Literature screening report

COVID-19 vaccines in the WHO's Emergency Use Listing (EUL) Report (14)

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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 24 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.

[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, 62.6% of the world populations, of which only 12.3% of people in low-income countries, have received at least one dose of a marketed COVID-19 vaccine as of 25 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 18 February 2022[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 25.02.2022).

[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_18February2022.pdf [Last updated 18 February 2022; Accessed 25 February 2022]

Methodology

We screened the data for the EUL-accepted vaccines as of 24 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 Breakthrough Infections

Omicron continues to be responsible for the majority of COVID-19 cases in numerous countries around the globe. While preliminary studies regarding the protective elements of vaccination effectiveness (VE) against Omicron have been congruent thus far (i.e.; less severe disease manifestations and decreased hospitalization rates as discussed in previous reports), knowledge gaps persist especially regarding the differences of VE against Omicron sub-lineages BA.1 and BA.2 and breakthrough infections.

As part of its national surveillance of the COVID-19 evolution, a test-negative case control study by the UK Health Security Agency (UKHSA) was conducted to determine the VE against BA.2 symptomatic disease compared to the BA.1 sub-lineage. Between 27 December 2021 and 21 January 2022, early analysis combining all vaccines (BNT162b2, mRNA-1273, and ChAdOx1) showed that VE against BA.1 symptomatic infection was **9% (95% CI, 7.0-10.0)** approximately 25+ weeks after

[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

completion of the primary vaccination doses.[5] Alternatively, VE against BA.2 symptomatic infection appeared to be slightly higher at **13% (95% CI, -26.0-40.0)** 25+ weeks after completion of the primary vaccination doses. [6] These early estimates also showed that pooled VE of available boosters in the UK was **63% (95% CI, 63.0-64.0)** against BA.1 and **70% (95% CI, 58.0-79.0)** against BA.2. [7] It should be noted that no statistical difference in VE against BA.1 and BA.2 infection was found — analyses will be repeated by the UKHSA. [8] Nevertheless, these current VE estimates against BA.1 and BA.2 sub-lineages give a small insight of the true situation as well as contribute to decisions concerning booster doses and potential relaxation of public health measures. Future analyses should also investigate VE of individual vaccines to determine which platforms offer the most protection.

With regard to breakthrough infections, a study was conducted in Houston, Texas utilizing genome sequenced specimens from 27 November 2021 through 05 January 2022 to investigate the disease character of Omicron. Findings largely support results from previous literature and demonstrated that individuals infected with the Omicron variant were significantly younger and had higher rates of breakthrough infections (BTIs), but also less likely to be hospitalized compared with individuals infected with Alpha or Delta variants.[9] Based on the CDC definition for breakthrough infections, researchers found that among 4468 patients with Omicron, **55.9% (2497/4468)** met

[5] SARS-CoV-2 variants of concern and variants under investigation in England Technical briefing 35. *UK Health Security Agency.* https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1050999/Technical-Briefing-35-28January2022.pdf

[6] SARS-CoV-2 variants of concern and variants under investigation in England Technical briefing 35. *UK Health Security Agency.* https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1050999/Technical-Briefing-35-28January2022.pdf

[7] SARS-CoV-2 variants of concern and variants under investigation in England Technical briefing 35. *UK Health Security Agency.* https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1050999/Technical-Briefing-35-28January2022.pdf

[8] SARS-CoV-2 variants of concern and variants under investigation in England Technical briefing 35. *UK Health Security Agency.* https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1050999/Technical-Briefing-35-28January2022.pdf

[9] Signals of Significantly Increased Vaccine Breakthrough, Decreased Hospitalization Rates, and Less Severe Disease in Patients with Coronavirus Disease 2019 Caused by the Omicron Variant of Severe Acute Respiratory Syndrome Coronavirus 2 in Houston, Texas. *The American Journal of Pathology.* *https://www.sciencedirect.com/science/article/pii/S000294402200044X*

the criteria for BTI.[10] Of patients who only received primary vaccinations meeting the BTI definition, **73% (1828/2497)** received full doses of BNT162b2, **22% (553/2497)** received a full dose of mRNA-1273, and **5% (115/2497)** received the Janssen vaccine.[11] When considering other variants of concern, analyses also showed that there were significantly higher percentage of patients with Omicron-associated BTIs compared with Alpha and Delta infections at **55.9%, 3.2%, and 24.3%,** respectively.[12] Further, among individuals who received a third dose of BNT162b2 or mRNA-12723 vaccines, the percentage of BTIs was lower at **15.9%** among the total number of patients infected with Omicron.[13]

Transmissibility

As the Omicron variant fully overtakes Delta as the dominant variant of concern in Switzerland and most of Europe, new information has been published which offers further insight on the differences between the two variants. A study from the UK assessed differences in transmissibility between the Delta and Omicron variants by using contact tracing data. This analysis reaffirmed an increased transmission of Omicron which is displacing the Delta variant in England, and around the world as well. Secondary attack rates(SAR) for Omicron vs. Delta showed that SAR for Omicron was higher than Delta in both household and non-household settings. Omicron cases made up a higher proportion of index cases than Delta- **16.1%** vs. **7.3%.** Notably, household transmission was significantly less likely in cases of those who received

