 2021]	VE against infection was **82%** (95% CI, 79-85) 14-90 days after the second dose and appeared to **wane over time** and was **63%** (95% CI, 55-68) 91-180 days after the second dose [27 Dec 2020 – 26 Oct 2021; Finland][cc] VE decreased from **89.2%** (95% CI, 88.8-89.6) in March 2021 to **58.0%** (95% CI, 56.9-59.1) in September 2021 VE reduced from **89.0%** (95% CI, 84.6-92.1; United States) [May to August] to **62.7%** (95% CI, 62.4-63.1; United States) [May to August][cci]	dose, but markedly increased after.[ccxii] VE decreased to 44.3% (95% CI, 43.2-45.4) by 20 weeks after the second dose. Protection against hospitalization decreased less with a VE of 80.0% (95% CI 76.8-82.7) and a VE against death of 84.8% (95% CI, 76.2-90.3) [England] *Against symptomatic COVID-19:* VE decreased by **25.4%** (95% CI, 13.7-42.5) among all ages and **32.0%** (95% CI, 11.0-69.0) among older individuals [Overall average from Systematic	waning of protection was observed at any time for ICU admissions. [United States, January 2021 to September 2021] There was no evidence of waning protection against hospitalization for Ad26.COV2.S (OR [95% CI], 1.25 [0.86, 1.80] in month 5+) [United States, January 2021 to September 2021] Adjusted estimated VE of 1 dose remained greater than **50%** after 2 weeks. [United States; 01 May 2021 to 07 August 2021)				

[cc] Study does not differentiate between COMIRNATY/BNT162b2 and SPIKEVAX/ mRNA-1273.
[cci] Study does not differentiate between the two mRNA vaccines, Pfizer and Moderna.
[ccxii] Study does not differentiate between BNT162b2, mRNA-1273, and ChAdOX-S.

	Estimated results show that vaccine effectiveness significantly wanes from 60 days after the second dose [Japan; February 2020 to December 2021] [cxcii] VE of first dose 68% (95% CI 67.0.% - 69.%; Canada) and 88% (95% CI 87.0% - 88.0%; Canada) [December 2020 to October 2021] Risk of infection decreased 4-6 months after the second vaccine dose, but markedly increased after.[cxciii] Adjusted estimated VE against infections	VE decreased by **18.5% points** (95% CI 8.4-33.4) among all ages and **19.9% points** among older individuals (95% CI; 9.2-36.7) [Overall average from Systematic Review and Meta-Regression][ccii] VE reduced from **96.9%** (range, 93.7-98.0) for the week of 1 May 2021 to **77.8%** (range, 70.1-86.8) by the week of August 28 2021. VE was 95.9% (95% CI, 95.5-96.2) 2 months after the first dose decreased to 80.3% (95% CI	Review and Meta-Regression][ccxiii] **50%** (95% CI, 16-69)14-73 days after second dose. Effectiveness did not fall significantly after longer intervals, however this could be influenced by the study's small number of participants *Against severe COVID-19:* VE decreased by **8.0%** (95% CI, 3.6-15.20) among all ages and **9.7%** (95% CI; 5.9-14.7) among older individuals [Overall average from Systematic Review and Meta-Regression][ccxiv]	VE was lower compared with mRNA vaccines, with no trend observed over time (95% CI, 80.0-90.6%).[United States] *Against symptomatic COVID-19:* VE decreased by **25.4%** (95% CI, 13.7-42.5) among all ages and **32.0%** (95% CI, 11.0-69.0) among older individuals [Overall average from Systematic Review and Meta-Regression][ccxvii] *Against severe COVID-19:* VE decreased by **8.0%** (95% CI,				

[cxcii] Study does not differentiate between Pfizer Moderna, and AstraZeneca.
[cxciii] Study does not differentiate between BNT162b2, mRNA-1273, and ChAdOX-S.
[ccii] Study does not differentiate between Pfizer/BioNTech-Comirnaty, Moderna-mRNA-1273, Janssen-Ad26.COV2.S and AstraZeneca-Vaxrevria.
[ccxiii] Study does not differentiate between Pfizer/BioNTech-Comirnaty, Moderna-mRNA-1273, Janssen-Ad26.COV2.S and AstraZeneca-Vaxrevria.
[ccxiv] Study does not differentiate between Pfizer/BioNTech-Comirnaty, Moderna-mRNA-1273, Janssen-Ad26.COV2.S and AstraZeneca-Vaxrevria.
[ccxvii] Study does not differentiate between Pfizer/BioNTech-Comirnaty, Moderna-mRNA-1273, Janssen-Ad26.COV2.S and AstraZeneca-Vaxrevria.

	peaked after 2 weeks **at 92.4%** [95% CI, 91.7%-93.1%] for BNT162b2), then gradually **fell to 78.6%** (95% CI, 78.0%-79.2%) at 2 to 3 months and **66%** (95% CI, 64.2%-68.0%) **6 months after the second dose**. [United States; 01 May 2021 to 07 August 2021] VE against COVID-19 infections **declined from 90.8%** (95% CI 89.4, 92.0) to **79.1%** (95% CI 75.8, 81.9) in the early group (fully vaccinated in April to June 2021). VE against ICU admission and deaths were comparable. [Malaysia]	79.3-81.2) at 7 months. [United States; December 2020 to September 2021] Waning protection against infections started in month 2 for mRNA-1273 (OR [95% CI] in month 6+, 2.76 [2.51, 3.04]). No waning of protection was observed at any time for ICU admissions. [United States, January 2021 to September 2021] Evidence of waning protection against hospitalization started in month 3 for mRNA-1273 (OR 95% CI, 1.66 [1.26, 2.19] in month 6+) [United States, January 2021 to September 2021] Estimated results show that vaccine	VE against severe outcomes (hospitalization and death) decreased from 83.7% (95% CI, 79.7-87.0) at 2-3 weeks to **63·7%** (59·6–67·4) at 18–19 weeks after the second dose in Scotland. In Brazil, VE decreased from 86·4% (85·4–87·3) at 2-3 weeks, to **42·2%** (32·4–50·6) at 18–19 weeks.[Brazil and Scotland] Against variants: Among individuals who received 2 doses of vaccines (with at least 1mRNA vaccine) VE against Delta declined steadily over time from 84% (95%CI, 81-86%) 7-59 days after the second	3.6-15.20) among all ages and **9.7%** (95% CI; 5.9-14.7) among older individuals [Overall average from Systematic Review and Meta-Regression][ccxviii] VE after 8.4 months was estimated at **33%** (95% CI, 0-86)				

[ccxviii] Study does not differentiate between Pfizer/BioNTech-Comirnaty, Moderna-mRNA-1273, Janssen-Ad26.COV2.S and AstraZeneca-Vaxrevria.

	Among patients aged 16 to 64, VE within one to three months after full vaccination was **91.8%** (95% CI, 80.3 to 96.6), and was **86.4%** (95% CI, 56.9 to 95.7) within four to six months[Japan, 01 July to 30 September 2021][cxciv] VE declined from **82% (95% CI, 79.0-85.0)** 14 to 90 days after vaccination to **53% (95% CI, 43.0-62.0)** after 6 months.[Finland; December 2020 to October 2021][cxcv]	effectiveness significantly wanes from 60 days after the second dose [Japan; February 2020 to December 2021][cciii] VE of first dose 68% (95% CI 67.0.% - 69.%; Canada) and 88% (95% CI 87.0% - 88.0%; Canada) [December 2020 to October 2021] Risk of infection decreased 4-6 months after the second vaccine dose, but markedly increased after. [cciv] Adjusted estimated VE against infections peaked after 2	dose to 71% (95%CI, 66-75%) ≥240 days after the second dose, but recovered to 93% (95%CI, 92-94%) ≥7 days after receiving an mRNA vaccine for the third dose.[Canada; November 2021 to December 2021]ccxv						

[cxciv] Study does not differentiate between BNT162b2 or mRNA-1273.
[cxcv] Study does not differential between mRNA-based vaccines.
[cciii] Study does not differentiate between Pfizer Moderna, and AstraZeneca.
[cciv] Study does not differentiate between BNT162b2, mRNA-1273, and ChAdOX-S.
[ccxv] Study does not differentiate between Pfizer, Moderna, or AstraZeneca.

	Against symptomatic COVID-19: VE decreased by **25.4%** (95% CI, 13.7-42.5) among all ages and **32.0%** (95% CI, 11.0-69.0) among older individuals [Overall average from Systematic Review and Meta-Regression[cxcvi] VE reduced by 22% (95% CI, 6-41) for every 30 days from the second dose for those aged 18 to 64 years. VE against infection was **82%** (95% CI, 79-85) 14-90 days after the second dose and appeared to **wane over time** and was **63%** (95% CI, 55-68) 91-180 days after	weeks at **96.3%** (95% CI, 95.6%-96.9%) then gradually **fell to 86.8%** (95% CI, 86.2%-87.4%) at 2 to 3 months and **74.2%** (95% CI, 71.6%-76.6%) **6 months after the second dose**. [United States; 01 May 2021 to 07 August 2021) Among patients aged 16 to 64, VE within one to three months after full vaccination was **91.8%** (95% CI, 80.3 to 96.6), and was **86.4%** (95% CI, 56.9 to 95.7) within four to six months[Japan, 01 July to 30 September 2021][ccv] VE declined from **82% (95% CI, 79.0-85.0)** 14 to 90 days after							

[cxcvi] Study does not differentiate between Pfizer/BioNTech-Comirnaty, Moderna-mRNA-1273, Janssen-Ad26.COV2.S and AstraZeneca-Vaxrevria.
[ccv] Study does not differentiate between BNT162b2 or mRNA-1273.

	the second dose [27 Dec 2020 – 26 Oct 2021; Finland][cxcvii] VE decreased from **86.9%** (95% CI, 86.5-87.3) in March 2021 to **43.3%** (95% CI, 41.9-44.6) in September 2021 VE declined from **81%** (95% CI, 68-89) 14-73 days after second dose. 4-6 months after second dose, VE remained at **70%** (95% CI, 62-76) and declined to **46%** (95% CI, 22-63) after six months. [second dose was administered ≥6 weeks after first dose]. VE declined from **86%** (95% CI, 73-93) 14-73 days	vaccination to **53% (95% CI, 43.0-62.0)** after 6 months.[Finland; December 2020 to October 2021][ccvi] VE against infection peaked at 90% months after the second dose and was **less than 50%** by the seventh month after the second dose.[Qatar; 01 January 2021 to 05 December 2021] *Against symptomatic COVID-19:* VE decreased by **25.4%** (95% CI, 13.7-42.5) among all ages and **32.0%** (95% CI, 11.0-69.0) among older individuals [Overall average from Systematic							

[cxcvii] Study does not differentiate between COMIRNATY/BNT162b2 and SPIKEVAX/ mRNA-1273.
[ccvi] Study does not differential between mRNA-based vaccines.

	after second dose. 6 months after second dose, VE declined to **61%** (95% CI, 45-73). [second dose was administered ≤6 weeks after first dose] *Against severe COVID-19:* VE decreased by **8.0%** (95% CI, 3.6-15.20) among all ages and **9.7%** (95% CI; 5.9-14.7) among older individuals [Overall average from Systematic Review and Meta-Regression][cxcviii] *Against Hospitalization and Death:* After reaching peak VE (96.8%) 2 months after 2nd dose, **VE did not decline over**	Review and Meta-Regression)[ccvii] *Against severe COVID-19 disease:* VE decreased by **8.0%** (95% CI, 3.6-15.20) among all ages and **9.7%** (95% CI; 5.9-14.7) among older individuals [Overall average from Systematic Review and Meta-Regression][ccviii] *Against hospitalization* VE among **18-64 years of age** remained approximately **greater than 86%** with no obvious time trend regardless of vaccine and **declined** from May through August among						

[cxcviii] Study does not differentiate between Pfizer/BioNTech-Comirnaty, Moderna-mRNA-1273, Janssen-Ad26.COV2.S and AstraZeneca-Vaxrevria.
[ccvii] Study does not differentiate between Pfizer/BioNTech-Comirnaty, Moderna-mRNA-1273, Janssen-Ad26.COV2.S and AstraZeneca-Vaxrevria.
[ccviii] Study does not differentiate between Pfizer/BioNTech-Comirnaty, Moderna-mRNA-1273, Janssen-Ad26.COV2.S and AstraZeneca-Vaxrevria.

	time, except for 7th months (VE 55.6%) with very few cases Evidence of waning protection against hospitalization started in month 2 for BNT162b2 (OR [95% CI], 3.97 [3.26, 4.83] in month 6+) [United States, January 2021 to September 2021] *Against variants:* Among individuals who received 2 doses of vaccines (with at least 1mRNA vaccine) VE against Delta declined steadily over time from 84% (95%CI, 81-86%) 7-59 days after the second dose to 71% (95%CI, 66-75%) ≥240 days after the second dose, but recovered to 93% (95%CI, 92-94%) ≥7 days after receiving an	**persons 65 years of age or older** who were vaccinated with mRNA-1273, from **97.1 to 93.7%**.[United States] *Against variants:* Among individuals who received 2 doses of vaccines (with at least 1mRNA vaccine) VE against Delta declined steadily over time from 84% (95%CI, 81-86%) 7-59 days after the second dose to 71% (95%CI, 66-75%) ≥240 days after the second dose, but recovered to 93% (95%CI, 92-94%) ≥7 days after receiving an mRNA vaccine for the third dose.[Canada; November 2021 to						

	mRNA vaccine for the third dose.[Canada; November 2021 to December 2021]cxcix VE against hospitalization among those 18-64 years of age remained approximately greater than 86% with no obvious time trend regardless of vaccine and declined from May through August among persons 65 years of age or older who were vaccinated with BNT162b2, from 94.8 to 88.6%.[United States] VE after 8.4 months was estimated at **87%** (95% CI, 60-96)	December 2021] ccix VE after 8.4 months was estimated at **89%** (95% CI, 67-96)							

[cxcix] Study does not differentiate between Pfizer, Moderna, or AstraZeneca.
[ccix] Study does not differentiate between Pfizer, Moderna, or AstraZeneca.

Transmission prevention	*Prior Delta Variant:* Vaccine effectiveness against infectiousness given infections **41.3%** VE against transmission **88.5%** VE against onwards transmission of Alpha **57% (95% CI, 5-85**) VE against onwards transmission (VET) of Alpha two weeks after full vaccination was **68%** (95% CI, 52-79); at 12 weeks VET was **52%** (95% CI, 29-67)	VE against onwards transmission: **52%** (95% CI, 33-69) VE against transmission from vaccinated index case to unvaccinated contact is **63%** (95% CI, 46-75) and **40%** (95% CI, 20-54) to a vaccinated contact.[ccxx] VE against transmissibility was **31%** (95% CI, 26-36) when the secondary case was not vaccinated and **10%** (95% CI, 0-18) when secondary case was fully vaccinated Estimated SAR to fully vaccinated	**48%** (limited data) May not be able to block the transmission of the alpha variant as efficiently as the wild type. VE against transmission from vaccinated index case to unvaccinated contact is **63%** (95% CI, 46-75) and **40%** (95% CI, 20-54) to a vaccinated contact.[ccxxi] Evidence of fully vaccinated individuals infecting other fully vaccinated individuals 81 breakthrough infections among 1100 HCWs; 32 breakthrough	VE against transmissibility was **31%** (95% CI, 26-36) when the secondary case was not vaccinated and **10%** (95% CI, 0-18) when secondary case was fully vaccinated Estimated SAR to fully vaccinated household contact was **42.7%** (95% CI, 13.6-77.9)	Unknown	Unknown	No available data	No available data

[ccxx] Study does not differentiate between Comirnaty/BNT162b2, Spikevax/ mRNA-1273, and Vaxzevria/ ChAdOz1 nCOV-19.
[ccxxi] Study does not differentiate between Comirnaty/BNT162b2, Spikevax/ mRNA-1273, and Vaxzevria/ ChAdOz1 nCOV-19.