[10] Signals of Significantly Increased Vaccine Breakthrough, Decreased Hospitalization Rates, and Less Severe Disease in Patients with Coronavirus Disease 2019 Caused by the Omicron Variant of Severe Acute Respiratory Syndrome Coronavirus 2 in Houston, Texas. *The American Journal of Pathology.* https://www.sciencedirect.com/science/article/pii/S000294402200044X

[11] Signals of Significantly Increased Vaccine Breakthrough, Decreased Hospitalization Rates, and Less Severe Disease in Patients with Coronavirus Disease 2019 Caused by the Omicron Variant of Severe Acute Respiratory Syndrome Coronavirus 2 in Houston, Texas. *The American Journal of Pathology.* https://www.sciencedirect.com/science/article/pii/S000294402200044X

[12] Signals of Significantly Increased Vaccine Breakthrough, Decreased Hospitalization Rates, and Less Severe Disease in Patients with Coronavirus Disease 2019 Caused by the Omicron Variant of Severe Acute Respiratory Syndrome Coronavirus 2 in Houston, Texas. *The American Journal of Pathology.* https://www.sciencedirect.com/science/article/pii/S000294402200044X

[13] Signals of Significantly Increased Vaccine Breakthrough, Decreased Hospitalization Rates, and Less Severe Disease in Patients with Coronavirus Disease 2019 Caused by the Omicron Variant of Severe Acute Respiratory Syndrome Coronavirus 2 in Houston, Texas. *The American Journal of Pathology.* https://www.sciencedirect.com/science/article/pii/S000294402200044X

the booster vaccine than those who only received 2 doses. This effect was less beneficial in cases of Omicron transmission (aRR of **0.78/0.88** vs aRR of **0.62/0.68** for Delta). In non-household settings, 2 or 3-dose vaccination offered a similar reduction in transmission risk for Delta cases and contacts, but only for contacts of those with Omicron. This study offers more insight into how vaccination/booster status can affect transmission dynamics even under conditions of reduced VE.[14]

Much has been said regarding the increased transmissibility of the Omicron variant. Current studies which focus on the distinction between the BA.1 and BA.2 sub-lineages can offer more specific information on the dynamics of these two lineages and how they function in large populations. To investigate natural immunity against BA.2 conferred by previous BA.1 infection, a study from Denmark used a pool of more than 1.8 million cases to examine re-infection rates in its population. Individuals who had 2 positive sera samples within a period of 20 days to 2 months were selected. From a total of **187** eligible re-infection cases, there were **47** instances of a BA.2 re-infection after BA.1 infection. These 47 cases offered more insight as to the vaccination status of this group- 42 of them were not vaccinated **(89%)**, 3 of them were vaccinated twice **(6%),** and 2 people **(4%)** only received one dose of a vaccine. Additionally, in this group reinfection cases were all mild, with no need for hospitalization. Strikingly, reinfection appeared to be more common in younger age groups. This study reaffirms the importance of vaccination even under conditions of reduced effectiveness- un-vaccinated people appear to be more vulnerable to re-infection from alternative variants of Omicron, suggesting that the boost in immunity from vaccination is helpful and prevents morbidity from COVID-19.[15]

Though real-time data regarding Omicron transmission is readily available, there is a potential for added value using models for transmission, which are able to factor in

[14] Comparative transmission of SARS-CoV-2 Omicron (B.1.1.529) and Delta (B.1.617.2) variants and the impact of vaccination: national cohort study, England. *medRxiv*. https://www.medrxiv.org/content/10.1101/2022.02.15.22271001v1

[15] Occurrence and significance of Omicron BA.1 infection followed by BA.2 reinfection. *medRxiv.* https://www.medrxiv.org/content/10.1101/2022.02.19.22271112v1

many parameters regarding vaccination rates. A stochastic modeling project from New Zealand simulated the spread of COVID-19, factoring in unvaccinated, vaccinated and boosted people to model potential for the start of local outbreaks. The model was applied to both the Delta and Omicron variants. This model output showed that regarding the Delta variant, a vaccinated traveler (not in quarantine) infected with COVID-19 was **9 times less** likely to seed an outbreak than an unvaccinated traveler with COVID-19, but this effect was not seen with the Omicron variant. This model showed that under conditions where Delta is dominant, unvaccinated people were responsible for **87%** of all infections. However, under the Omicron variant, this number dropped to **45%**, with vaccinated people making up **39%**, and boosted people being responsible for **15%**. However, it was shown that only **3%** of infections occurred between 2 people who were both boosted, suggesting that high rates of booster administration can help limit Omicron outbreaks.[16]

Immunogenicity of Booster Doses

Considering globally high rates of Omicron transmission, a study of blood donors in New York City who had either two or three doses of an mRNA vaccine (Pfizer or Moderna) compared neutralizing antibody titers for people who had received 2 or 3 doses and had experienced breakthrough infection, looking at the effect against several variants of concern, including Omicron. The study compared 2-dose vaccinated participants who experienced a breakthrough infection with 2-dose vaccinated participants who remained un-infected. Findings showed that 2-dose vaccinated participants with breakthrough Omicron infections had median plasma titers that were **4.2** times greater against the Wuhan-hu-1 variant, **7.4** times greater against the Delta variant, and **161.5** times greater against the Omicron variant. Additionally, participants with omicron breakthrough had neutralizing titers that were **2.9**-times higher when compared to boosted participants. This study asserts that Omicron breakthrough infection is more powerful in increasing neutralizing antibody

[16] Likelihood of infecting or getting infected with COVID-19 as a function of vaccination status, as investigated with a stochastic model for New Zealand (Aotearoa) for Delta and Omicron variants. *medRxiv*. https://www.medrxiv.org/content/10.1101/2021.11.28.21266967v1

titers against Omicron than vaccination, but this effect was seen to be reduced in individuals who had received a third dose of vaccination.[17]

Booster Doses

Heterologous Boosters

A test-negative design study aiming to evaluate the effectiveness of the BNT162b2 vaccine as a booster dose in individuals vaccinated with two doses of CoronaVac against SARS-CoV-2 infections and severe outcomes found that the mRNA booster dose increased the protection against SARS-CoV-2 infections. Based on the results, a BNT162b2 booster, 6 months after the second dose of CoronaVac, improved the vaccine effectiveness against infection to **92.7% (95% CI: 91.0−94.0)** and **97.3% (95% CI: 96.1−98.1)** against severe outcomes 14 to 30 days after the booster. Compared with younger age groups, individuals 80 years of age or older had lower protection after the second dose but similar protection after the booster. Overall, the study supports a BNT162b2 booster vaccine dose after two doses of CoronaVac, particularly for the elderly.

Fourth Dose

With the new emerging evidence that the immunogenicity of boosted-individuals is waning over time, some countries and scientists have decided to administer and test the safety, immunogenicity, and effectiveness of a fourth COVID-19 vaccine dose. Although a fourth dose appeared to lower the confirmed rate of infection and severe illness and increased the neutralizing capacity against the Omicron variant, the duration of protection of the fourth dose remained poorly known, especially against variants of concerns such as Omicron. An open-label, clinical intervention trial investigating the immunogenicity, efficacy, and safety of BNT162b2 or mRNA1273 fourth dose against Omicron in health care workers found that a fourth COVID-19

[17] SARS-CoV-2 neutralization after mRNA vaccination and variant breakthrough infection. *medRxiv* https://www.medrxiv.org/content/10.1101/2022.02.09.22270692v1

mRNA dose restored antibody titers to the peak of post-third dose titers.[18] Based on the results, recipients of both vaccine types had a **9- to 10-fold increase** in IgG and neutralizing titers within 2 weeks of their fourth dose and an **8-fold increase** in live Omicron neutralization. Another study analysing the administration of a fourth SinoPharm dose in individuals previously vaccinated with three homologous doses demonstrated that the fourth dose was safe and capable of recalling waned immunity responses 6 months after the third dose; however, the peak RBD-NAbs level induced by the 4th dose was inferior to the peak of the 3rd dose.[19] Overall, a fourth dose of any COVID-19 vaccine appears to increase the immune response up to the previously attained levels while it appeared safe and tolerable in individuals; nevertheless, further studies evaluating the dynamics of the immune response granted by fourth doses are needed.

Immunogenicity

A study of vaccinated healthcare workers (HCW) in Germany analysed their sera samples in order to examine anti-SARS-CoV-2 specific antibodies and t-cell responses over time, with a secondary goal of establishing a potential correlate of protection for quantifying immune responses to SARS-CoV-2 vaccines. This analysis showed that on average, younger people had more robust immune responses to the vaccines -in this case, Pfizer, Moderna or AstraZeneca- immediately from receipt of the vaccine. However, over time, antibody titres dropped steadily for all age and demographic groups at an almost linear rate. At 200 days after receipt of a second dose, neutralization capacity had dropped from over **90%** to almost **40%**. This study suggested that a **75%** neutralizing capability and a T-cell (interferon-gamma) response above **200 mIU/ml** should be considered as a threshold for protection.[20]

[18] 4th dose COVID-19 mRNA Vaccines' Immunogenicity & Efficacy Against Omicron VOC. *medRxiv.* https://www.medrxiv.org/content/10.1101/2022.02.15.22270948v1

[19] Fourth doses of inactivated SARS-CoV-2 vaccine redistribute humoral immune response away from the Receptor Binding Domai. *medRxiv.* https://www.medrxiv.org/content/10.1101/2022.02.19.22271215v1.full-text

[20] Immune responses after twofold SARS-CoV-2 immunisation in elderly residents and Health Care Workers in nursing homes and homes with assisted living support - Proposal for a correlate of protection. *medRxiv*. https://www.medrxiv.org/content/10.1101/2022.02.09.22270747v1

Another study investigated the dynamics of different immunological markers in health care workers over time after receiving the BNT162b2 (Pfizer/Comirnaty) vaccine. The study looked at anti-RBD IgG, anti-spike trimeric IgG, and neutralizing antibody responses up to 6 months after vaccination. The study showed that immune response in this sample peaked at 2 weeks. Anti-RBD IgG levels began to decrease and showed a decrease of 4.5-fold by 3 months, and 13-fold by 6 months. Using another metric, the antri-Trimeric S IgG titers showed a less pronounced, but still significant, decrease of 2.8 and 4.7 fold at 3 and 6 months, respectively. Interestingly, neutralizing antibody titers (Nabs) did not show a steep decrease over time.[21]