	Proportion of the total effect (mediated by Ct values) of two vaccinations on transmission of the Alpha variant was **18%** (95% CI, 9-64) *<u>During Delta Variant:</u>* Similar Ct values (<25) were found in both vaccinated and unvaccinated groups VE against onwards transmission (VET) of Delta two weeks after full vaccination was **50%** (95% CI, 35-61); at 12 weeks VET was **24%** (95% CI, 20-28) Proportion of the total effect (mediated by Ct values) of two vaccinations on transmission of the Delta variant	household contact was **6.2%** (95% CI, 2.8-13.0)	infections among 4000 HCWs VE against onwards transmission of Alpha **35% (95% CI, -26 – 74**) Proportion of the total effect (mediated by Ct values) of two vaccinations on transmission of the Alpha variant was **16%** (95% CI, 1-80) VE against onwards transmission (VET) of Alpha two weeks after full vaccination was **24%** (95% CI, 18-30); at 12 weeks VET was **2%** (95% CI, -2-6) VE against onwards transmission (VET) of Delta two weeks after full vaccination was					

	was **23%** (95% CI, 17-33) Studies from Scotland and England demonstrated reductions in secondary infections among families of vaccinated individuals compared to families of unvaccinated individuals. VE against onwards transmission: **62%** (95% CI, 57-67) VE against transmission from vaccinated index case to unvaccinated contact is **63%** (95% CI, 46-75) and **40%** (95% CI, 20-54) to a		**52%** (95% CI, 22-70); at 12 weeks VET was **38%** (95% CI, -1-62) Proportion of the total effect (mediated by Ct values) of two vaccinations on transmission of the Delta variant was **7%** (95% CI, 5-10) VE against onwards transmission of Delta **42% (95% CI, 14-69**) VE against transmissibility was **31%** (95% CI, 26-36) when the secondary case was not vaccinated and **10%** (95% CI, 0-18) when secondary case was fully vaccinated					

	vaccinated contact.[ccxix] VE against onwards transmission of Delta **31% (95% CI, -3 – 61**) VE against infection [within a ten-day window] when having a confirmed household exposure **80.4%** (95% CI, 73.6-85.5) Additional infections occurred in 49.8% (95% CI, 48-51.6) of homogenously unvaccinated household members and 12.5% (95% CI, 9.1-17) of homogenously vaccinated household								

[ccxix] Study does not differentiate between Comirnaty/BNT162b2, Spikevax/ mRNA-1273, and Vaxzevria/ ChAdOz1 nCOV-19.

	members [within a ten-day window] VE against transmissibility was **31%** (95% CI, 26-36) when the secondary case was not vaccinated and **10%** (95% CI, 0-18) when secondary case was fully vaccinated Estimated SAR from fully vaccinated index case was **8.3%** (95% CI, 5.6-12.1) and **35.9%** (95% CI, 34.1-37.6) for unvaccinated index cases Estimated SAR to fully vaccinated household contact was **15.8%** (95% CI, 15.0-16.7) VE against susceptibility to infection **80.5%**								

	(95% CI, 78.9-82.1) VE against infectiousness given infection **41.3%** (95% CI, 9.5-73.0) VE against transmission **88.5%** (95% CI, 82.3-94.8) Delta infection: SAR in fully vaccinated household members was **12.5%,** while the SAR in unvaccinated and partially vaccinated individuals was **27.8%** and **25.0%**, respectively
Transmission prevention: Omicron	Secondary attack rate was **31%** in households infected with the Omicron VOC and **21%** in households with the Delta VOC. Unvaccinated secondary cases demonstrated similar attack rates in households with the Omicron VOC (**29%**) and the Delta VOC (**28%**). Fully vaccinated individuals had a secondary attack rate of **32%** in Omicron infected households and **19%** in Delta infected households. Among individuals who had received a third (booster) shot, secondary attack rate was **25%** for Omicron and **11%** for Delta.

	The odds ratio (OR) for Omicron infection of unvaccinated persons was **1.04** (95% CI, 0.87-1.24) and **0.54** (95% CI, 0.4-0.71) for boosted individuals. Comparing across variants, unvaccinated individuals in Omicron infected households had an estimated OR of **1.17** (95% CI, 0.99-1.38) compared to Delta infected households. For vaccinated and boosted individuals, the estimated OR was **2.61** (95% CI, 2.34-2.90) and **3.66** (95% CI, 2.65-5.05), respectively.							
Breakthrough infections	From 6,161 patients with a positive nasopharyngeal SARS-CoV-2 PCR, 1,120 (18%) were breakthrough infections – 97% of these occurred after 2 May (emergence of Delta variant). Of the 1,120 cases, 126 (12%) were hospitalized. Of the 126 breakthrough admissions, 59 were vaccinated with BNT162b2 Individuals vaccinated in January and	From 6,161 patients with a positive nasopharyngeal SARS-CoV-2 PCR, 1,120 (18%) were breakthrough infections – 97% of these occurred after 2 May (emergence of Delta variant). Of the 1,120 cases, 126 (12%) were hospitalized. Of the 126 breakthrough admissions, 36 were vaccinated with mRNA-1273. Breakthrough infections	As of 10 June, 1.5 million individuals have been fully vaccinated with Covishield in Odisha Province, India. Between 1 March to 10 June, 239 breakthrough infections (SARS-CoV-2 positive after having received two doses of Covishield) were identified. Of these, 199 (83.3%) were symptomatic, 24 (10.0%) were hospitalized - 59 individuals had comorbidities	From 6,161 patients with a positive nasopharyngeal SARS-CoV-2 PCR, 1,120 (18%) were breakthrough infections – 97% of these occurred after 2 May (emergence of Delta variant). Of the 1,120 cases, 126 (12%) were hospitalized. Of the 126 breakthrough admissions, 10 were vaccinated with Ad26.COV2.S	Of 22 individuals fully vaccinated, 20 were infected. Of 26 individuals who received a single dose, 23 were infected.[Bahrain] Of 1033 participants, 16 (1.55%) developed PCR positive COVID-19 infection two weeks after the second dose while 3 (0.29%) had re-infection. [Pakistan]	Omicron (B.1.1.529) was neutralized less effectively by serum from breakthrough infection patients, with a 6.3-fold reduction compared to delta variants. [81ccxxxv] Of 1401 study participants, 32.9% (461 of 1401) were hospitalized after receiving 2 doses of Sinovac compared with 47.8% (669 of 1401) of unvaccinated hospitalized	As of 10 June, 380,000 individuals have been fully vaccinated with Covaxin in Odisha Province, India. Between 1 March to 10 June, 35 breakthrough infections (SARS-CoV-2 positive after having received two doses of Covishield) were identified. Of these, 29 (82.9%) were symptomatic, 3 (8.6%) were hospitalized. 5 individuals had comorbidities	No available data

[ccxxxv] Study does not differentiate between inactivated vaccinates, CoronaVac or AZD1222.

	February had a **51%** (95% CI, 40-68) increased risk for breakthrough infections compared to individuals vaccinated in March and April Breakthrough infections remained under 1% for fully vaccinated individuals (no difference between Pfizer or Moderna recipients between May and August 2021 In a study of 10,412 participants, of which 8,554 were vaccinated, breakthrough infections were reported by 74	remained under 1% for fully vaccinated individuals (no difference between Pfizer or Moderna recipients between May and August 2021 In a study of 10,412 participants, of which 8,554 were vaccinated, breakthrough infections were reported by 74 (1.0%) among fully vaccinated individuals and 198 (2.3%) among partially vaccinated. [United States; December 2020 to September 2021][ccxxvi]	Median antibody titer: 647.5 AU/ ml <u>Vietnamese study</u>: High viral loads were observed 2-3 days before symptom onset among 49 symptomatic breakthrough cases (out of 62). Their peak viral loads measured at any point in time were higher than that of asymptomatic cases (IQR: 16.5 log10/mL vs 30.8 log10/mL, respectively). NAbs were measured for 10 breakthrough cases, all 10 cases had lower NAbs at day 14 and 90 post second vaccination	**4.2%** of fully vaccinated HCWs developed breakthrough infections – all cases were symptomatic but mild, only one case required hospitalization[ccxxxii] Rate of breakthrough infections was comparable to Pfizer and Moderna recipients during the initial stages of the study, but increased to 1.96% (2 times the breakthrough rate of mRNA vaccines) In a study of 10,412 participants, of which 8,554 were vaccinated,		individuals. [Turkey]	Median antibody titer: 213.5 AU/ ml **4.2%** of fully vaccinated HCWs developed breakthrough infections – all cases were symptomatic but mild, only one case required hospitalization [ccxxxvi] In a study of 614 of HCW, 13% (81 of 614) had breakthrough infections – within breakthrough infections, 63% (51 of 81**)** were Covaxin recipients. [India; January to July 2021] Out of 355 fully vaccinated HCWs,	

[ccxxvi] Study does not differentiate between Pfizer, Moderna, or Johnson & Johnson.
[ccxxxii] Study does not differentiate between Covishield (*n*=62.4%) and Covaxin (*n*=37%).
[ccxxxvi] Study does not differentiate between Covishield (*n*=62.4%) and Covaxin (*n*=37%).

	(1.0%) among fully vaccinated individuals and 198 (2.3%) among partially vaccinated. [United States; December 2020 to September 2021][ccxxii] In a case series of 20 HCWs, 90% (18 of 20) had confirmed infection after the first dose (47.1% within the first week, 41.2% within the second week, and 11.8% within the third week. 2 HCWs (10.0%) had infection one week after the second dose. [Saudi Arabia; December	From 126,586 vaccine recipients, 492 (0.39%) were found to have breakthrough infections during the 10-month observational period. 97.2% of the identified breakthrough cases (478 of 492) were asymptomatic or mild and 2.8% (14 of 492) required hospitalization. [Switzerland; December 2021 to October 2021][ccxxvii] Of 23,697 vaccinated HCPs, 0.58% tested positive for COVID (138 of 23,697 cases that received at least one dose of an	compared to controls From 126,586 vaccine recipients, 492 (0.39%) were found to have breakthrough infections during the 10-month observational period. 97.2% of the identified breakthrough cases (478 of 492) were asymptomatic or mild and 2.8% (14 of 492) required hospitalization. [Switzerland; December 2021 to October 2021][ccxxx] In a study of 614 of HCW, 13% (81 of 614) had breakthrough infections – within	breakthrough infections were reported by 74 (1.0%) among fully vaccinated individuals and 198 (2.3%) among partially vaccinated. [United States; December 2020 to September 2021][ccxxxiii] From 126,586 vaccine recipients, 492 (0.39%) were found to have breakthrough infections during the 10-month observational period. 97.2% of the identified breakthrough cases (478 of 492) were asymptomatic or mild and 2.8% (14			16 had symptomatic breakthrough infections >14 days after the second dose. No significant difference was observed between Covishield and Covaxin. [India; 16 January 2021 to 31 July 2021]	

[ccxxii] Study does not differentiate between Pfizer, Moderna, or Johnson & Johnson.
[ccxxvii] Study does not differentiate between Pfizer, Moderna, AstraZeneca, or Janssen.
[ccxxx] ***Study does not differentiate between Pfizer, Moderna, AstraZeneca, or Janssen.
[ccxxxiii] Study does not differentiate between Pfizer, Moderna, or Johnson & Johnson.

	2020 to March 2021] From 126,586 vaccine recipients, 492 (0.39%) were found to have breakthrough infections during the 10-month observational period. 97.2% of the identified breakthrough cases (478 of 492) were asymptomatic or mild and 2.8% (14 of 492) required hospitalization. [Switzerland; December 2021 to October 2021][ccxxiii] Of 23,697 vaccinated HCPs, 0.58% tested positive for COVID (138 of 23,697 cases that received at least one dose of an	mRNA vaccine) – 105 of which only received one dose and 33 (0.15% 33 of 22,458 cases who received both vaccine doses) were among those who completed vaccination. Among the 138 postvaccination cases, 64 were vaccinated with Moderna. Among 1,128 cluster-associated cases of COVID, 918 (81%) were identified as breakthrough infections. Of these, 293 (32%) received the Moderna vaccine. Characteristics of breakthrough infection cases were similar across Pfizer, Moderna, and	breakthrough infections, 37% (30 of 81**)** were Covishield recipients. [India; January to July 2021] Out of 355 fully vaccinated HCWs, 16 had symptomatic breakthrough infections >14 days after the second dose. No significant difference was observed between Covishield and Covaxin. [India; 16 January 2021 to 31 July 2021] Omicron (B.1.1.529) was neutralized less effectively by serum from breakthrough infection patients, with a 6.3-fold	of 492) required hospitalization. [Switzerland; December 2021 to October 2021][ccxxxiv] Among HCW participating in the Sisonke clinical trial, 40,538 breakthrough infections were confirmed – 609 of which occurred during Beta variant predominance, 22,279 cases during Delta, and 17,650 during Omicron. There were a total of 1,914 hospitalizations (77 in the Beta, 1,429 in the Delta, and 408 in the Omicron periods). During Omicron, 91% hospitalized HCWs required				

[ccxxiii] Study does not differentiate between Pfizer, Moderna, AstraZeneca, or Janssen.
[ccxxxiv] Study does not differentiate between Pfizer, Moderna, AstraZeneca, or Janssen.

	mRNA vaccine) – 105 of which only received one dose and 33 (0.15% 33 of 22,458 cases who received both vaccine doses) were among those who completed vaccination. Among the 138 postvacciantion cases, 74 were vaccinated with Pfizer. Among 1,128 cluster-associated cases of COVID, 918 (81%) were identified as breakthrough infections. Of these, 504 (55%) received the Pfizer vaccine. Characteristics of breakthrough infection cases were similar across Pfizer, Moderna, and	Johnson & Johnson vaccines. Cumulative incidence of breakthrough infection was **0.59%** (95% CI, 0.55-0.64) 6 months after the second dose.[Qatar] *Delta (B.1.617.2):* Estimated lower VE against Delta infection since **higher odds of breakthrough infection** were found when comparing Delta and Alpha-infected patients - **odds ratio: 1.96** (95%CI. 1.22-3.14][Portugal, 17 May 2021 to 04 July 2021] [ccxxviii] *Omicron (B.1.1529):*	reduction compared to delta variants. [81] [ccxxxi]	general ward care, 6% high care, and 3% intensive care which were significantly different from the Delta (89% general, 4% high, 7% intensive care) and Beta (78% general, 7% high, 16% intensive care) periods. [South Africa; March 2021 to December 2021] Among 1,128 cluster-associated cases of COVID, 918 (81%) were identified as breakthrough infections. Of these, 121 (13%) received the Johnson & Johnson vaccine. Characteristics of breakthrough infection cases were similar				

[ccxxviii] Study does not differentiate between mRNA vaccines.
[ccxxxi] Study does not differentiate between inactivated vaccinates, CoronaVac or AZD1222.

	Johnson & Johnson vaccines. Overall test positivity rate was 6.4% during the period of Delta dominance and 24.4% during a proxy Omicron period.[South Africa] Of 365 cases with covid in a long-term care facility, the mean attack rate was **18.0%** (95% CI 12.8-23.2) among those fully vaccinated compared with 27.5% (95% CI, 16.3-38.7) among unvaccinated persons. [France] Cumulative incidence of breakthrough infection was **0.84%** (95% CI, 0.79-0.89) 6	Of 111 participants, 59% (66 of 111) had confirmed infection while 14% (15 of 111) were probable cases, the **total attack rate for Omicron was 74%** (81/110).[Norway; November 2021 to December 2021][80ccxxix] Over a period of 8.4 months, **13 out of 387** (3.4%) of vaccinated followed up individuals developed a breakthrough infection [78]		across Pfizer, Moderna, and Johnson & Johnson vaccines.				

[ccxxix] Study does not differentiate between mRNA vaccines.

	months after the second dose.[Qatar] *Delta (B.1.617.2):* Estimated lower VE against Delta infection since higher odds of breakthrough infection were found when comparing Delta and Alpha-infected patients - odds ratio: 1.96 (95%CI. 1.22-3.14][Portugal, 17 May 2021 to 04 July 2021] [ccxxiv] *Omicron (B.1.1529):* Breakthrough cases described symptoms as mild or moderate, had viral loads ranging from 15,011.2 to over 40,000 AU.mL[79]									

[ccxxiv] Study does not differentiate between mRNA vaccines.

	Of 111 participants, 59% (66 of 111) had confirmed infection while 14% (15 of 111) were probable cases, the **total attack rate for Omicron was 74%** (81/110).[Norway; November 2021 to December 2021][80] [ccxxv] Over a period of 8.4 months, **8 out of 212** (3.8%) of vaccinated followed up individuals developed a breakthrough infection [78]							
	SAFETY AND ADVERSE EVENTS							
	BNT162b2/ COMIRNATY	**Spikevax/ Moderna COVID-19 Vaccine/ mRNA-1273**	**Vaxzevria/ ChAdOx1 nCoV-19/ AZD1222/ Covishield**	**Janssen COVID-19 vaccine/Johnson & Johnson**	**Covilo/ /BBIBP-CorV**	**CoronaVac**	**COVAXIN / BBV152**	**Nuvaxovid/ NVX-CoV2373/ Covovax**

[ccxxv] Study does not differentiate between mRNA vaccines.