A cross-sectional comparative study from Serbia aimed to measure anti-S antibody levels in individuals vaccinated with 3 different SARS-Cov-2 vaccines, including he BNT162b2 and BBIBP-CorV vaccines. The study also measured anti-S Ab levels in convalescent sera samples. The highest mean antibody levels were found in the BNT162b2 group, followed by Gam-COVID-Vac (not covered in this report) and BBIBP-CorV. Seropositivity in the convalescent group was seen to be **81%,** whereas it was **83%** for the BBIBP-CorV vaccinated individuals and 100% in BNT162b2 vaccinated individuals.[22]

A prospective longitudinal observational study of healthcare workers gathered data on cross neutralization against the Delta variant (B.1.617.2). Over an 8-month period, anti-S IgG antibodies were seen to decrease significantly from a high of **147 (102-298),** to a low of **97 (96-98)**. Similar trends were seen for surrogate neutralizing antibodies and anti-RBD antibodies. However, neutralization against Delta appeared to be conserved over time, as 50/53 (**94%**) of participants had detectable neutralizing

[21] Differential Dynamics of SARS-CoV-2 Binding and Functional Antibodies upon BNT162b2 Vaccine: A 6-Month Follow-Up. *Viruses*. https://www.mdpi.com/1999-4915/14/2/312

[22] Immunogenicity of BNT162b2, BBIBP-CorV and Gam-COVID-Vac vaccines and immunity after natural SARS-CoV-2 infection-A comparative study from Novi Sad, Serbia. *PloS one.* https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0263468

ability at 8 months after their first dose. This confirms the existing data about trends of humoral immunity and neutralizing activity against SARS-CoV-2 over time.[23]

A study from Argentina analyzed the SARS-CoV-2 specific humoral response of BBIBP-CorV vaccinated healthcare workers with or without exposure to SARS-CoV-2 infection. The study examined antibody titers over time, up to 3 months post second-dose of vaccination. Results from this study showed that participants who were exposed to SARS-CoV-2 before vaccination showed a significantly stronger immune response, in the form of high anti-spike IgG antibody levels, than those not exposed to SARS-CoV-2. This effect was seen to be independent of time. Additionally, a single dose of the BBIBP-CorV vaccine was seen to induce higher antibody titers than 2 doses did in those who were naïve to the pathogen. After 3 months, both groups showed a decline in antibody levels.[24]

A study used an international SARS-CoV-2 antibody standard to compare the nAbs of a vector-based vaccine, an mRNA vaccine, and a protein-based vaccine. The vaccines used which are of interest for this report are NVX-CoV2373, Comirnaty (Pfizer) and Vaxzevria. Samples were collected from vaccinated individuals 2 weeks to a month after receiving the vaccine. Results showed that Comirnaty elicited the strongest neutralizing antibody titer, followed by NVX-CoV2373, and then Vaxzevria. Statistical analysis showed that Comirnaty and NVX-CoV2373 had comparable mean nAB levels.[25]

A study of vaccinated people in Libya aimed to evaluate levels of antibodies against SARS-CoV-2 and their persistence, both post vaccination and post infection. The study sample included people vaccinated with AstraZeneca, Sputnik, Sinovac, and

[23] Neutralizing antibody activity against the B.1.617.2 (delta) variant 8 months after two-dose vaccination with BNT162b2 in health care workers.*Clinical microbiology and infection.* https://pubmed.ncbi.nlm.nih.gov/35124261/

[24] Humoral response to the BBIBP-CorV vaccine over time in healthcare workers with or without exposure to SARS-CoV-2. *Molecular immunology.* https://pubmed.ncbi.nlm.nih.gov/35091231/

[25] Calibrated comparison of SARS-CoV-2 neutralizing antibody levels in response to protein-, mRNA-, and vector-based COVID-19 vaccines. *NPJ Vaccines*. https://www.nature.com/articles/s41541-022-00455-3

Sinopharm. Out of a total 9460 seropositive individuals included in the study, 65.6% were vaccinated. Notably, a total of 38.3% of people were seropositive without reporting a previous infection, suggesting a high level of asymptomatic infection. Over 21 weeks of surveillance, the dynamics of the levels of antibodies in this sample were tracked. From 1 week to 11 weeks after vaccination, those vaccinated with AstraZeneca showed a higher titer than those vaccinated with Sinopharm and Sinovac. Titers from those vaccinated with AstraZeneca showed a peak at 7 weeks post-vaccination, with gradual decline after. This differed in those vaccinated with Sinovac and Sinopharm, as the IgG levels in these samples continued to rise until week 15. At this point, all vaccines surveyed in the study showed similar titers. Ultimately, the rate of decline was most noticeable in AstraZeneca and Sinopharm. However, it is worth noting that this study was mainly able to gather information about immune response to a single dose of a vaccine, which ultimately reduces the relevance of this study the efficacy of single doses has proven to be limited.[26]

Children Vaccination

The most recent updates on literature on child vaccination are mainly concerning three areas: vaccine effectiveness against Omicron, suitability of non-mRNA vaccine candidates for children and adolescents, and assessment of myocarditis risk.

A study from the UK used a test-negative case control study design to analyze national SARS-CoV-2 testing, hospitalization, and vaccination data to estimate VE of BNT162b2 against PCR-confirmed COVID-19. BNT162b2 vaccination in 12–17-year-olds was seen to be associated with reduced vaccine effectiveness against symptomatic COVID-19 caused by Omicron as compared to Delta. Overall, the data shows a rapid increase in vaccine effectiveness against symptomatic COVID-19 after receipt of a second dose for both Delta and Omicron, although this protection level declines to as little as **23%** against Omicron after an extended amount of time. This study also showed that robust protected against hospitalization due to the Delta variant

[26] Anti-SARS-CoV-2 IgG antibodies after recovery from COVID-19 or vaccination in Libyan population: comparison of four vaccines. *medRxiv*. https://www.medrxiv.org/content/10.1101/2022.02.18.22271130v1.article-info

was offered by even one dose. This study reaffirms what we know so far about vaccine effectiveness in children against Omicron, which is that children and adolescents are susceptible to the same kind of waning immunity and reduced protection against Omicron as adults.[27]

An interim report from a phase 3 clinical trial of CoronaVac among children and adolescents in Chile reported safety and immunogenicity data. These preliminary results showed low levels of adverse events, with the primary adverse reaction reported being mild and local pain at the injection site. No age group showed rates of systemic reactions at higher than **2.2%.** Additionally, adolescents appeared to have marginally higher rates of adverse events than children aged 3-11. 4 weeks post-vaccination, significant increases in total and neutralizing antibodies against SARS-CoV-2 were observed, and significant neutralizing capacity was observed in plasma from the 3-11 age group and the 12-17 age group. Significant T-cell activation was also observed 4 weeks after the second dose. Notably, a reduced neutralization response was observed against the Delta and Omicron variants, as compared to the D614G variant. This study concluded that the CoronaVac vaccine is safe for children and adolescents, and immunogenic enough that it would likely confer protection against SARS-CoV-2 infection.[28]

A self-controlled case series study in Italy was designed to investigate the associations between SARS-CoV-2 mRNA vaccines and myocarditis in people aged 12-39. During a 9-month study period, **441** participants out of a study cohort of almost 3 million vaccinated people were seen to develop myocarditis or pericarditis. Focusing on child and adolescent age groups within the study, those from age 12-17 had an increased risk of myocarditis between 0-7 days post-vaccination with the BNT162b2 vaccine. There were not enough events occurring under the mRNA-1273 vaccine to make

[27] Adolescent vaccination with BNT162b2 (Comirnaty, Pfizer-BioNTech) vaccine and effectiveness against COVID-19: national test-negative case-control study, England. *medRxiv*. https://www.medrxiv.org/content/10.1101/2021.12.10.21267408v1

[28] An inactivated SARS-CoV-2 vaccine is safe and induces humoral and cellular immunity against virus variants in healthy children and adolescents in Chile. *medRxiv.* https://www.medrxiv.org/content/10.1101/2022.02.15.22270973v1

statistically significant associations for the 12-17 age group. However, in the 18-29 age group, an increased risk of myocarditis or pericarditis was seen between 0-7 days of receipt of a first or second dose of mRNA-1273. Predictably, this study found that there was an association between youth, being male, and getting myocarditis/pericarditis after vaccination. It also found that the risk increased after the second dose.[29]

A study in the US was conducted to create a risk benefit analysis to weigh the benefits of one or two doses of vaccine against the risk of myocarditis among a stratified youth population. The total number of cases of either myocarditis or pericarditis was **253**. **86.9%** of these cases were hospitalized. Incidence rates per million after two doses in males aged 12-15 was **162.2** while for males aged 16-17 it was **93.** This study makes the somewhat uncommon assertion that after conducting a risk-benefit analysis weighing myocarditis risk against COVID-19 hospitalization due to the Delta variant, the 2-dose vaccine schedule was not universally favorable. The authors of this study suggest the promotion of a more individualized vaccine schedule for children and adolescents, particularly those more at risk of myocarditis.[30]

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

[29] Post-marketing active surveillance of myocarditis and pericarditis following vaccination with COVID-19 mRNA vaccines in persons aged 12-39 years in Italy: a multi-database, self-controlled case series study. *medRxiv*. https://www.medrxiv.org/content/10.1101/2022.02.07.22270020v1

[30] Vaccine-Associated Myo/Pericarditis in Adolescents: A Stratified Risk-Benefit Analysis. *Eur J Clin Invest*. https://pubmed.ncbi.nlm.nih.gov/35156705/

Synoptic Table

Synoptic table about SARS-CoV-2 vaccines accepted in the WHO's Emergency Use Listing containing ONLY the newest information (as of 24 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)
EFFECTIVENESS AGAINST ANY SARS-COV-2 INFECTION								
Effectiveness of Single Dose	**74% (95% CI, 71.0-76.0)** at 21-55 days post-vaccination.[Canada; 04 April 2021 to 02 October 2021][1i] **53% (95% CI, 32.0-68.0)** ≥ 14 days after.[Pooled ratio from meta-analyses] [2]	**74% (95% CI, 71.0-76.0)** at 21-55 days post-vaccination.[Canada; 04 April 2021 to 02 October 2021][1ii]	**49% (95% CI, 17.0-68.0)** for one dose.[India][3] **59% (95% CI, 53.0-65.0)** at 21-55 days post-vaccination.[Canada; 04 April 2021 to 02 October 2021][1] **31.0% (95% CI, 12.7-45.5)** 21 days after.[Brazil; 17 January 2021	No new data	No new data	No new data	No new data	No new data