Common side effects	Pain at the injection site, fatigue, headache, myalgia, chills and fever, arthralgia Optimal safety for asthma patients. More adverse events reported after the first than the second dose for recipients who had prior COVID-19 infections <u>Acute adverse events (AAE)</u> **17.8** cases of dizziness, **9.7** of headache, **7.1** of nausea and **3.2** of syncope per 10,000 doses administered were observed in Saudi Arabia One in ten AAEs were considered serious, but only 0.1 per 10,000 doses required hospitalization for	Pain at injection site, headache, fatigue, myalgia, arthralgia, Covid arm (cutaneous hypersensitivity). The vaccine is considered safe for cancer patients undergoing treatments. Anaphylaxis rates associated with vaccine is comparable to those of other vaccines and is ranked fifth in reported anaphylaxis rates, behind rabies, tick-borne encephalitis, measles-mumps-rubella-varicella, and human pappilomavirus vaccines	Fatigue, myalgia, arthralgia, headache, lethargy, fever, & nausea, urticaria Anaphylaxis rates associated with vaccine is comparable to those of other vaccines and is ranked fifth in reported anaphylaxis rates, behind rabies, tick-borne encephalitis, measles-mumps-rubella-varicella, and human papilomavirus vaccines	Headache, fever, chills, fatigue, myalgia, and nausea. Anaphylaxis rates associated with vaccine is comparable to those of other vaccines and is ranked fifth in reported anaphylaxis rates, behind rabies, tick-borne encephalitis, measles-mumps-rubella-varicella, and human pappilomavirus vaccines	Pain at the injection site, dizziness, fever, headache, fatigue, nausea, vomiting, & allergic dermatitis.	Pain at injection site, headache, fatigue, tremors, & flushing, inflammatory reaction, urticaria, myalgia	Pain at injection site, headache, pyrexia, fatigue, myalgia	Pain at injection-site, headache, muscle pain, fatigue

	non-anaphylaxis reasons The vaccine is considered safe for cancer patients undergoing treatments. Anaphylaxis rates associated with vaccine is comparable to those of other vaccines and is ranked fifth in reported anaphylaxis rates, behind rabies, tick-borne encephalitis, measles-mumps-rubella-varicella, and human pappilomavirus vaccines							
Risk of developing	Cerebral venous sinus thrombosis **OR 4.40*** (95% CI, 3.56-5.44) **Absolute risk 0.6** (95% CI, 0.5-0.7) per million doses	Cerebral venous sinus thrombosis **OR 2.67*** (95% CI, 1.77-4.03) **Absolute risk 0.6** (95% CI, 0.3-1.1) per million doses	Cerebral venous sinus thrombosis **OR 15.43*** (95% CI, 13.73-17.34) **Absolute risk 7.5** (95% CI, 6.9-8.3) per million doses	Cerebral venous sinus thrombosis **Absolute risk 0.7** (95% CI, 0.2-2.4) per million doses Cerebral venous sinus thrombosis with thrombocytopenia				

adverse event[ccxxxvii]	Cerebral venous sinus thrombosis with thrombocytopenia **Absolute risk 0.0** (95% CI, 0.0-0.1) per million doses Guillain-Barre syndrome **OR 1.53*** (95% CI, 1.34-1.75) Haemorrhagic stroke **OR 0.82** (95% CI, 0.66-1.02) Ischemic stroke **OR 2.73*** (95% CI, 2.48-3.01) Transient ischemic attack **OR 1.24*** (95% CI, 1.13-1.36) Acute pericarditis **OR 3.33*** (95% CI, 1.29-10.14)[ccxxxviii]	Cerebral venous sinus thrombosis with thrombocytopenia **Absolute risk 0.0** (95% CI, 0.0-0.2) per million doses Guillain-Barre syndrome **OR 1.74*** (95% CI, 1.43-2.12) Haemorrhagic stroke **OR 0.72** (95% CI, 0.50-1.04) Ischemic stroke **OR 1.56*** (95% CI, 1.28-1.90) Transient ischemic attack **OR 0.99** (95% CI, 0.84-1.16) Acute pericarditis **OR 3.33*** (95% CI, 1.29-10.14)[ccxl]	Cerebral venous sinus thrombosis with thrombocytopenia **Absolute risk 4.4** (95% CI, 3.9-4.9) per million doses Guillain-Barre syndrome **OR 2.74*** (95% CI, 2.49-3.02) Haemorrhagic stroke **OR 0.53** (95% CI, 0.41-0.69) Ischemic stroke **OR 2.13*** (95% CI, 1.92-2.37) Transient ischemic attack **OR 1.38*** (95% CI, 1.27-1.50)	**Absolute risk 0.7** (95% CI, 0.2-2.4) per million doses Acute pericarditis **OR 3.33*** (95% CI, 1.29-10.14)[ccxlii] Thrombosis with thrombocytopenia syndrome Reporting rate of **3.83** per million vaccine doses				

[ccxxxvii] Values with a * were deemed significant in the report
[ccxxxviii] Study does not differentiate between vaccines.
[ccxl] Study does not differentiate between vaccines.
[ccxlii] Study does not differentiate between vaccines

	Thrombosis with thrombocytopenia syndrome Reporting rate of **0.0085** per million vaccine doses[ccxxxix]	Thrombosis with thrombocytopenia syndrome Reporting rate of **0.0085** per million vaccine doses[ccxli]						
Rare adverse events	Myocarditis & myopericarditis, pericarditis, thrombosis , anaphylaxis and swelling of the lips, face, and tongue related to anaphylaxis (11 anaphylaxis cases per million doses administered), paroxysmal ventricular arrhythmia, leg paresthesia, pityriasis rosea (lesions improved completely after ~8 weeks), lymphocytic vasculitis, varicella-zoster	Myocarditis & myopericarditis, pericarditis, orofacial swelling & anaphylaxis. Potential risk factor for Bell's palsy (most improve upon follow-up), herpes zoster reactivation, varicella zoster reactivation, herpes zoster ophtalmicus, eczema & urticaria, transverse myelitis, Guillain-Barré syndrome, acute generalized exanthematous	Transverse myelitis, high fever, cutaneous hypersensitivity, vasculitis, thromboembolism, vaccine induced immune thrombotic thrombocytopenia, intracerebral haemorrhage, small vessel vasculitis, psoriasis, rosacea, raynaud's phenomenon, Ischaemic stroke, anaphylaxis, recurrent herpes zoster, generalized	Thrombosis, thrombocytopenia, increased risk of developing Guillain-Barré syndrome post vaccination, herpes zoster ophtalmicus, pseudothrombocytopenia, vaccine induced thrombocytopic thrombosis, cutaneous reactions, optic neuritis, subacute thyroiditis, CNS demyelination, bullous local reaction, acute vertigo[31] adver	Cutaneous reactions, herpes zoster, CNS demyelination, eosinophilic panniculitis[38] Rare adverse events were similar among the vaccine groups and control group within 7 days. Pityriasis rosea, uveitis	Myalgia, fever, pityriasis rosea (lesions improved completely after ~8 weeks), reactivation of herpes zoster and herpes simplex. Most reactions improved without treatment within a few weeks, Guillain-Barré syndrome, subacute thyroiditis, erythema multiforme, uveitis, vaccine induced thrombotic thrombocytopenia, serum sickness-	Subacute thyroiditis, herpes zoster	Cutaneous reactions Myocarditis was reported in one vaccine recipient, occurring 3 days after second dose

[ccxxxix] Does not differentiate between BNT162b2 and mRNA-1273.
[ccxli] Does not differentiate between BNT162b2 and mRNA-1273.

	reactivation, Kikuchi-Fujimoto disease, thrombotic thrombocytopenic purpura, IgA nephropathy flare-up, Guillain-Barré syndrome, psoriasis, immunoglobulin A vasculitis, immune complex vasculitis, Rhabdomyolysis, subacute thyroiditis, Bell's Palsy, erythema multiforme, vaccine induced interstitial lung disease, macular neuroretinopathy, brachial neuritis, thyroid eye disease, exacerbation of subclinical hyperthyroidism, rhabdomyolysis, internal jugular vein thrombosis, herpes simplex, herpes zoster, virus keratitis, cervical lymphadenopathy,	pustulosis, rhabdomyolysis, cervical lymphadenopathy, glomerulonephritis, Behçet's disease, neurological autoimmune disease, axillary adenopathy, multiple sclerosis, cutaneous reactions, Löfgren's syndrome, erythema multiforme, pemphigus vulgaris, graft rejection (corneal), thrombotic thrombocytopenic purpura, reactivation of BCG scars, urticarial vasculitis, CNS demyelination, thrombocytopenia, thyroiditis, thyrotoxicosis, polymyalgia rheumatic, acute vertigo[31]	bullous fixed drug eruption, Guillain-Barré syndrome, pityriasis rosea. Vaccination in individuals with adrenal insufficiency can lead to adrenal crises, Dariers disease, vaccine induced acute localized exanthematous pustulosis, Henoch-Schönlein Purpura, rhabdomyolysis, Grave's disease, acute demyelinating polyradiculoneuropathy, erythema nodosum, polyarthralgia, recurrence of cutaneous T-cell lymphoma, neurological autoimmune disease, multiple sclerosis, sudden sensorineural hearing loss, acute-onset polyradiculoneuro	97% of reported reactions after vaccine administration were non-serious.		like reaction, cutaneous reactions, neuromyelitis optica spectrum disorders (transverse myelitis or optic neuritis), bullous pemphigoid, CNS demyelination, deafness, glomerulonephritis		

	glomerulonephritis, Ramsay-Hunt syndrome, Sweet's syndrome, neurological autoimmune disease, axillary adenopathy, multiple sclerosis, meningoencephalitis, intracerebral haemorrhage due to vasculitis, cutaneous reactions, pigmented purpuric dermatosis, graft rejection (corneal), flexural exanthema, severe non-anaphylatic allergic reaction, uveitis, erythroderma, Behçet's disease, brachial plexus neuritis, systemic capillary leak syndrome, chronic graft-versus-host-disease flare up, vaccine-induced pneumonitis,		pathy, cutaneous reactions, leukocytoclastic vasculitis, Löfgren's syndrome, acute eosinophilic pneumonia, bullous sweet syndrome, neuralgic amyotrophy of the lumbosacral plexus, sudden sensorineural hearing loss, graft rejection (corneal), erythema annulare centrfugum, graft rejection (stromal), leukocytoclastic vasculitis, subacute thyroiditis, vaccine-induced pneumonitis, myositis, glomerulopathy, nephrotic syndrome, macular neuroretinopathy[33], takotsubo cardiomyopathy[34], Kawasaki[35], acute					

	reactivation of BCG scars, CNS demyelination, urticarial reactions, transverse myelitis, thyrotoxicosis, acquired haemophilia A (AHA)[23,24], transient lymphedema[25], anti-LGI1 encephalitis[26], eosinophilic granulomatosis[27], rarepyoderma gangrenosum[28], transverse myelitis[29], acute vertigo[31], leukocytoclastic vasculitis[32] Systemic allergic symptoms were more common in BNT162b2 than mRNA-1273, however, anaphylaxis rates were similar for both mRNA vaccines, could potentially worsen		vertigo[31], chilblain-like lesions[36]					

	migraines in people who already suffer from migraines Having adverse reactions is associated with enhanced SARS-CoV-2 IgG antibody response							
Potential associated adverse events (causal links not yet proven)	Cerebral venous sinus thrombosis and intracranial haemorrhage, aseptic meningitis, autoimmune hepatitis, multiple sclerosis relapse, myeloperoxidase anti-neutrophil cytoplasmic antibody-positive optic perineuritis, central retinal vein occlusion, paracentral acute middle maculopathy & acute macular neurotinopathy, Stevens-Johnson syndrome/ toxic epidermal necrolysis,	Cerebral venous sinus, Autoimmune hepatitis, myocardial infarction, autoimmune haemolytic anaemia, hypophysitis & panhypopituitarism, erythema nodosum, pulmonary embolism, minimal change disease, encephalomyelitis, lupus nephritis, retinal vein occlusion, takotsubo syndrome, encephalitis, status epilepticus ,	Autoimmune hepatitis, Acute hyperglycaemic crisis, Facial nerve palsy, cervical myelitis, alopecia areata, takotsubo (stress) cardiomyopathy, acute disseminated encephalomyelitis, cerebral venous sinus thrombosis (higher risk for women), ophthalmic vein thrombosis, retinal vein occlusion, Still's disease, autoimmune encephalitis, acute abducens palsy, lichenoid eruption, multisystem	Facial Diplegia, acute macular neurotinopathy, cerebral venous sinus thrombosis, oral lichen planus	Cerebral venous sinus thrombosis , Longitudinally extensive transverse myelitis	Cerebral venous sinus thrombosis , Likely vaccine associated disease enhancement (VADE), autoimmune hepatitis	No available data	No available data

	lichenoid cutaneous skin eruption, acute mania and psychotic features, acute psychosis due to anti-N-methyl-D-aspartate receptor (anti-NMDAR) encephalitis, alopecia areata, rhombencephaliti, multisystem inflammation and organ dysfunction, aplastic anaemia, bullous pemphigoid, minimal change disease, miller fisher syndrome, unilateral acute foveolitis, encephalomyelitis, acute posterior multifocal placoid pigment epitheliopathy, trigeminal neuralgia, vestibular neuritis, autoimmune acquired factor XIII/13 deficiency, Still's disease,	pleuropericardial diffusion One case developed IgA Nephropathy after receiving the second dose of mRNA-1273.	inflammatory syndrome, parosmia, encephalopathy, reactivation of bipolar mania						

	autoimmune acquired factor XIII/13 deficiency, Still's disease, cranial nerve palsy, inflammatory bowl disease, pancreatitis, lupus nephritis[39]							
Myocarditis data	Mainly reported in young adults and adolescents *First dose (1-28 days post vaccination):* Incidence rate ratio of **1.37** (95% CI, 1.12-1.67) *Second dose:* Incidence rate ratio of **1.60** (95% CI, 1.31-1.97) *Third dose:* Incidence rate ratio of **2.02** (95% CI, 1.40-2.91) *Males <40 years: First dose [1-28 days post vaccination]:*	Mainly reported in young adults and adolescents *First dose (1-28 days post vaccination):* No association *Second dose:* Incidence rate ratio of **13.71** (95% CI, 8.46-22.20) *Third dose:* No association (small sample size) *Males <40 years: First dose [1-28 days post vaccination]:*	*First dose (1-28 days post vaccination):* Incidence rate ratio of **1.27** (95% CI, 1.05-1.55) *Second dose:* No association *Third dose:* No association (small sample size) *Males <40 years: Second dose [1-28 days post vaccination]:* Incidence rate ratio of **2.57** (95% CI, 1.52-4.35)	No available data	No available data	No available data	No available data	Myocarditis was reported as viral myocarditis. Participant fully recovered after 2 days of hospitalisation. No episode of anaphylaxis or vaccine-associated enhanced COVID-19 was reported

	Incidence rate ratio of **1.66** (95% CI, 1.14-2.41) *Second dose [1-28 days post vaccination]:* Incidence rate ratio of **3.41** (95% CI, 2.44-4.78) *Third dose [1-28 days post vaccination]:* Incidence rate ratio of **7.60** (95% CI, 2.44-4.78) <u>Israeli study:</u> Estimated incidence within 42 days after receipt of first dose per 100,000 vaccinated persons was **2.13** cases (95% CI, 1.56-2.7) <u>Male patients</u> Incidence of **4.12** (95% CI, 2.99-5.26) per 100,000 vaccinated **3.19** cases (95% CI, 2.37-4.02) per	Incidence rate ratio of **2.34** (95% CI, 1.03-5.34) *Second dose [1-28 days post vaccination]:* Incidence rate ratio of **16.52** (95% CI, 9.10-30.0) <u>*Females <40 years*</u> *Second dose [1-28 days post vaccination]:* Incidence rate ratio of **7.55** (95% CI, 1.67-34.12) 5.8 cases per 1 million second dose administrations **95.4** (95% CI, 52.1-160.0) **cases** per 1 million second dose administrations in patients aged 12-39						