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

			to 27 November 2021][4] *Against Symptomatic Disease:* **31.6% (95% CI, 12.0-46.8)** 21 days after.[Brazil; 17 January 2021 to 27 November 2021][4]					
Effectiveness of Two Doses	**95% (95% CI, 96.0-97.0)** ≥ 7 days after.[Pooled ratio from meta-analyses] [2] **82% (95% CI, 80.0-84.0)** among 16-64 years old and **60% (95% CI, 36.0-76.0)** among 65 years or older with history of prior infection. [Israel; 01 March 2021 to 26 November 26 2021][5]	No new data	**54% (95% CI, 27.0-71.0)** for two doses.[India][3] **59.0% (95% CI, 33.1-74.8)** 14 days after.[Brazil; 17 January 2021 to 27 November 2021][4] *Against symptomatic disease*: **65.1% (95% CI, 40.9-79.4)** 14 days after.[Brazil; 17 January 2021 to 27 November 2021][4] *Against Severe Disease:*	Not Applicable (One Dose Schedule)	No new data	No new data	No new data	No new data

			95% (95% CI, 44.0-100.0) for any doses.[India][3]					
EFFECTIVENESS AGAINST VARIANTS								
Alpha	**80% (95% CI, 76.0-84.0)** against infections after single dose.[Canada; 04 April 2021 to 02 October 2021][1iii]	**80% (95% CI, 76.0-84.0)** against infections after single dose.[Canada; 04 April 2021 to 02 October 2021][1iv]	No new data	No new data	No new data	No new data	No new data	No new data
Gamma	**80% (95% CI, 76.0-84.0)** against infections after single dose.[Canada; 04 April 2021 to 02 October 2021][1v]	**80% (95% CI, 76.0-84.0)** against infections after single dose.[Canada; 04 April 2021 to 02 October 2021][1vi]	No new data	No new data	No new data	No new data	No new data	No new data
Delta	**63% (95% CI, 56.0-69.0)** against infection after single	**63% (95% CI, 56.0-69.0)** against infection after single	No new data	No new data	No new data	No new data	No new data	No new data

[iii] Study does not differentiate between mRNA-based vaccines.
[iv] Study does not differentiate between mRNA-based vaccines.
[v] Study does not differentiate between mRNA-based vaccines.
[vi] Study does not differentiate between mRNA-based vaccines.

	dose.[Canada; 04 April 2021 to 02 October 2021][1vii]	dose.[Canada; 04 April 2021 to 02 October 2021][1viii]						
Omicron	*Against Symptomatic Disease:* **9% (95% CI, 7.0-10.0)** for BA.1 and **13% (95% CI, -26.0-40.0)** against BA.2 [England][6ix]	*Against Symptomatic Disease:* **9% (95% CI, 7.0-10.0)** for BA.1 and 13% **(95% CI, -26.0-40.0)** against BA.2 [England][6x]	*Against Symptomatic Disease:* **9% (95% CI, 7.0-10.0)** for BA.1 and 13% **(95% CI, -26.0-40.0)** against BA.2 [England][6xi]	No new data	No new data	No new data	No new data	No new data
EFFECTIVENESS AGAINST HOSPITALIZATION								
Any SARS-CoV-2 Infection	*Single Dose:* **86% (95% CI, 80.0-90.0)** at 21-55 days post-vaccination.[Canada; 04 April 2021 to 02 October 2021][1xii]	*Single Dose:* **86% (95% CI, 80.0-90.0)** at 21-55 days post-vaccination.[Canada; 04 April 2021 to 02 October 2021][1xiii]	*Single Dose:* **94% (95% CI, 85.0-97.0)** at 21-55 days post-vaccination.[Canada; 04 April 2021 to 02 October 2021][1]	No new data	No new data	No difference against clinical course at the ICU found between vaccinated and unvaccinated[Turkey][7]	No new data	No new data

[vii] Study does not differentiate between mRNA-based vaccines.
[viii] Study does not differentiate between mRNA-based vaccines.
[ix] Technical brief does not differentiate between vaccines.
[x] Technical brief does not differentiate between vaccines.
[xi] Technical brief does not differentiate between vaccines.
[xii] Study does not differentiate between mRNA-based vaccines.
[xiii] Study does not differentiate between mRNA-based vaccines.