	100,000 vaccinated <u>Female patients</u> Incidence of **0.23** (95% CI, 0-0.49) per 100,000 vaccinated **0.39** cases (95% CI, 0.10-0.68) per 100,000 vaccinated <u>≥30 years</u> Incidence of **1.13** (95% CI, 0.66-1.60) per 100,00 vaccinated **5.8 cases** per 1 million second dose administrations **95.4** (95% CI, 52.1-160.0) **cases** per 1 million second dose administrations in patients aged 12-39 **5.07** cases per 100,000	*<u>12–39-year-olds (within 28 days of vaccination:</u>* <u>Female patients</u> **2.0** (95% CI, 0.7-4.8) per 100,000 vaccinated <u>Male patients</u> **6.3** (95% CI, 3.6-10.2) per 100,000 vaccinated							

	Disease severity Mild: **1.62** (95% CI, 1.12-2.11) Intermediate: **0.47** (95% CI, 0.21-0.74) Fulminant: **0.04** (95% CI, 0-0.12) Risk per 100,000 persons 1st dose (male): **0.64** 2nd dose (male); **3.83** 1st dose (female): **0.07** 2nd dose (female): **0.46** 1st dose (male 16-19): **1.34** 2nd dose (male 16-19): **15.07** *12–39-year-olds (within 28 days of vaccination:* Female patients **1.3** (95% CI, 0.8-1.9) per 100,000 vaccinated Male patients								

	1.5 (95% CI, 1.0-2.2) per 100,000 vaccinated							
	CHILDREN VACCINATION							
	BNT162b2/ COMIRNATY	**Spikevax/ Moderna COVID-19 Vaccine/ mRNA-1273**	**Vaxzevria/ ChAdOx1 nCoV-19/ AZD1222/ Covishield**	**Janssen COVID-19 vaccine/Johnson & Johnson**	**Covilo/ /BBIBP-CorV**	**CoronaVac**	**COVAXIN / BBV152**	**Nuvaxovid/ NVX-CoV2373/ Covovax**
Efficacy	*Adolescents (12-15):* After one dose had efficacy of **75% (CI, 7.6-95.5)** After second dose efficacy of **100% (CI, 78.1-100)** *Children (5-11):* After second dose efficacy of **90.7% (CI, 67.7-98.3)**	*Adolescents (12-17):* 14 days after one dose had efficacy of **92.7% (CI, 67.8-99.2)** After second dose efficacy of **93.3% (CI, 47.9-99.9)** ***Against SARS-CoV-2 Infection:*** 14 days after first dose efficacy of **68.9% (95% CI, 49.9-82.1)**	No available data Paused ongoing trials in children aged 6-17 due to concerns over rare blood clots reported in adult population	No available data Announced at beginning of April ongoing study in adolescents but paused to investigate blood clots in adult population	*Children (3-17):* Unknown. Ongoing clinical trial only looked at safety, tolerability, and immunogenicity [ccxliii] * * The study design administered **three doses** of 2 µg, 4 µg, or 8 µg of vaccine	*Children (3-17):* Unknown. Clinical trial only looked at safety, tolerability and immunogenicity	No available data	*Adolescents (16-17):* PREVENT-19 clinical trial[ccxliv] expanded to assess efficacy, safety, and immunogenicity in 12–17-year-old adolescents

[ccxliii] Safety and immunogenicity of an inactivated COVID-19 vaccine, BBIBP-CorV, in people younger than 18 years: a randomised, double-blind, controlled, phase 1/2 trial. *The Lancet Infectious Diseases.* https://www.thelancet.com/journals/laninf/article/PIIS1473-3099(21)00462-X/fulltext

[ccxliv] A Study to Evaluate the Efficacy, Immune Response, and Safety of a COVID-19 Vaccine in Adults ≥18 Years With a Pediatric Expansion in Adolescents (12 to <18 Years) at Risk for SARS-CoV-2. *ClinicalTrials.gov*. ClinicalTrials.gov Identifier: NCT04611802. https://clinicaltrials.gov/ct2/show/NCT04611802?term=Novavax&cond=Covid19&draw=2

	Children (Under 5 years): Ongoing trials	14 days after second dose efficacy of **55.7% (95% CI, 16.8,82.1)** ***Against asymptomatic:*** 14 days after first dose efficacy of **59.5% (95% CI, 28.4-77.3)** 14 days after second dose efficacy of **39.2 (95% CI, -24.7-69.7)** *Children (6month-11):* Ongoing trials						
Effectiveness	*Adolescents Against SARS-CoV-2 infection:* **91.5%** (95% CI, 88.2-93.9) **91%** (95% CI, 88-93) **92%** (95% CI, 79%–97%)" from July-Dec 2021 *Adolescents Against hospitalisation:*	No available data	No available data	No available data	No available data	No available data	No available data	No available data

	81% (95% CI, -55-98) **93%** (95% CI,83-97) **94%** (95% CI, 91 to 97) *Adolescents against ICU care:* **98%** (95% CI, 93 to 99)[82] *Waning VE in Adolescents 12-16:* VE against breakthrough infection reduced to **75% (95% CI: 71%, 79%)** after 90-149 days after second dose and **58% (95% CI: 52%, 64%**) 150-180 days after second dose VE against symptomatic infection was 78% **(95% CI: 73%, 82%)** after 90-140 days and **65% (95% CI: 58%, 71%)** after 150-180 days[83]								

	effectiveness of 2 doses against MIS-C was **91%** (95% CI, 78%–97%)[84]							
Immunogenicity	*Adolescents (12-15) serum-neutralizing titer:* 1 month after 2nd dose had **1283.0 GMN_{50} (CI, 1095.5-1402.5)** *Adolescents/young adult (16-25) serum-neutralizing titer:* 1 month after 2nd dose had **705.1 GMN_{50} (CI, 621.4-800.2)** *Children (5-11):* 1 month after 2nd dose had **1,197.6 GMT (95% CI, 1106.1-1296.6)** SARS-CoV-2-neutralizing antibody *Children (Under 5):* Ongoing trials[85]	*Adolescents (12-17):* Neutralizing antibody titer after 2nd dose was **1401.7 GMN_{50} (CI, 1276.3-1539.4)** Serological response was **98.8% (CI, 97.0-99.7)** *Children (6-11):* Seroreponse of **99.3%** *Children (6month-11):* Ongoing trials[86] *Adolescents (12-17) Against Omicron:* **11.8-fold reduction** in GMT compared to wild-type	No available data	No available data	*Children (3-17):* Neutralizing antibodies after 28 days after 2nd dose ranged from **105.3-180.2 GMT** in 3-5 years cohort, **84.1-168.6 GMT** in 6-12 years cohort, and **88.0-155.7 GMT** in 13-17 years cohort Neutralizing antibodies after 28 days after 3rd dose ranged from **143.5-224.5 GMT** in 3-5 years cohort, **127-184.8 GMT** in 6-12 years cohort, and **150.7-199 GMT** in 13-17 years cohort GMC of anti-RBD antibody in adolescent cohort aged 12-17 was	*Children (3-17):* Neutralizing antibody response after 2nd dose **(100%)** with GMT ranging from **45.9-212.6**	Ongoing clinical trial[88] Neutralizing antibodies after 56 days after 2nd dose was **358.6 GMT (95% CI, 287.2-447.8)** in 2-6 years group, **366.9 (95% CI, 297.0-453.3)** in 6-12 years group, and **317.4 (95% CI, 224.4-449.2)** in 12-18 years group	Ongoing clinical trial[89]

	Adolescents (11-16) Against Omicron: **3-4-fold reduction** in neutralization detectable titers in only **3 of 15** adolescents GMT for WA1 were **329** (range 94-1096)**.** For Omicron, was **39** (range 25-64)	*Children (6012) Against Omicron:* **22.1 fold reduction** in GMT compared to wild-type[87]			**102.9 BAU/mL (95%CI; 91.0-116.4)** after 4 weeks since 2nd dose			
Safety and Adverse events	Rare possibility of developing multisystem inflammatory syndrome *Adolescents (12-15):* Local and systemic events were generally mild to moderate Severe injection-site pain **(1.5%)** Fever **(20%)** High Fever **(0.1%)** Adverse events **(6%)**	Rare possibility of developing multisystem inflammatory syndrome *Adolescents (12-17):* Solicited local reactions after 2nd dose **(93.4%)** Most common solicited adverse reactions were Injection-site pain **(92.7%)** Headache **(70.2%)**	No available data	Rare possibility of developing multisystem inflammatory syndrome	*Children (3-17):* Most common adverse reaction was pain at injection site in 3–5-year group **(4%)**, 6-12-year group **(1.2%)**, and 13-17-year group **(7.9%)** Most common systemic reactions in all three age cohorts were mild to moderate **fever** and **cough**	*Children (3-17):* Adverse reactions in 12–17 year group **(35%)**, 3-5 year group **(26%)**, and 6-11 year group **(18%)** Reported at least one adverse event **(27%)** Most reported events were mild and moderate and only **(<1%)** grade 3 events Injection-site pain **(13%)** Fever **(25%)**	Ongoing clinical trial[88] Most common local reaction of mild injection site pain in no more than **35%** of all age groups Most frequent solicited systemic adverse event was mild-to-moderate fever- **5%** of 12-18 group, **10%** of 6-12 group, and **13%** of 2-6 group	Ongoing clinical trial[89]

	Severe adverse events **(0.6%)** *Adolescent/young adults (16-25):* Local and systemic events were generally mild to moderate Severe injection-site pain **(3.4%)** Fever **(17%)** Adverse events **(6%)** Severe adverse events **(1.7%)** *Children (5-11):* Pain at injection site, fatigue, headache, chills were reported. Overall, the vaccine is safe and tolerable *Children (Under 5):* Ongoing trials[85] Additional reports of rare cases of multisystem inflammatory syndrome	Fatigue **(67.8%)** Grade 3 adverse events **(6.8%)**) Most common solicited local reaction: injection-site pain after first injection **(93.1%)** and second injection **(92.4%)** Most common systemic **reactions: fatigue, myalgia,** and **chills** *Children (6-11):* Vaccine was generally well tolerated *Children (6month-11):* Ongoing trials[86]			Adverse events were mostly mild to moderate in severity **18.1%** reactogenicity reported on day 1 in adolescents 12-17, most common immediate local events were **mild pain and tenderness** at injection site, No serious adverse events			

	Among 8,113,058 doses administered to 4,079,234 12–17-year-old children, 9 developed multisystem inflammatory syndrome in France. Reporting rate was 1.1 (95% CI, 0.5-2.1) per million doses administered. Out of 4,249 VAERS reports of adverse events, 4,149 **(97.6%)** were **nonserious events**. *<u>Adverse events cases:</u>* 15-year old boy developed nephrotic syndrome							
Myocarditis Data	Few reported cases of acute myocarditis and pericarditis in 16-25 year olds (mainly in males)	Few reported cases of acute myocarditis and pericarditis (mainly in males)	No available data	No available data	No available data	No available data	No available data	No available data

	From large VAERS cohort, 11 verified reports of myocarditis **4.3 cases per 100,000** (95% C.I. 2.6–6.7) 18 year olds after second dose <u>Male patients 12-17 years</u> **97 cases per million** (1 in 10,000 males) <u>Female patients 12-17 years</u> **16 cases per million** (1 in 63,000 females) <u>16-29 years</u> Incidence of **5.49** (95% CI, 3.59-7.39) per 100,00 vaccinated <u>Male patients (16-29 years)</u> Incidence of **10.69** (95% CI, 6.93-14.46) per	*<u>16-17 year old boys in US</u>*: *Second dose*: 31.2 cases per million doses administered							

	100,000 vaccinated Incidence of **13.6 cases** (95% CI, 9.30-19.20) per 100,000 vaccinated *<u>12-15 year old boys in US</u>*: *First dose*: 4.8 cases per million doses administered *Second dose*: 42.6 cases per million doses administered *<u>12-15 year old girls in US</u>*: *First dose*: 0.5 cases per million doses administered *Second dose*: 4.3 cases per million doses administered *<u>16-17 year old boys in US</u>*: *First dose*: 5.2 cases per million								

	doses administered *Second dose*: 71.5 cases per million doses administered *<u>16-17 year old girls in US</u>*: *First dose*: 0.0 cases per million doses administered *Second dose*: 8.1 cases per million doses administered							
	HETEROLOGOUS VACCINATION							
Vaccine Schedule	**BNT162b2/ChAdOx1** Administration of ChAdOx1 as second/booster dose	**ChAdOx1/mRNA-1273** Administration of mRNA-1273 as second/booster dose	**ChAdOx1/BNT162b2** Administration of BNT162b2 as second/booster dose	Not Applicable (one dose schedule) For more information refer to booster section	**BBIBP/BNT162b2**	**CoronaVac/ChAdOx1** Press releases have confirmed that Thailand will use the AstraZeneca vaccine as the second dose for individuals whose	**ChAdOx1/BBV152** Administration of Covaxin as second/booster dose	Ongoing trial[90] (Com-Cov2)[ccxlvi]

[ccxlvi] Comparing COVID-19 Vaccine Schedule Combinations. *University of Oxford.* https://comcovstudy.org.uk/about-com-cov2

						first dose was Sinovac[ccxlv] **CoronaVac/Convidecia**		
Immunogenicity	*GMCs of SARS-CoV-2 anti-spike IgG at 28 days post booster:* Heterologous **(7133 ELU/mL, CI 6415-7932)** vs. Homologous **(14080 ELU/mL, CI 12491-15871)** *SFC frequency (T0cell ELISpot):* Heterologous **(99 SFC/10^6 PBMCs)** vs. Homologous **(80 SFC/10^6 PBMCs)** ***Heterologous mRNA:*** **84.7%** effectiveness (95% CI, 83.1-86.1)	**Spike-specific IgG antibodies:* Heterologous **(3602 BAU/mL)** vs. Homologous **(4189 BAU/mL)** **Neutralizing antibodies:* Heterologous **(100%)** vs. Homologous **(100%)** ***Heterologous mRNA:*** **84.7%** effectiveness (95% CI, 83.1-86.1) *Results based on immunosuppressed population	*RBD antibody titres:* Heterologous **(7756.68 BAU/mL, CI 7371.53-8161.96)** vs. Homologous **(99.84 BAU/mL, CI 76.93-129.59)** at day 14 *IgG antibody titres:* Heterologous **(3684 BAU/mL)** vs. Homologous **(101.2 BAU/mL)** at day 14 *Neutralizing antibodies:* Heterologous **(100%)** at day 14 vs.	Not Applicable (one dose schedule) For more information refer to booster section	Unknown (on-going clinical trial)[49]	**CoronaVac/ChAdOx1 :** *Anti-S Antibodies:* Heterologous **(797 U/mL; 95% CI, 598.7-1062)** vs. Homologous CoronaVac **(94.4 U/mL; 95% CI : 76.1-122.1)** vs. Homologougous ChAdOx1 **(818 U/mL; 95% CI: 662.5-1010)** **CoronaVac/Convidecia** *Neutralizing antibodies :* Heterologous **54.4 GMT** (95% CI, 37.9-78) vs. Homologous CoronaVac	*RBD antibody titres:* Heterologous **(1866 GMT; 95% CI, 1003-3472)** vs. Homologous Covishield **(2260 GMT; 95% CI, 1881-2716)** vs. Homologous Covaxin **(710 GMT, 95% CI, 461-1092)** *N-protein IgG:* Heterologous **(1145 GMT; 95% CI, 520.7-2520)** vs. Homologous Covishield **(353.7 GMT; 95% CI, 219.9-568.9)** vs.	No available data Ongoing trial[90]

[ccxlv] Malaysia to stop using Sinovac vaccine after supply ends - minister. *Reuters* [press release]. https://www.reuters.com/world/asia-pacific/malaysia-stop-using-sinovac-vaccine-after-supply-ends-minister-2021-07-15/

			Homologous **(30%)** at day 14 Heterologous **(median 99%)** vs. Homologous (BNT162b2/BNT162b2) **(median 62%)**			**12.8 GMT** (95% CI, 9.3-17.5)	Homologous Covaxin **(742.4 GMT; 95% CI, 485.8-1134)** *Neutralizing antibody titres :* Heterologous **(171.4 GMT; 95% CI, 121.3-242.3)** vs. Homologous Covishield **(111 GMT; 95% CI, 98.59-124.9)** vs. Homologous Covaxin **(86 GMT; 95% CI, 138.2-252.0)**	
Immunogenicity against variants	No available data	No available data	*Neutralizing Antibodies for Alpha, Beta, Gamma, and Delta:* Heterologous **2.3-fold to 3.6-fold** higher neutralizing antibodies than homologous *Omicron (B.1.1.529):*	No available data	No available data	No available data	*Neutralizing antibody titres **B.1.539.4:*** **GMT (95% CI, 263.9-1103)** *Neutralizing antibody titres **Alpha:*** **396.1 GMT (95% CI, 199.1-788)** *Neutralizing antibody titres **Beta:***	No available data