Alpha	No new data	No new data	No new data	No new data	No new data	No new data	No new data	No new data
Delta	*Single Dose*: **85% (95% CI, 71.0-92.0)** [Canada; 04 April 2021 to 02 October 2021][1xiv]	*Single Dose*: **85% (95% CI, 71.0-92.0)** [Canada; 04 April 2021 to 02 October 2021][1xv]	No new data	No new data	No new data	No new data	No new data	No new data
DURATION OF PROTECTION, TRANSMISSION & BREAKTHROUGH INFECTIONS								
Duration of Protection (Antibodies)	Neutralizing antibodies decreased by **23.9%**, and the anti-spike/receptor binding domain antibody decreased by **53.8%** at 24 weeks.[Korea][8]	No new data	No new data	No new data	No new data	No new data	No new data	No new data
Duration of Protection (Vaccine Effectiveness)	**88.3% (95% CI, 83.2-91.8)** against any infection and **declined** to about **65%** at the end of an 8-month follow-up.[Czech Republic; 27	VE against Delta infection **decreased from 82% (95% CI, 80.0-84.0)** at 3-4 weeks after the second dose of vaccine **to 33%**	**58% (95% CI, 23.0-77.0)** 14 to 73 days after the second dose. [United Kingdom][10]	No new data	No new data	No new data	No new data	No new data

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

	December 2020 to 31 August 2021][9] **85% (95% CI, 72.0-92.0)** against any infection and declined to **51% (95% CI, 22.0-69.0)** at a median of 201 days after second dose.[United Kingdom][10] VE against Delta infection **decreased from 82% (95% CI, 80.0-84.0)** at 3-4 weeks after the second dose of vaccine **to 33% (95% CI, 27.0-39.0)** at 27-30 weeks after the second dose. [Italy; 27 December 2020 to 07 November 2021][11][xvi]	**(95% CI, 27.0-39.0)** at 27-30 weeks after the second dose. [Italy; 27 December 2020 to 07 November 2021][11][xviii] VE against Delta-associated severe disease **decreased from 96% (95% CI, 95.0-97.0) to 80% (95% CI, 76.0-83.0)** at 27-30 weeks after the second dose.[Italy; 27 December 2020 to 07 November 2021][11][xix]						

[xvi] Study does not differentiate between mRNA-based vaccines.
[xviii] Study does not differentiate between mRNA-based vaccines.
[xix] Study does not differentiate between mRNA-based vaccines.

	VE against Delta-associated severe disease **decreased from 96% (95% CI, 95.0-97.0) to 80% (95% CI, 76.0-83.0)** at 27-30 weeks after the second dose.[Italy; 27 December 2020 to 07 November 2021][11][xvii]							
Breakthrough Infections	Of 2497 patients with Omicron BTI, **73% (1828/2497)** received full doses of BNT162b2[USA; 27 November 2021 to 05 January 2022][12]	Of 2497 patients with Omicron BTI, **22% (553/2497)** received full doses of mRNA-1273[USA; 27 November 2021 to 05 January 2022][12]	No new data	Of 2497 patients with Omicron BTI, **5% (115/2497)** received a full dose of Janssen[USA; 27 November 2021 to 05 January 2022][12]	No new data	No new data	No new data	No new data
				IMMUNOGENICITY				
General	200 days post 2nd dose, neutralization capacity drop from **90% to 40%**[13][xx]	200 days post 2nd dose, neutralization capacity drop from **90% to 40%**[13]	200 days post 2nd dose, neutralization capacity drop from **90% to 40%**[13]	No new data	*Mean anti-S Ab titer :* **68.50 AU/mL, SD = 72.78** [16]	*IgG Ab, One dose, week 15:* **113.6 AU/ml**[19]	No new data	*Nab:* **548 IU/mL**[18]

[xvii] Study does not differentiate between mRNA-based vaccines.
[xx] Study does not differentiate between Pfizer, Moderna, or AstraZeneca

	Boosted subjects with pre-Omicron breakthrough infection had **4.9 times** greater neutralization against Delta[14xxi] *Anti-RBD IgG:* *At 3 months:* **4.5-fold** decrease *At 6 months:* **13-fold** decrease *Anti-Trimeric S IgG:* *at 3 months:* **2.8-fold** decrease *at 6 months:* **4.7-fold** decrease[15] *Mean anti-S Ab titer:* **210.11 AU/mL, SD=100.42**[16] *Against Delta :* *Median (IQR) anti-S1 IgG :* Decrease from **147 (102-298)** to **8 (4-13)** over 8 months	Boosted subjects with pre-Omicron breakthrough infection had **4.9 times** greater neutralization against Delta[14xxii]	*Nabs:* **202 IU/ml** [18] *Anti-spike IgG:* **257 AU/ml (p value<0.005)**[19]		**83%** Seropositivty[16] *IgG anti-spike Ab :* GMC **: 377.0 IU/mL (95% CI, 324.4-438.3)** After 3 mo**: 125.4 IU/mL (95% CI, 88.2-178.4)**[20]			

[xxi] Study does not differentiate between Pfizer and Moderna
[xxii] Study does not differentiate between Pfizer and Moderna

	Anti-RBD Ab: Decrease from **20,159 (19,023-21,628)** to **15,324 (13,055-17,288)** over 8 months[17] *Nabs:* **557 IU/mL**[18]							
Omicron (B.1.1.529)	Boosted subjects with pre-Omicron breakthrough infection had **26.4-times** greater neutralization[14xxiii]	Boosted subjects with pre-Omicron breakthrough infection had **26.4-times** greater neutralization[14xxiv]	No new data	No new data	No new data	No new data	No new data	No new data
CHILDREN VACCINATION								
Effectiveness	*VE over time (DELTA):* 12-15: peak at **93.2% (95% CI, 81.5-97.5)** after 7-13 days 16-17: peak at **96.1% (95% CI, 95.2-96.8**) after 14-34 days[21]		No new data	No new data	No new data	No new data	No new data	No new data
Effectiveness against	*VE over time:* 12-15: peak at **83.1% (95%CI**							