			13/20 seropositive against Omicron[91]				**151 GMT (95% CI, 80.21-284.3)** *Neutralizing antibody titres* ***Delta***: **241.2 GMT (95% CI, 74.99-775.9)**	
Reactogenicity	Observed increase in systemic reactogenicity after boost in heterologous schedules in comparison with homologous schedules *Adverse events in heterologous:* Adverse events **(90)** Grade 1 **(54.4%)** Grade 2 **(37.8%)** Grade 3 **(7.8%)** Grade 4 **(0%)** Arthralgia, Migraine, Back Pain *Adverse events in homologous:*	*Adverse events in heterologous and homologous vaccination groups were very similar *Majority of adverse events self-reported were Pain at injection site, Swelling at injection site, Fever, Headaches, Fatigue, Chills, GI effects, Myalgia, Arthralgia *Results based on immunosuppressed population	*Adverse events in heterologous:* Headache **(44%)**, Myalgia **(43%)**, Malaise **(42%)**, Fever **(2%)**, Injection site pain **(88%)**, Induration **(35%)**, Erythema **(31%)** *Severity of adverse events in heterologous:* Mild **(68%)**, Moderate **(30%)**, Severe **(2%)**	Not Applicable (one dose schedule) For more information refer to booster section	Unknown (on-going clinical trial)[92]	**CoronaVac/ChAdOx1:** Unknown **CoronaVac/Convidecia:** Convidecia recipients reported more adverse reactions and reported higher occurrence of solicited injection-site pain)	*Most common local adverse events:* Pain at injection site **(11.1%)** *Most common systemic adverse events:* Pyrexia **(27.77%, 11.1%)** after 1st and 2nd dose Malaise **(33.3%, 5.5%)** after 1st and 2nd dose	No available data Ongoing trial[90]

	Adverse events **(81)** Grade 1 **(59.3%)** Grade 2 **(39.5%)** Grade 3 **(1.2%)** Grade 4 **(0%)**							
	BOOSTER DOSES							
Vaccine Schedule	**BNT162b2/BNT162b2**	**mRNA-1273/mRNA-1273**	**ChAdOx1/ChAdOX1**	**Ad26.CoV.2.S/ Ad26.CoV.2.S**	**Covilo/ Covilo**	**CoronaVac/CoronaVac**	**Covaxin/Covaxin**	**NVX-CoV2373/ NVX-CoV2373**
Approved Administration	*Israel:* 12-year-old and over can received homologous booster shot 5 months after full jab[ccxlvii] *United States:* Starting September, adults who received mRNA vaccine 8	Phase II booster trial of three booster doses are ongoing[93] Moderna sought FDA approval of its COVID-19 vaccine booster[ccxlix] *United States:* Starting September, adults	Preliminary results on tolerability and immunogenicity of third dose of ChAdOx1 vaccines showed strong boost to the immune response[94]	Johnson & Johnson has said it will submit all of their new data to the FDA for potential consideration for adding a booster dose and consideration to authorize two-dose regimen[ccl]	*UAE:* Offering booster doses of Pfizer and Sinopharm to people who received full Sinopharm jab ≥6 months ago	**Turkey** and the **United Arab Emirates** began homologous booster shots **Indonesia** and **Thailand** are considering giving homologous booster shot to HCW[ccli]	**India** has started administering homologous booster doses	Ongoing phase II trials[95] Results below are based on ongoing phase II trial

[ccxlvii] Israel offers COVID-19 booster to all vaccinated people. *Reuters* [press release]. https://www.reuters.com/world/middle-east/israel-offers-covid-19-booster-shots-all-vaccinated-people-2021-08-29/

[ccxlix] Moderna seeks U.S. authorization for COVID-19 vaccine booster. *Reuters* [press release]. https://www.reuters.com/business/healthcare-pharmaceuticals/moderna-submits-initial-data-covid-19-vaccine-booster-us-fda-2021-09-01/

[ccl] Two dose version of Johnson & Johnson shot 94% effective against Covid-19, study finds. *CNN.* https://edition.cnn.com/2021/09/21/health/johnson-vaccine-two-doses-booster/index.html

[ccli] Indonesia and Thailand consider booster shots amid doubts over Sinovac vaccine. *Reuters* [press release]. https://www.reuters.com/world/china/indonesia-thailand-consider-booster-shots-amid-doubts-over-sinovac-vaccine-2021-07-08/

	months ago are eligible for booster *Europe:* Starting in fall, most European countries are planning on rolling out booster shots to immunocompromised and elder populations with some countries administering to overall population[ccxlviii]	who received mRNA vaccine 8 months ago are eligible for booster						
Time-to-booster dose	**6 months to 8 months** after initial two-dose regimen Israel offers up to **5 months** after initial two-dose regimen UK has shortened time interval up to **3 months** after initial two-dose regimen due to	**6 months to 8 months** after initial two-dose regimen	**6-9 months** after initial two-dose regimen	**2 months** after one dose regimen[96]	**6 months** after initial two-dose regimen	**6 months to 12 months** After primary vaccination **8 months** after the primary vaccination to healthy adults ≥60 years	**6 months** after initial two-dose regimen	**6 months** after initial two-dose regimen (**189 days**)[95]

[ccxlviii] A country-by-country guide to coronavirus vaccine booster plans. *POLITICO* [press reléase]. https://www.politico.eu/article/vaccine-booster-coronavirus-covid-19-europe-delta-varian-who/

	new Omicron variant[cclii]							
Efficacy	*Symptomatic COVID-19:* **95.6%** during Delta prevalent period **95.3% (**95% CI, 89.5-98.3) **96.5%** (95% CI, 89.3-99.3) in *16-55 year old* **93.1%** (95% CI, 78.4-98.6) in *≥55 year old*	No available data	No available data	No available data	No available data	No available data	Ongoing clinical trials[xxxvii]	No available data
Effectiveness	*Effectiveness against testing positive:* **12%** (95% CI, 8-17) in first 7 days after booster **58%** (95% CI, 56-61) 14 days after booster	*Effectiveness against infection:* **94%** (95% CI, 91-95) **91%** (95% CI, 90-92) **87%** (95% CI, 83-91)	No available data	No available data	No available data	*Effectiveness against symptomatic infection:* **78.8%** (95% CI, 76.8-80.6) *Effectiveness against hospitalization:* **86.3%**	No available data	No available data

[cclii] UK's minimum gap for Covid-19 booster jabs to be halved to three months. *The Guardian* [press release]. Accessed on 12 December 2021. https://www.theguardian.com/world/2021/nov/29/covid-booster-jabs-to-be-offered-to-all-uk-adults-after-three-month-gap

	85% (95% CI, 83-86) 28 days after booster *Effectiveness against symptomatic infection:* **92%** (95% CI, 91-92) **85.6%** (95% CI, 79.2-90.1) relative to two doses **88%** (95% CI, 87-88) **82%** (95% CI, 79-85) *Effectiveness in ≥50:* **84.4%** (95% CI, 82.8-85.8) against symptomatic COVID-19 **94.0%** (93.4-94.6) against symptomatic COVID-19 compared with unvaccinated *Effectiveness against hospitalization:*	*Effectiveness against hospitalization:* **86%** (95% CI, 82-89)				*Effectiveness against ICU admission:* **92.2%** *Effectiveness against COVID-19 related death:* **86.7%**		

	87% 0-6 days after receiving booster dose **92% to 97% lower** than those who received 2 doses **88%** (95% CI, 86-90)							
Effectiveness against Variants	**Delta (B.1.617.2):** **77%** (95% CI, 75.0-79.0) against infection [USA; 01-31 December 2921] ***Omicron (B.1.1.529):*** **75.5%** (95% CI, 56.1-86.3) effectiveness against symptomatic infection[67] If assuming 25-fold decrease compared to wild-type, **81%** (95% CI, 59-95) **54.6%** (95% CI, 30.4-70.4)	**Delta (B.1.617.2):** 95.2% (93.4%-96.4%) **Omicron (B1.1.529):** 62.5% (95% CI 56.2-67.9%)[72]		***Omicron (B.1.1.529):*** **63%** (95% CI, 31-81) against hospitalization 0-13 days post booster **84%** (95% CI, 67-92) against hospitalization 14-27 days post booster **85%** (95% CI, 54-95) against hospitalization 1-2 months post booster[97]				

	effectiveness against symptomatic infection in ≥60-year-old[69] **62%** (95% CI, 59.0-65.0) against infection [USA; 01-31 December 2021][71] **91%** (95 CI, 85.0-94.0) against hospitalization [USA; 01-31 December][71] **96%** (95% CI, 91.0-98.0) against death [USA; 01-31 December][71]							
Immunogenicity	*Neutralizing titers:* Elicits **>5-8 more** for wild type after 6 months after 2nd dose **6.1-fold increase** (95% CI, 5.5-6.8) following booster compared to 2-initial doses **97.6%** (mean 95.9%) inhibition	Booster doses (mRNA1273 or mRNA1273.351) increased neutralizing antibody titers against wild-type	*Antibody Levels:* Higher levels after third dose (tIgG EU **3746**; IQR: 2047-6420) *Spike Cellular Immune Response:* Increased from **200 SFUx10⁶ PBMC (IQR, 127-389)** after the	5X10[10] vp booster dose elicited **9-fold** increase at day 7 compared to first dose after 29 days in 18-55-year-olds 1.25X10[10] vp booster dose elicited **6-7.7-fold** increase at day 28 compared to first	*Specific Antibodies:* **99.66%** participants had detectable antibodies 28 days after the booster *IgG Seroconversion:* **175/176** vaccinees were	*Seropositivity:* **Adults (≥18):** **98%** (95% CI, 90.76-99.96) in participants who received their 2nd dose 14 days apart and 3rd dose 2 months afterwards **100%** (95% CI, 93.51-100.00) in	*Neutralizing Antibodies ($PRNT_{50}$):* **30-fold increase** with **746 GMT** (95% CI, 515-1081) 4 weeks after booster *S-protein IgG:* Increase of IgG to **11,119 GMT** (95% CI, 8,689-14,229)	*Anti-spike IgG:* Increase of **4.6-fold** compared to peak response after 2nd dose (**Day 217 GMEU = 200408**; 95% CI: 159796-251342) *Wild-type Neutralizing Response:*

	one month after booster **18104 GMT** (95% CI, 13911-23560) *IgG Antibodies:* **1.7-fold increase** (95% CI, 1.6-1.9) following booster compared to 2-initial doses ***≥ 60 years:*** *Neutralizing antibody:* **9.34 times higher** than second dose *IgG Antibodies in* **97%** seroconversion with increase in IgG antibody titers **33-fold increase** in IgG after booster dose		second dose to **399 SFUx10^6 PBMC (IQR, 314-662)** after the third one	dose after 29 days in 18-55 and ≥65-year-old *S-binding Antibodies:* Higher levels in booster group (**beta coefficient: 0.64** [98.3% CI< 0.41-0.81]) **97%** response *Neutralizing Antibodies:* Increase observed after booster **98%** response *Interferon-γ/ T Cells Levels:* **Increase** in T cell recall **72.7%** response	seropositive for IgG 14 days after receiving third dose Mean IgG value increased **8.00-fold** compared to before third vaccination **6.1-fold increase** 28 days after booster dose compared to 28 days after second dose *Anti-RBD IgG:* Increased by **8.14-fold** higher than before third vaccine *Memory B cells:* Third dose increased the percentage of RBD-specific memory B cells **(0.96%)**	participants who received their 2nd dose 14 days apart and 3rd dose 8 months afterwards **100%** (95% CI, 92.60-100.00) in participants who received their 2nd dose 28 days apart and 3rd dose 2 months afterwards **100%** (95% CI, 92.60-100.00) in participants who received their 2nd dose 28 days apart and 3rd dose 8 months afterwards **Older adults (≥60):** **96%** (95% CI, 81.65-99.91) *Neutralizing Antibodies:* **60%** higher NAbs activity against wild-type compared to 2-doses	4 weeks after booster dose *Anti-RBD & Anti-nucleocapsid IgG:* **Increase** in IgG antibodies 4 weeks after booster dose	Increase of **4.3-fold** compared to peak response after 2nd dose **(IC50 = 6231; 95% CI: 4738-8195)** *Serum IgG:* **4.7-fold increase** from **43,905 EU** following primary vaccination to **204,367 EU** following booster *Older Participants (60-84):* **5.4-fold** increase in antibody response **5.1-fold increase** in serum IgG *Younger Participants (18-59):* **3.7-fold** increase in antibody response **4.1-fold increase** in serum IgG

						Adults (≥18): **74.2 GMT** (95% CI, 59.0-93.3) in participants 14d-2m 28 days after booster **175.1 GMT** (95% CI, 138.221.0) in participants 14d-8m 28 days after booster **51.9 GMT** (95% CI, 41.3-65.3) in participants 28d-2m 28 days after booster **215.7 GMT** (95% CI, 162.6-286.2) in participants 28d-8m 28 days after booster **Older Adults (≥60):** **178.9 GMT** (95% CI, 125.2-255.6) in participants 28d-8m 28 days after booster *<u>Anti-S IgG and NAbs:</u>* **20-fold** increase 4 weeks post booster vaccination		

						NAbs were maintained **60** to **180 days** post booster		
Immunogenicity against variants	**Beta (B.1.351):** Elicits **15-21** more neutralizing titers for Beta variant after 6 months after 2nd dose **Delta (B.1.671.2):** **>5-fold** increase in neutralizing titers against Delta compared to dose 2 titers in 18–55-year-olds **>11-fold** increase in neutralizing titers against Delta compared to dose 2 titers in 65–85-year-olds **Omicron (B.1.1.529):** **37.0-fold decrease** in neutralization compared to Delta after 0.5 months after booster **24.5-fold decrease** in neutralization	Preliminary results of booster doses of mRNA-1273 vaccine show robust antibody response against Delta variant **Beta (B.1.351):** **6.7-fold** increase in neutralization against Beta compared to 2-initial doses **Omicron (B.1.1.529):** **12-fold increase** in neutralization titer (GMT) against Omicron compared to 2-initial doses[100]	Third dose provided higher antibody titters against Alpha, Beta, and Delta variants	No available data	**Beta (B.1.351):** **71.6%** plasma inhibitions against Beta variant **215.7 pVNT** neutralizing antibodies against Beta variant 14 days after booster[101] **Delta (B.1.671.2):** **83.4%%** plasma inhibitions against Delta variant **250.8 pVNT** neutralizing antibodies against Delta 14 days after booster[101] **Lambda:** **89.0%** plasma inhibitions against Lambda variant **Omicron:** **4-fold increase** in neutralization titer against Omicron	**Beta (B.1.351):** **3.0-fold** decrease in neutralizing antibodies compared to wild type **Gamma (P.1):** **3.1-fold** decrease in neutralizing antibodies compared to wild type **Delta (B.1.671.2):** **2.3-fold** decrease in neutralizing antibodies compared to wild type **2.5-fold** higher neutralizing potency than 2-dose vaccination	**Alpha (B.1.1.7):** **161-fold increase** with **338 GMT** (95% CI, 188-607) 4 weeks after booster dose **Beta (B.1.351):** **265-fold increase** with **147.3 GMT** (95% CI, 75-289) 4 weeks after booster dose **Delta (B.1.671.2):** **32.6-fold increase** with **252 GMT** (95% CI, 133-482) 4 weeks after booster dose **Delta Plus:** **174-fold increase** with **174 GMT** (95% CI, 64-474) 4 weeks after booster dose	High levels of functional antibodies against Alpha (B.1.1.7), Beta (B.1.351), and Delta (B.1.671.2) **Alpha (B.1.1.7):** **21.9-fold increase** in anti-S IgG compared to 2-initial doses **Beta (B.1.351):** **40.6-fold increase** in serum IgG[103] **24.5-fold increase** in anti-S IgG compared to 2-initial doses **Delta (B.1.671.2):** Increase of **6.6-fold** in antibody response compared to Delta response observed with primary vaccination

	compared to Delta after 3 months after booster **17-fold increase** in neutralization titer compared to 2-initial doses[98] **41-fold increase** (95% CI, 30-56) in neutralizing antibodies compared to 2-initial dose in **younger participants**[99] **43-fold increase** (95% CI, 32-58) in neutralizing antibodies compared to 2-initial doses in **middle-aged**[99] **27-fold increase** (95% CI, 20-36) in neutralizing antibodies compared to 2-initial doses in **older participants**[99]				compared to 2-dose vaccination[100] **11-fold decrease** in neutralization titer 14 days after booster dose compared to wild type[100] **3.3-fold increase** in neutralizing activity 28 days after booster compared to 2-initial doses against Omicron[102] **48.73 pVNT** neutralizing antibodies against Omicron 14 days after booster[101]			**24.4-fold increase** in anti-S IgG compared to 2-initial doses **<u>Omicron (B.1.1.529):</u>** **20.1-fold increase** in anti-S IgG compared to 2-initial doses[103]
Reactogenicity	Preliminary results show consistent tolerability	Similar safety and tolerability compared to second dose	Lower reactogenicity after third dose	No available data	Ongoing trial	The third shot is considered to be safe	Most reported adverse events were **mild and**	Booster dose was **well tolerated**

	25% reported at least one adverse event *Common solicited AE:* Injection site pain, injection site redness, injection site swelling, fatigure, muscle pain, fever *≥Grade 3 AE:* **6.6%** reported grade 3 or higher reactogenicity with **0.7%** being local reactions and **5.9%** systemic events	*Common solicited local adverse events:* Injection-site pain **(68.4% for mRNA-1273.351, 90% for mRNA-1273)** fatigue **(36.8% for mRNA-1273.351, 70% for mRNA-1273)** headache **(36.8% for mRNA1273.351, 55.0% for mRNA-1273)** myalgia **(31.6% for mRNA-1273.351, 45.0% for mRNA-1273)** arthralgia **(21.1% for mRNA-1273, 50.0% for mRNA-1273)**	compared to first dose			*Common side effects:* Pain at the injection site. *Adverse events:* Unrelated to the vaccination	**resolved within 24 hours** *Solicited Adverse Events:* **8** solicited adverse events were reported **5.4%** care of pain, **2.1%** itching **1%** redness	Local and systemic **reactogenicity increased** between Dose 1, Dose 2, and Dose 3 **90%** of symptoms were rated as mild or moderate
Protection against COVID-19	***Confirmed Infection:*** Adults (≥18): **93% relative reduction** in symptomatic infection (hazard ratio: 0.07; 95% CI, 0.02-0.20)[104]	No available information	No available information	No available information	No available information	No available information	Ongoing clinical trials[xxxvii]	No available information

	92% relative reduction in asymptomatic infection (hazard ratio: 0.08; 95% CI, 0.01-0.48)[104] <u>Youngest age group (16-29):</u> **17.2 (95% CI, 15.4-19.2) lower rate** in booster group <u>30-39 age group:</u> **9.0 (95% CI, 8.4-9.7) lower rate** in booster group <u>40-49 age group:</u> **9.7 (95% CI, 9.2-10.3) lower rate** in booster group <u>50-59 age group:</u> **12.2 (95% CI, 11.4-13.0) lower rate** in booster group <u>Oldest age group (≥60):</u> **12.3 (95% CI, 10.4-12.3) lower rate** in booster group

	12.3 (95% CI, 11.8-12.8) lower rate in booster group ***Severe Illness:*** 40-59 age group: **21.7 (95% CI, 10.6-44.2) lower rate** in booster group Older population (≥60): **19.5 (95% CI, 12.9-29.5) lower rate** in booster group **17.9 (95% CI, 15.1-21.2) lower rate** in booster group ***Mortality:*** ≥60 years old: **14.7 (95% CI, 10.0-21.4) lower rate** in booster group ≥50 years old: Adjusted hazard ratio for death due								

	to COVID-19 in booster compared to non-booster was **0.10 (95% CI, 0.07 to 0.14)** or **90% lower** mortality rate							
Duration of Protection	*≥60 years old:* 3 months after booster dose, neutralizing antibody levels remained adequate although significant decrease is reported **(25,429 AU/mL to 8306 AU/mL)** *Viral Load:* **52% decrease** in Ct-reduction post the booster shot over time (decline in reducing viral loads over time)	No available data	No available data	No available data	No available data	No available data	No available data	No available data
Other	Detailed report from Pfizer regarding booster doses can be found here: https://www.fda.gov/media/152161/download					For more detailed information regarding immunogenicity of		

	14-20 days after booster, marginal effectiveness increases to **70-84%** ***<u>Incidence Rate:</u>*** <u>Infection in individuals <60:</u> **0.22 (95% CI, 0.22-0.23) incidence rate** in booster compared to non-booster <u>Infection in individuals ≥60:</u> **0.16 (95% CI, 0.15-0.17) incidence rate** in booster compared to non-booster <u>Severe illness in individuals <60:</u> **0.33 (95% CI, 0.21-0.52) incidence rate** in booster compared to non-booster						third dose refer to study[cciii]		

[cciii] A third dose of inactivated vaccine augments the potency, breadth, and duration of anamnestic responses against SARS-CoV-2. *medRxiv.* *https://www.medrxiv.org/content/10.1101/2021.09.02.21261735v1*

	Severe illness in individuals ≥60: **0.12 (95% CI, 0.10-0.14) incidence rate** in booster compared to non-booster							
	HETEROLOGOUS BOOSTER DOSES							
Vaccine Schedule	*Heterologous 1:* **mRNA1273/BNT162b2** *Heterologous 2:* **Ad26.CoV.2.S/BNT162b2** *Heterologous 3:* **ChAdOx1/BNT162b2** *Received BNT162b2 as booster dose	*Heterologous 1:* **BNT162b2/mRNA1273** *Heterologous 2:* **Ad26.CoV.2.S/mRNA1273** *Heterologous 3:* **ChAdOx1/mRNA1273** *Received mRNA1273 as booster dose	*Heterologous 1:* **BNT162b2/ChAdOx1*** *Received ChAdOx1 as booster dose	*Heterologous 1:* **BNT162b2/Ad26.CoV.2.S** *Heterologous 2:* **mRNA1273/Ad26.CoV.2.S** *Heterologous 3:* **ChAdOx1/Ad26.CoV.2.S.** *Received Ad26.CoV.2 as booster dose	*Heterologous 1:* **SinoPharm/BNT162b2**	*Heterologous 1:* **CoronaVac/ChAdOx1** *Heterologous 2 :* **CoronaVac/BNT162b2** *Heterologous 3 :* **CoronaVac/SinoPharm** *Heterologous 4:* **CoronaVac/mRNA1273** *Received CoronaVac as initial regimen	No available data	*Heterologous 1:* **BNT162b2/NVX-CoV2373** *Heterologous 2:* **ChAdOx1/NVX-CoV2373** *Received NVX-CoV2373 as booster dose
Time-to-booster dose	At least **3 months** after receiving two dose regimen	At least **3 months** after receiving two dose regimen	**6 months** after initial two-dose regimen	**4 months** after initial two-dose BNT162b2 regimen At least **3 months** after receiving two dose regimen	**6 months** after initial two-dose regimen	*Heterologous 1:* **21 to 26 days** after full jab of CoronaVac *Heterologous 2:*	No available data	**6 months** after initial two-dose regimen

Effectiveness	*Heterologous 1:* **94%** (95% CI, 91-96) effectiveness against infection *Heterologous 2 – Effectiveness in ≥50:* **87.4%** (95% CI, 84.9-89.4) against symptomatic COVID-19[105] **93.1%** (95% CI, 91.7-94.3) against symptomatic COVID-19 compared to unvaccinated	*Heterologous 1:* **92%** (95% CI, 88-95) effectiveness against infection *Heterologous 3:* **91%** (95% CI, 63-98) effectiveness against infection	No available data	No available data	No available data	**6 months** after primary vaccination of CoronaVac *Heterologous 3:* **6 months** after primary vaccination of CoronaVac *Heterologous 4:* **6 months** after primary vaccination of CoronaVac *Heterologous 1:* **93.2%** (95% CI, 92.9-93.6) against symptomatic infections **97.7%** against hospitalization **98.9%** against ICU admission **98.1%** against COVID-19 related death *Heterologous 2:*	No available data	No available data

Effectiveness against Variants	*Heterologous 3:* **82%** (95% CI, 68-90) effectiveness against infection No available data	No available data	***Omicron (B.1.1.529):*** *Heterologous 1:* **71.4%** (95% CI, 41.8-86.0) against symptomatic infection[67]	No available data	No available data	**96.5%** (95% CI, 96.2-96.7) against symptomatic infections **96.1%** against hospitalization **96.2%** against ICU admission **96.8%** against COVID-19 related death No available data	No available data	No available data
Immunogenicity	*Binding Antibody Responses:* **2-fold or greater rise** in bAb noted in **98-100%** of BNT162b2 recipients *Neutralizing Antibody Responses:*	*Binding Antibody Responses:* **2-fold or greater rise** in bAb noted in **96-100%** of mRNA1273 recipients *Neutralizing Antibody Responses:*	***Heterologous 1:*** *Anti-spike IgG:* In individuals <70: **12440 ELU/mL** (95% CI, 10420-14852) In individuals ≥70: **14961 ELU/mL** (95% CI, 12065-18551)	***Heterologous 1:*** **14.8 to 32.4-fold** increase in neutralization titers against wild-type virus *Binding Antibody Responses (bAb):*	No available data	***Heterologous 1:*** Heterologous vaccination had a **9-fold greater GMT** (7,947 U/mL) than fully patients fully vaccinated with AZD1222 and the	No available data	***Heterologous 1:*** *Anti-spike IgG:* In individuals <70: **14961 ELU/mL** (95% CI, 12065-18551) In individuals ≥70: **9130 EUL/mL** (95% CI, 6783-12289)

	341.3-677.9 IU50/mL 15 days after booster with BNT162b2 Participants who received mRNA-based booster vaccination had four-fold increase compared to Ad26.COV2.S. ***Heterologous 2:*** *S-binding Antibodies:* **Higher levels** after booster **(beta coefficient: 0.73,** [98.3% CI, 0.57-0.90]) *Neutralizing Antibodies:* **Higher levels** in booster compared to 2 doses **100%** response *T-Cell/ Interferon-γ:* **Higher levels** in booster compared to 2 doses **91.5%** response	**676.1-901.8 IU50/mL** 15 days after booster with mRNA1273 Participants who received mRNA-based booster vaccination had four-fold increase compared to Ad26.COV2.S. ***Heterologous 1:*** *Anti-spike IgG:* In individuals <70: **44547 ELU/mL** (95% CI, 38424-51645) In individuals ≥70: **25118 ELU/mL** (95% CI, 17698-35650) *Cellular Response :* In individulas <70 : **143 (95% CI, 82-250)** In individuals ≥70: **88 (95% CI, 46-168)** ***Heterologous 2:***	*Cellular Response :* In individuals <70 : **105** (95% CI, 67-164) In individuals ≥70: **84** (95% CI, 45-156)	**2-fold or greater rise** in bAb noted in **98-100%** of Ad26.COV2.S. recipients *Neutralizing Antibody Responses:* **31.2-382.2 IU50/mL** 15 days after booster with Ad26.COV2.S. *Anti-spike IgG:* In individuals >70: **17312 ELU/mL** (95% CI, 13678-21911) In individuals ≥70: **16855 ELU/mL** (95% CI, 13360-21264) *Cellular Response:* In individuals <70: **114** (95% CI, 55-236) In individuals ≥70: **109** (95% CI, 64-187) ***Heterologous 3 :*** *Anti-spike IgG:*		highest antibody response, IgA, and neutralizing antibodies than other groups *Neutralizing Antibody Responses:* **12.4-fold** increase in neutralizing response *Anti-RBD Antibody:* **9865 U/mL** 14-days after booster **7947 BAU/mL** (95% CI, 7277,8679) 14-days after booster leading to **9-fold** greater than individuals fully vaccinated with ChAdOx1 *Anti-RBD IgG:* **1492 BAU/mL** (95% CI, 1367-1629) 14-days after booster **1358 BAU/mL** 14-days after booster		*Cellular Response:* In individuals <70: **69** (95% CI, 45-156) In individuals ≥70: **45** (95% CI, 22-92) ***Heterologous 2:*** *Anti-spike IgG:* In individuals <70: **8389 ELU/mL** (95% CI, 6599-10665) In individuals ≥70: **5822 ELU/mL** (95% CI, 4495-7541) *Cellular Response:* In individuals <70: **137** (95% CI, 88-213) In individuals ≥70: **55** (95% CI, 35-89)

	Heterologous 3: *Anti-spike IgG:* In individuals <70: **22479 ELU/mL** (95% CI, 18276-27648) Individuals ≥70: **19091 EUL/mL** (95% CI, 15554-23432) **2364 BAU/mL** 14-days after booster *Cellular Response:* In individuals <70 : **119 (95% CI, 83-169)** sport forming cells per 10^6 peripheral blood mononuclear cells In individuals ≥70: **113 (95% CI, 64-200)** sport forming cells per 10^6 peripheral blood mononuclear cells	*S-binding Antibodies:* **Higher levels** after booster **(beta coefficient: 0.94,** [98.3% CI, 0.85-1.12]) *Neutralizing Antibodies:* **Higher levels** in booster compared to 2 doses **100%** response *T-Cell/ Interferon-γ:* **Higher levels** in booster compared to 2 doses **91.7%** response ***Heterologous 3:*** *Anti-spike IgG:* In individuals <70: **35522 ELU/mL** (95% CI, 29205-43204) In individuals ≥70: **27702 ELU/mL** (95% CI, 21337-35966)		In individuals <70: **5582 ELU/mL** (95% CI, 4415-7057) In individuals ≥70: **5464 ELU/mL** (95% CI, 4266-6998) *Cellular Response:* In individuals <70: **141** (95% CI, 100-200) In individuals ≥70: **82** (95% CI, 54-124)		*Anti-S1-IgA:* **5.25 OD/CO** (IQR, 3.94-9.00) 14-days after booster ***Heterologous 2:*** Median values of IgG-S titers were higher in group that received BNT162b2 as booster than CoronaVac BNT162b2 boosted IgG-S median titers by **factor of 46.6** but IgG-N titers decreased by **factor of 6.5** *Neutralizing Antibody Responses:* **11.2-fold increase** in neutralizing response *Anti-spike RBD:* Single booster dose of BNT162b2		

		Cellular Response: In individuals <70: **228** (95% CI, 177-294) In individuals ≥70: **101** (95% CI, 54-187)				induced higher anti-spike RBD IgG antibody levels, compared to single booster dose of CoronaVac **20,787 U/mL** 14 days after booster **5152 BAU/mL** 14 days after booster ***Heterologous 3:*** *Anti-spike RBD:* **1073 U/mL** 14 days after booster **154 BAU/mL** 14 days after booster ***Heterologous 4:*** *IgG:* **9.3-fold increase** in median IgG titer compared to 2-initial doses **(250 to 2313 BAU/mL)** *Seropositivity:* Increase from **96.4% to 100%** after booster dose		

Immunogenicity against variants	*Binding Antibody Responses:* Baseline bAb levels for **Delta** were **34-45% lower** compared to Wa-1 strain Following boost, bAB levels for **Delta** were **15-36% lowe**r compared to Wa-1 strain ***Heterologous 1:*** *Neutralizing Ab:* **22.7-fold decrease** in neutralization after 0.5 months after booster compared to **Delta** ***Heterologous 3:*** *Pseudotype virus neutralizing antibody NT_{50}:* **315 GMT** (95% CI, 1314–1998) against **Delta**	*Binding Antibody Responses:* Baseline bAb levels for **Delta were 34-45% lower** compared to Wa-1 strain Following boost, bAB levels for **Delta** were **15-36% lower** compared to Wa-1 strain *Neutralizing Antibody Responses:* **Delta and Beta** variants were only available in those boosted with mRNA-1273 ***Heterologous 1:*** *Pseudotype virus neutralizing antibody NT_{50}:* **508.7 GMT** (95% CI, 408.6-633.4) against **Delta** ***Heterologous 3:***	*AZD1222/ BNT162b2* Demonstrated **80%** response rate against Omicron serum sample & **14.7-fold** decrease in GMT *AZD1222/ mRNA-1273* Demonstrated **82%** response rate against Omicron serum sample & **17.5-fold** decrease in GMT *Pseudovirus neutralizing antibody NT_{50}:* **260 GMT** (95% CI, 217-313) against **Delta**	***Heterologous 1:*** **10.9 to 21.2-fold** increase in pseudo virus neutralization assay (one volunteer did not have any against B.1.351) *Binding Antibody Responses:* Baseline bAb levels for **Delta** were **34-45% lower** compared to Wa-1 strain Following boost, bAB levels for **Delta** were **15-36% lower** compared to Wa-1 strain *Pseudotype virus neutralizing antibody NT_{50}:* **418 GMT** (95% CI, 330-530) against **Delta** **41-fold increase** against **Omicron**	No available data	***Heterologous 1:*** *Neutralizing antibodies*: **wild type > B.1.617.2 > B.1.1.7 > B.1.351** **B.1.351 > wild type > B.1.1.7 > B.1.617.2** Individuals boosted had higher neutralizing antibodies compared to two doses of either vaccine ($p<0.0001$)[106] **271 $PRNT_{50}$** 14 days after booster against **Delta** variant[107] ***Heterologous 2:*** **6.3-fold increase** in neutralization titers against **Delta** 28 days after booster dose compared to 2-initial doses	No available data	***Heterologous 1:*** *Pseudotype neutralizing antibody NT_{50}:* **165 GMT** (95% CI, 131-209) against **Delta** ***Heterologous 2:*** *Pseudotype neutralizing antibody NT_{50}:* **124 GMT** (95% CI, 99-156) against **Delta**

	470 PRNT$_{50}$ 14 days after booster against **Delta** variant **521 PRNT$_{50}$** 14 days after booster against **Omicron** variant	*Pseudotype virus neutralizing antibody NT$_{50}$:* **559.7 GMT** (95% CI, 441.3-709.9) against **Delta**		compared to 2-initial doses ***Heterologous 3:*** *Pseudotype virus antibody NT$_{50}$:* **125 GMT** (95% CI, 99-159) against **Delta**		**6.3-fold decrease** in neutralization titers against **Omicron** 28 days after booster dose compared to wild type **411 PRNT$_{50}$** 14 days after booster against **Delta** variant **543 PRNT$_{50}$** 14 days after booster against **Omicron** variant[107] ***Heterologous 3:*** **61.3 PRNT$_{50}$** 14 days after booster against **Delta** variant		
Reactogenicity	*Adverse Events:* **72-92%** participants reported local pain or tenderness	*Adverse Events:* **75-86%** participants reported local pain or tenderness	No available data	*Adverse Events:* **71-84%** participants reported local pain or tenderness Malaise, myalgias, and headaches	No available data	Similar results to homologous booster administration Reactogenicity of mRNA1273 booster was	No available data	No available data

	Malaise, myalgias, and headaches were commonly reported **14.4%** of the participants reported unsolicited adverse events	Malaise, myalgias, and headaches were commonly reported **15.6%** of participants reported unsolicited adverse events		were commonly reported **12%** of participants reported unsolicited adverse events		acceptable and better tolerated with increasing age and shorter time since booster dose		
Other						Ongoing clinical trial examining immunogenicity and safety of third dose vaccination with ChAdOx1 or BNT162b2 vaccine among adults who received full jab of CoronaVac[ccliv]		
IMMUNOGENICITY								
Immunogenicity	*Single Dose (≥4 weeks):* **79.4% IgG seropositivity** (95% CI, 75.7-83.1)[108]	*14 days after second dose:* *18-55 years*: $PRNT_{80}$ GMT	*28 days after second dose median antibody titres:*	*IgG Antibodies:* **1299.5 AU/mL** highest median *29 days after vaccination:*	*14 days after second dose:* *18-55 years:* GMT ***211.2* (95% CI, 158.9-280.6**).	*Single dose (≥4 weeks)*: **37.7±57.08 IU/ml (min: 0, max: 317.25);** 57.02% of participants did not develop	*IgG Antibodies:* **342.7 AU/mL** highest median *Single dose (≥4 weeks:*	

[ccliv] Third Dose Vaccination with AstraZeneca or Pfizer COVID-19 Vaccine Among Adults Received Sinovac COVID-19 Vaccine. *ClinicalTrials.gov.* https://clinicaltrials.gov/ct2/show/NCT05049226

	Second dose (≥4 weeks): **96.5% IgG seropositivity** (95% CI, 94.9-98.1) to **92% IgG seropositivity onwards** *7-14 days after second dose:* *18-55 years*: GMT ranged from **1.7 to 4.6** times the GMT of the convalescent serum. *65-85 years*: GMT ranged from **1.1 to 2.2** times the GMT of the convalescent serum. *8 months after second dose:* Anti-S antibody titre median **751.2 AU/ mL** (IQR: 422.0-1381.5)	**654.3 (95% CI, 460.1-930.5**). *56-70 years:* $PRNT_{80}$ GMT **878 (95% CI, 516-1494**). *≥71 years*: $PRNT_{80}$ GMT **317 (95% CI, 181-557**). *8 months after second dose:* Anti-S antibody titre median **1539.5 AU/ mL** (IQR: 876.7-2626.7)	*18–55 years*: **20,713 AU/mL [IQR 13,898 - 33,550**] *56–69 years*: 1**6,170 AU/mL [IQR 10,233 - 40,353]**. *≥70 years*: **17,561 AU/mL [IQR 9,705 - 37,796]**.	*18-55 years:* GMC **586 (95% CI, 445-771**); GMT **224 (95% CI, 168-298**). *≥65 years*: GMC **312 (95% CI, 246-396);** GMT **212 (95% CI, 163-266**). *57 days after vaccination:* *18-55 years*: **754 (95% CI, 592-961**); GMT **288 (95% CI, 221-376**). *8 months after second dose:* Anti-S antibody titre median **451.6 AU/ mL** (IQR: 103.0-2396.7	*≥60 years: GMT **131.5** (95% CI, 108.2-159.7**).	sufficient antibody titres (<25.6 IU ml) **28.1% IgG seropositivity** (95% CI, 25.0-31.2) *Two doses (2 weeks):* **164.4 BAU/ mL** *Two doses (≥4 weeks)*: **194.61±174.88 IU/ml (min: 0, max: 677.82);** 11.48% of participants did not develop sufficient antibody titres (<25.6 IU ml) **94.8 BAU/ mL** **77.4% IgG seropositivity** (95% CI, 75.5-79.3) *Two doses (8-12 weeks):* 34.7 BAU/ mL	**43.8%** seropositive for anti-spike antibody > 15 AU/mL GMT **16.8 (95% CI, 15.80-17.88)** for SARS-CoV-2 spike antibody titre *Two doses (≥4 weeks)*: **80.0%** seropositive for anti-spike antibody > 15 AU/mL GMT **48.3 (95% CI, 47.46-48.92)** for SARS-CoV-2 spike antibody titre	

Immunogenicity against Delta variant	**7.77-fold reduction** in neutralization titres for **Delta (B.1.617.1)** when compared with wild-type **11.30-fold reduction** in neutralization titres for **Delta (B.1.617.2)** when compared with wild-type **157 $PRNT_{50}$** neutralization against **Delta (B.1.617.1)** **355 $PRNT_{50}$** neutralization against **Delta (B.1.617.2)**							
Immunogenicity against the Mu variant	6.8-fold decrease in neutralizing titres when compared to convalescent sera	Neutralizing titre similar to that of BNT162b2 sera	Neutralizing titre similar to that of BNT162b2 sera	No available data	No available data	No available data	No available data	No available data

Immunogenicity against Omicron variant (not specific to vaccines)	Fully vaccinated **17-fold** decrease in neutralization against Omicron when compared to wild type[109] Boosted (3-dose schedule) **7-fold** decrease in neutralization against Omicron when compared to wild type[109]							
Immunogenicity against Omicron variant	**29.8-fold decrease** in mean neutralizing titres compared to wild-type, **10.3-fold decrease** compared to Beta, **25.1-fold decrease** compared to Delta[110] Plasma specimens one month after full mRNA vaccination, NT_{50} values were 127±66 times lower for Omicron	**20-fold decrease** in neutralization 6 months after vaccination compared to Delta[110] **1/10 seropositive** against Omicron[91] Plasma specimens one month after full mRNA vaccination, NT_{50} values were 127±66 times lower for Omicron than the wild type (Wuhan) strain.	Mean neutralizing titres drop to below the detectable threshold in all but one participant[110] **0/20 seropositive** against Omicron[91] The mean Omicron titre estimate in the infected + double vaccinated group suggests protection against symptomatic Omicron disease is **80%**[109]	Vaccine lacked detectable neutralizing activity against Omicron.[48] Demonstrated **9%** response rate against Omicron serum sample[113]		Not a single serum sample demonstrated neutralizing antibodies against the Omicron VOC among 25 blood samples[116]	Only 5/20 live virus samples exhibited neutralization titres above the lower limit of quantification.[115]	

	than the wild type (Wuhan) strain. After 5 months, the neutralization potency was 27±17 lower for Omicron.[48] Persons who had prior SARS-CoV-2 infections and then were fully (two-dose) vaccinated had NT_{50} values **154** times greater than the pre-vaccination convalescent phase titres[48] A third booster dose increased the neutralization capacity against Omicron by **38** times.[48] **11.4-fold decrease** in neutralization 6 months after vaccination compared to Delta	After 5 months, the neutralization potency was 27±17 lower for Omicron.[48] Persons who had prior SARS-CoV-2 infections and then were fully (two-dose) vaccinated had NT_{50} values **154** times greater than the pre-vaccination convalescent phase titres[48] A third booster dose increased the neutralization capacity against Omicron by **38** times.[48] The mean Omicron titre estimate in the infected + double vaccinated group suggests protection against symptomatic Omicron disease is **91%**[109]	Demonstrated **50%** response rate against Omicron serum sample & **12.8-fold** decrease in GMT[113] Only 5/20 live virus samples exhibited neutralization titres above the lower limit of quantification.[115] No neutralizing antibodies were observed in serum samples obtained 1 months after the receipt of the second dose[114]						

	25-fold decrease in neutralization titers against Omicron variant compared to wild-type[111] **41-fold decrease** in neutralization level against Omicron[112] **9/20 seropositive** against Omicron [91] Demonstrated **33%** response rate against Omicron serum sample[113] **9/20 participants** neutralized Omicron variant 1 month after 2nd dose[114]	Demonstrated **100%** response rate against Omicron serum sample & **15.8-fold** decrease in GMT[113] No neutralizing antibodies were observed in serum samples obtained 4-6 months after the receipt of the second dose[114]						
EFFICACY								
Single dose[cclv]	**52%** (95% CI, 29.5 to 68.4; starting at 12 days) or 82.2% (75.1 to 87.3;	**95.2%** (95% CI, 91.2.8 to 97.4; starting at >14 days).	**72.8%** (starting at 22 days up to 60 days).	Single dose vaccine	Unknown	**35.1%** (95% CI, -6.6 to -60.5) [conducted in a setting with high P.1 transmission].	No available data	**83.4%** (95% CI, 73.6-89.5) starting at ≥14 days

[cclv] Against SARS-COV-2 infection

	starting at ≥14 days). **91%** (95% CI, 85-94). ≥80 years : **71.4%** (95% CI, 46.5-90.6) vaccine efficacy for symptomatic disease 14 days after one dose [United Kingdom, 18 Dec 2020 – 26 Feb 2021] ≥65 years : **56%** (95% CI 19-76) at 28-34 days and **62%** (95% CI 23-81) at 35-48 days post-vaccination [United Kingdom, 8 Dec 2020 – 15 Mar 2021] [cclvi]		**88%** (95% CI, 75-94).[cclvii] ≥80 years : **80.4%** (95% CI, 36.4-94.5) vaccine efficacy for symptomatic disease 14 days after one dose [United Kingdom, 18 Dec 2020 – 26 Feb 2021 ≥65 years : **56%** (95% CI 19-76) at 28-34 days and **62%** (95% CI 23-81) at 35-48 days post-vaccination [United Kingdom, 8 Dec 2020 – 15 Mar 2021] [cclviii]					
Two doses[cclix]	**95.0%** (95% CI, 90.3-97.6) starting at ≥7 days in	**94.1%** (95% CI, 89.3-96.8) after median follow-up	**63.1% (**95% CI, 51.8-71.7) starting at ≥14 days for	**66.9%** (95% CI 59.0-73.4) after 14 days and	After 14 days, efficacy against symptomatic	After 14 days, efficacy against symptomatic	*Symptomatic SARS-CoV-2 infection:*	**89.7%** (95% CI, 80.2-94.6) starting at ≥7 days

[cclvi] Does not differentiate between BNT162b2 and ChAdOx1 nCoV-19.
[cclvii] Conducted between 8 December 2020 and 8 February 2021. Study sample = ≤1 million participants.
[cclviii] Does not differentiate between BNT162b2 and ChAdOx1 nCoV-19.
[cclix] Against SARS-CoV-2 infection.

	population without prior SARS-CoV-2 infection **94.6%** (95% CI, 89.9-97.3) starting at ≥7 days in population with or without prior infection	of less than 63 days **93.2%** (95% CI, 91.0-94.8) <u>Against severe disease:</u> **98.2%** (95% CI, 92.8-99.6) *<u>Prevention against COVID-19 illness:</u>* **93.2%** (95% CI, 91.0-94.8; United States) *<u>Prevention against severe disease:</u>* **98.2%** (95% CI, 92.8-99.6; United States) *<u>Prevention against asymptomatic infection starting 14 days after second infection:</u>* **63.0%** (95% CI, 56.6-68.5; United States)	two standard doses **80.7%** (95% CI, 62.1-90.2) starting at ≥14 days for first low dose and standard second dose **66.7%** (95% CI, 57.4-74.0) starting at ≥14 days for pooled analysis efficacy *<u>Against mild-to-moderate symptomatic COVID-19 >14 days after second injection</u>*: **21.9%** (95% CI, -49.9 to 59.8; South Africa) [24 June – 09 November 2020]	**66.1%** (95% CI 55.0-89.1) after 28 days for VE against moderate-severe-critical COVID-19 **76.7%** (95% CI 54.6 to 89.1) after 14 days and **85.4%** (95% CI 54.2 to 96.9) after 28 days for VE against severe-critical COVID-19	cases was **72.8%** (95% CI 58.1-82.4; in WIV04 vaccine) or **78.1%** (95% CI 64.8 to 86.3; in HBO2 vaccine).	cases was **50.7%** (95% CI 35.9 to 0-62.0). 99.17% of NAb titres were above or equal to the Nab positivity cut-off (20 units) against wild-type.	**77.8%** (95% CI, 65.2-86.4) *<u>Severe symptomatic SARS-CoV-2 infection:</u>* **93.4** (95% CI, 57.1-99.8) *<u>Symptomatic COVID-19 in ≥60 years old:</u>* **67.8%** (95% CI, 65.2-86.4) against symptomatic COVID-19 *<u>Symptomatic COVID-19 in 18-59 years old:</u>* **79.4%** (95% CI, 66.0-88.2) against symptomatic COVID-19	**90.4%** (95% CI, 82.9-94.6) **100%** (95% CI, 87-100) against moderate-to-severe COVID-19 **100%** (95% CI, 34.6-100) against severe COVID-19 **90%** (95% CI, 80-95) (≥7 days after second dose)
Against asymptomatic infection	**90%** (starting at 14 days) regardless of symptom status	**63.0%** (95% CI, 56.6-68.5)	Statistically non-significant **reduction of 22.2%** (95% CI -	At day 71, vaccine efficacy against asymptomatic infections was	Efficacy against symptomatic and asymptomatic cases was **64%**	Unknown	**63.6** (95% CI, 29.0-82.4) efficacy against	Unknown

			9.9 to 45.0) for asymptomatic cases **61.9%** efficacy	**65.5%** (95% CI 39.9 to 81.1).	(95% CI 48.8 to 74.7; in WIV04 vaccine) or 73.5% (95% CI 60.6 to 82.2; in HBO2 vaccine).		asymptomatic cases	
EFFICACY AGAINST VARIANTS								
Alpha (B.1.1.7)	Two doses of the vaccine **effectively neutralize** the B.1.1.7 variant and the D614G substitution.	**NAbs remained high** and consistent with titres of the wildtype for the B.1.1.7 variant.	**70.4%** (95% CI, 43.6-84.5) against symptomatic infection with alpha variant (B.1.1.7); **28.9%** (95% CI, -77.1 to 71.4) against asymptomatic infection with B.1.1.7.	**3.6-fold** reduction in neutralization capacity when compared to wild-type.	Demonstrated reduced neutralizing capacity. However, there were no differences in the NAbs titres against B.1.351 in vaccinated individuals vs. those naturally infected, suggesting the vaccine has a similar level of protection against infection as natural infections.	**10.4-fold** reduction in neutralization capacity when compared to natural infection sera. **85.83%** of NAb titres were above or equal to the Nab positivity cut-off (20 units) against wild-type. Neutralization decreased by **4.1-fold** when compared to wild-type.	$PRNT_{50}$ **0.8** when compared with wild type against Alpha (no significant difference in neutralization capacity)	Two dose efficacy against the B.1.1.7 variant **86.3%** (95% CI, 71.3-93.5) **93.6%** (95% CI, 81.7-97.8) against the Alpha variant *Against non-B.1.1.7 variant* **96%** (95% CI, 74-99.5) (≥7 days after second dose) *Against B.1.1.7 variant* **86%** (95% CI, 71-94) (≥7 days after second dose)
Beta (B.1.351)	Neutralization was **diminished by a factor of 5**. Despite this, the BNT162b2 mRNA vaccine still	NAbs were **6-fold** lower. Nevertheless, NAbs were still found to be protective.	Two doses of the vaccine had no efficacy against the B.1.351 (VE = **21.9%;** 95% CI, -49.9 to 59.8).	Efficacy against moderate-severe-critical Covid-19 due to the variant was **52.0%** (>14 days) and **64.0%**	No published data	NT_{GM} **35.03 (95% CI, 27.46-44.68**); **8.75-fold** reduction in neutralization capacity when	GMT **61.57 (95% CI, 36.34-104.3)** against Beta variant with significant	**51.0%** (95% CI, -0.6-76.2) efficacy against B.1.351 variant

	provides some protection against B.1.351 **100%** (95% CI, 53.5-100).		*Against mild-to-moderate symptomatic COVID-19 associated with B.1.351 variant >14 days after second injection*: **10.4%** (95% -76.8 to 54.8; South Africa) [24 June – 09 November 2020]	(>28 days). Efficacy against severe-critical COVID-19 was **73.1%** (>14 days) and **81.7%** (>28 days). Demonstrated **3.6-fold** reduction in neutralization sensitivity. Neutralization titres were decreased by **6.7-fold**.		compared to natural infection sera. **82.5%** of NAb titres were above or equal to the Nab positivity cut-off (20 units) against wild-type.	reduction in neutralization titre	
Gamma (P.1)	*Single dose:* *≥21 days*: **83%** against hospitalization and death. *Two doses*: *≥14 days*: **98%** against hospitalization and death.	**3.2-fold** reduction in neutralization capacity when compared to wild-type.	*Single dose:* *≥21 days*: **94%** against hospitalization and death. *Two doses:* **64%** (95% CI, -2-87) [n=18] Efficacy against Zeta (P.2) [2 doses]: **69%** (95% CI, 55-78)	Demonstrated **3.4-fold** reduction in neutralization sensitivity.	No published data	**49.6%** against P.1 (>14 days after 1st dose). Neutralization decreased by **7.5-fold** when compared to wild-type.	No available data	No available data
Delta (B. 1.671.2)	**Reduced NAb activity** relative to B.1.1.7 strain.	**2.1-fold** reduction in neutralization capacity when compared to wild-type.	*Single dose:* *≥21 days*: **90%** against hospitalization and death.	Demonstrated **1.6-fold** reduction in neutralization sensitivity.	Demonstrated **reduced neutralizing capacity**. However, there	NT_{GM} **24.48** (95% CI,19.2-31.2). **69.17%** of NAb titres were above	**65.2** (95% CI, 33.1-83.0) estimated efficacy	No available data

				Neutralization titres were decreased by **5.4-fold**.	were no differences in the NAbs titres against B.1.617.2 in vaccinated individuals vs. those naturally infected, suggesting the vaccine has a similar level of protection against infection as natural infections.	or equal to the Nab positivity cut-off (20 units) against wild-type.	GMT **68.97** (95% CI, 24.72-192.4) against Delta variant with significant reduction in neutralization titre	
Omicron (B.1.1.529)	**22.5%** (95% CI, 8.5-40.7) against symptomatic infection							

Phase III Trials Results

Synoptic table about SARS-CoV-2 vaccines accepted in the WHO's Emergency Use Listing containing information on Phase III Clinical Trial Results

	BNT162b2/ COMIRNATY (Pfizer-BioNTech, USA)	Spikevax/ Moderna COVID-19 Vaccine/ mRNA-1273 (Moderna, USA)	Vaxzevria/ ChAdOx1 nCoV-19/ AZD1222/ Covishield (AstraZeneca/Oxford, UK, India)	Janssen COVID-19 vaccine/Johnson & Johnson (Janssen, USA)	Covilo/ BBIBP-CorV (Sinopharm, China)	CoronaVac (Sinovac, China)	COVAXIN / BBV152 (Bharat Biotech, India)	Nuvaxovid/ NVX-CoV2373/ Covovax (Novavax, Czech Republic, India)
PHASE III TRIALS RESULTS [cclx]								
Number of participants (vaccine/ placebo)	43,448 (21,720/ 21,728)	30,420 (15,210/15,210)	17,178 (8597/8581)	39,321 (19,630/19,691)	26,917 (13,459/13458); or 26,914 (13,465/13,458)	9,823 (4,953/4,870)	25,798 (12,899/12899)	14,039 (7,020/7,019)
Total COVID-19 cases (vaccine/ control)	170(8/162)	196 (11/185)	332 (84/248)	464 (116/348)	121(26/95) or 116(21/95)	253(85/168)	130 (24/106)	106(10/96)
Efficacy estimates in Phase III trials	Starting from 7 days after 2nd dose: **95.0%** (95% CI, 90.3 to 97.6) in population without prior SARS-CoV-2 infection. Efficacy of **94.6%** (95% CI,	After a median follow-up of less than 63 days: Efficacy of **94.1%** (95% CI, 89.3 to 96.8; P<0.001). **100%** among	Two standard doses: efficacy was **63·1%** (95% CI 51.8 to 71.7; ≥14 days) while those with first low dose and standard 2nd dose the	VE against moderate-severe-critical Covid-19 was **66.9%** (95% CI 59.0 to 73.4) after 14 days post vaccine administration,	After 14 days, efficacy against symptomatic cases was **72.8%** (95% CI 58.1 to 82.4; in WIV04 vaccine) or **78.1%** (95% CI 64.8 to	After 14 days, efficacy against symptomatic cases was **50.7%** (95% CI 35.9 to 0-62.0).	**77.8%** (95% CI, 65.2-86.4) against symptomatic COVID-19 starting at ≥14 days after second dose	**83.4%** (95% CI, 73.6-89.5) starting at ≥14 days after first dose **89.7%** (95% CI, 80.2-94.6) starting

[cclx] Phase III trials were conducted between 27 July and 14 November 2020 for BNT162b2/ COMIRNATY, 27 July and 23 October 2020 for Spikevax/ Moderna, 23 April and 6 December 2020 for Vaxzevria/ ChAdOx1 nCoV-19/ AZD1222/ Covishield, 21 September 2020 and 22 January 2021 for Janssen Covid-19 vaccine/ Johnson & Johnson, 16 July and 20 December 2020 for Sinopharm/ BBIB-CorV, 21 July and 16 December 2020 for the Sinovac/ CoronaVac vaccine, 16 November 2020 and 7 January 2021 for the COVAXIN vaccine, and 28 September 2020 and 28 November 2020 for the Novavax vaccine. All trials were conducted prior to the transmission of the more contagious variant strains, particularly the delta variant (B.1.617.2). Studies are currently ongoing to determine the effectiveness of the vaccines against the delta variant.

	89.9 to 97.3) in population with or without prior infection. **100%** among adolescents (12-15 years old).	adolescents (12 to <18 years old).	efficacy was **80.7%** (95% CI 62.1 to 90.2). Pooled analysis efficacy was **66.7%** (95% CI 57.4 to 74.0). For any nucleic acid amplification test-positive swab: efficacy was 54.1% (95% CI 44.7 to 61.9).	and **66.1%** (95% CI 55.0 to 89.1) after 28 days. VE against severe-critical COVID-19 cases was **76.7%** (95% CI 54.6 to 89.1) after 14 days and **85.4%** (95% CI 54.2 to 96.9) after 28 days. SII-ChAdOx1 nCoV-19 has a non-inferior immune response compared to AZD1222 and an acceptable safety/ reactogenicity profile	86.3; in HBO2 vaccine).			at ≥7 days after second dose
Efficacy against hospitalization and death	**100%** (after 7 days)	**100%** (≥14 days)	**100%** (after 21 days)	**76.7%** (≥14 days) or **85.4%** (≥28 days)	**100%** (>14 days)	**100%** (>14 days)	**93.4%** (>14 days) against severe COVID-19	**100%** (after 7 days).
Phase III clinical trial serious adverse events	Serious adverse events were observed in a similar proportion of vaccine (0.6%) and placebo (0.5%) recipients. These events also occur at a similar frequency within	The frequency of grade 3 adverse events was similar in both the vaccine (1.5%) and placebo groups (1.3). Serious adverse events were observed in a	Serious adverse events were balanced across the study arms. 79 cases occurred in the vaccine group and 89 cases in the placebo group – 3 cases were considered related	Serious adverse events were reported in 0.4% of vaccine recipients and 0.4% of placebo recipients. Seven of the serious adverse events were considered	A cross-sectional survey collected data on adverse events following vaccination in the UAE - none of the symptoms were of serious nature or required hospitalization.	Overall incidence of serious adverse events was 0.5% (31 in placebo group and 33 in vaccine group). All adverse events were determined to be unrelated to the vaccine.	Rates of local and systemic AEs reported in the BBV152 group as mild (11·2%), moderate (0·8%), or severe (0·3%) were comparable to the placebo group	Phase II: Nine serious adverse events were reported, only one of which was assessed as related to the vaccine: acute colitis.

	the general population.	similar proportion in both groups (0.6%). 3 Bell's Palsy cases occurred in the vaccine group and one Bell's Palsy case occurred in the placebo group.	to the experimental or control vaccine (out of 11 636 vaccine recipients): transverse myelitis, haemolytic anaemia and a case of fever higher than 40°C.	to be related to the vaccine: Guillain-Barré syndrome (1), pericarditis (1), brachial radiculitis (1), hypersensitivity (1), Bell's Palsy (2), & severe generalized weakness, fever & headache (1).			15 deaths, none considered related to the vaccine or placebo	
PHASE III TRIAL OTHER								
Comments	Specific populations were excluded (HIV and immunocompromised patients, and pregnant women).	Calculation of efficacy were not based on the total number of confirmed Covid-19 cases.		**<u>2-DOSE EFFICACY</u>** *<u>Efficacy against symptomatic (moderate to severe/ critical) SARS-CoV-2 infection</u>* **94%** (95% CI, 58-100) in the US. **75%** (95% CI, 55-87) globally. *<u>Efficacy against severe SARS-CoV-2 infection</u>* **100%** (95% CI, 33-100)	Only 2 severe cases occurred in the control group and none in the vaccine group (very few cases to get a reliable estimate).	-	-	Novavax is currently awaiting FDA, EMA, and WHO EUL approval. Upcoming information regarding results of clinical trials or approval will be updated in upcoming reports

Vaccine Production Sites

Synoptic table about SARS-CoV-2 vaccines accepted in the WHO's Emergency Use Listing containing information on the vaccine production sites

	BNT162b2/ COMIRNATY (Pfizer-BioNTech, USA)[cclxi]	Spikevax/ Moderna COVID-19 Vaccine/ mRNA-1273 (Moderna, USA)[cclxii]	Vaxzevria/ ChAdOx1 nCoV-19/ AZD1222/ Covishield (AstraZeneca/Oxford, UK, India)[cclxiii]	Janssen COVID-19 vaccine/Johnson & Johnson (Janssen, USA)[cclxiv]	Sinopharm/BBIBP-CorV, China[cclxv]	Sinovac CoronaVac, China[cclxvi]	COVAXIN / BBV152 (Bharat Biotech, India)	Nuvaxovid/ NVX-CoV2373/ Covovax
EUL holder	BioNTech Manufacturing GmbH (Germany)	ModernaTX, Inc. (USA) Moderna Biotech (Spain)	AstraZeneca AB (Sweden)	Janssen-Cilag International NV (Belgium)	Beijing Institute of Biological Products Co., Ltd. (BIBP) (China)	Sinovac Life Sciences Co., Ltd. (China)	Bharat Biotech International Limited (India)	Novavax CZ a.s. (Czech Republic) Covovax Serum Institute of India Pvt. Ltd. (India)
Production sites (Drug substance)	BioNTech Manufacturing GmbH (Mainz, Germany) BioNTech Manufacturing	Lonza Biologics, Inc., (USA) Moderna TX, Inc. (USA)	Henogen S.A (Belgium) Catalent Maryland, Inc. (USA)	Janssen Vaccines & Prevention B.V. (The Netherlands) Janssen Biologics B.V. (The Netherlands)	Beijing Institute of Biological Products Co., Ltd. (China)	Sinovac Life Sciences Co., Ltd. (China)	-	Novavax (Bohumil, Czech Republic)

[cclxi] WHO recommendation BioNTech Tozinameran – COVID-19 mRNA vaccine (nucleoside modified) – COMIRNATY. *WHO.* https://extranet.who.int/pqweb/vaccines/who-recommendation-covid-19-mrna-vaccine-nucleoside-modified-comirnaty

[cclxii] 1. WHO recommendation ModernaTX, Inc/USFDA COVID-19 mRNA vaccine (nucleoside modified). *WHO*. https://extranet.who.int/pqweb/vaccines/who-recommendation-modernatx-incusfda-covid-19-mrna-vaccine-nucleoside-modified
2. WHO recommendation Moderna COVID-19 mRNA Vaccine (nucleoside modified). *WHO*. https://extranet.who.int/pqweb/vaccines/covid-19-mrna-vaccine-nucleoside-modified

[cclxiii] WHO recommendation AstraZeneca/ EU approved sites COVID-19 vaccine (ChAdOx1-S) [recombinant]. *WHO.* https://extranet.who.int/pqweb/vaccines/covid-19-vaccine-chadox1-s-recombinant-0

[cclxiv] WHO recommendation Janssen-Cilag International NV (Belgium) COVID-19 Vaccine (Ad26.COV2-S [recombinant]). *WHO*. https://extranet.who.int/pqweb/vaccines/who-recommendation-janssen-cilag-international-nv-belgium-covid-19-vaccine-ad26cov2-s

[cclxv] WHO recommendation COVID-19 vaccine BIBP/Sinopharm. *WHO.* https://extranet.who.int/pqweb/vaccines/who-recommendation-covid-19-vaccine-bibp

[cclxvi] WHO recommendation of Sinovac COVID-19 vaccine (Vero Cell [Inactivated]) – CoronaVac. *WHO*. https://extranet.who.int/pqweb/vaccines/who-recommendation-sinovac-covid-19-vaccine-vero-cell-inactivated-coronavac

	Marburg (Marburg, Germany) Rentschler Biopharma SE (Laupheim, Germany) Wyeth BioPharma Division of Wyeth Pharmaceuticals (USA)	Lonza AG (Switzerland)	Oxford Biomedica (UK) Ltd. (United Kingdom) SK Bioscience (Republic of Korea) Halix B.V (Netherlands) WuXi Biologics (China)	Emergent Manufacturing Operations Baltimore LLC (USA)				
Production sites (Drug product)	Baxter Oncology GmbH (Halle/ Westfallen, Germany) BioNTech Manufacturing GmbH (Mainz, Germany) Pfizer Manufacturing Belgium NV (Belgium) Novartis Pharma Stein AG (Switzerland) Mibe GmbH Arzneimittel	Baxter Pharmaceutical Solutions, LLC. (USA) Catalent Indiana, LLC. (USA) Rovi Pharma Industrial Services, S.A. (Spain)	Catalent Anagni (Italy) CP Pharmaceuticals (United Kingdom) IDT Biologika (Germany) SK Bioscience (Republic of Korea) Universal Farma, S.L. ("Chemo") (Spain) Amylin Ohio LLC (USA)	Janssen Biologics B.V. (The Netherlands) Janssen Pharmaceutica NV (Belgium) Aspen SVP. (South Africa) Catalent Indiana LLC. (USA) Grand River Aseptic Manufacturing Inc. (USA) Catalent Anagni S.R.L. (Italy)	Beijing Institute of Biological Products Co., Ltd. (China)	Sinovac Life Sciences Co., Ltd. (China)	-	Novavax (Bohumil, Czech Republic)

	(Brehna, Germany) Delpharm Saint-Remy (France) Sanofi-Aventis Deutschland GmbH (Germany)							
Diluent suppliers	Pfizer Perth, Australia Fresenius Kabi, USA	-	-	-	-	-	-	-

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