[xxiii] Study does not differentiate between Pfizer and Moderna
[xxiv] Study does not differentiate between Pfizer and Moderna

Omicron (B.1.1.529)	**78.2-86.9**) after 7-13 days 16-17: peak at **76.1% (73.4-78.6**), decline to **23%** over 70+ days[21]							
Safety and adverse events	*Myocarditis risk, 0-7 days post :* *12-17 :* **RI=5.74 (95% CI, 1.52-21.72)** *18-29 :* **RI=4.02, (95% CI,1.81-8.91)**[22] *Myocarditis :* Incidence per million after dose two in males **12–15 :162.2** **16–17 93.0** [23]	*Myocarditis risk, 0-7 days post:* *18-29:* **RI=9.58, (95% CI 3.32-27.58)** [22]	No new data	No new data	No new data	Mild local adverse reactions, no immediate SAE. Immediate systemic reactions at rates of no more than 2.2% (all ages) [24]	No new data	no new data
Immunogenicity	no new data	No new data	No new data	No new data	No new data	*Plasma neutralizing capability :* Ages 3-11: **GMU 713.1 (95% CI, 565.8-898.8)** Ages 12-17: **(GMU 492.2, 95% CI=342.0-708.3**)[24] *Neutralization against Delta :*	No new data	No new data

						GMT 141.6 (95% CI, 113.6-176.5)-reduction of **1.9-fold** [24] *Neutralization against Omicron:* **(GMT 16.8 (95% CI,13.95-20.26)**, reduction of **15.8-fold**[24]		
BOOSTER DOSES								
Effectiveness	*Effectiveness against hospitalization:* **97% (95% CI, 95-99)** [USA; August-December 2021][25xxv] **88% (95% CI, 81-93)** in immunocompromised individuals [USA; August-December 2021][25xxvi]	*Effectiveness against hospitalization:* **97% (95% CI, 95-99)** [USA; August-December 2021][25xxvii] **88% (95% CI, 81-93)** in immunocompromised individuals [USA; August-December 2021][25xxviii]	No new data	No new data	No new data	No new data	No new data	No new data

[xxv] Study does not differentiate between Pfizer and Moderna
[xxvi] Study does not differentiate between Pfizer and Moderna
[xxvii] Study does not differentiate between Pfizer and Moderna
[xxviii] Study does not differentiate between Pfizer and Moderna

Breakthrough infections	**0.7%** breakthrough infection rate[26] **30%** absolute risk reduction in ≥45 years old[26]	No new data	No new data	No new data	No new data	No new data	No new data	No new data
Duration of protection	*Immunogenicity:* **65%** GMLs by week 10 to 14 in BNT162b2-extended/BNT162b2 and infection-naïve[27] **40%** GMLs by week 10 to 14 in BNT162b2/BNT162b2 and infection-naïve[27] *Effectiveness against symptomatic disease:* **25% to 40% VE** from 15 weeks or more following booster dose[xxix27] *Effectiveness against hospitalization:*	*Effectiveness against symptomatic disease:* **25% to 40%** from 15 weeks or more following booster dose[xxxi27] *Effectiveness against hospitalization:* **90% to 95% VE** up to 9 weeks[xxxii27]	No new data	No new data	No new data	No new data	No new data	No new data

[xxix] Study does not differentiate between Pfizer and Moderna

[xxxi] Study does not differentiate between Pfizer and Moderna

[xxxii] Study does not specify primary vaccination course

	75% VE after 10 to 14 weeks[xxx27]							
4th Dose	*Immunogenicity:* **9- to 10-fold increase** 14 days after 4th dose in IgG and neutralizing antibodies[28xxxiii] *Immunogenicity against Omicron:* **8-fols increase** in neutralization[28xxxiv]	*Immunogenicity:* **9- to 10-fold increase** 14 days after 4th dose in IgG and neutralizing antibodies[28xxxv] *Immunogenicity to Omicron:* **8-fols increase** in neutralization[28xxxvi]	No new data	No new data	*Immunogenicity:* **19-fold increase** in neutralizing antibodies[29] *Immunogenicity to Omicron:* **2.9-fold increase** in neutralizing antibodies[29]	No new data	No new data	No new data
HETEROLOGOUS BOOSTER DOSES								
Vaccine Schedule	*Heterologous 1:* **mRNA1273/BNT162b2** *Heterologous 2:* **Ad26.CoV.2.S/BNT162b2** *Heterologous 3:* **ChAdOx1/BNT162b2**	*Heterologous 1:* **BNT162b2/mRNA1273** *Heterologous 2:* **Ad26.CoV.2.S/mRNA1273** *Heterologous 3:* **ChAdOx1/mRNA1273**	*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.**	*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**	No available data	*Heterologous 1:* **BNT162b2/NVX-CoV2373** *Heterologous 2:* **ChAdOx1/NVX-CoV2373** ***Received NVX-CoV2373 as booster dose**

[xxx] Study does not specify primary vaccination course

[xxxiii] Study does not differentiate between Pfizer and Moderna

[xxxiv] Study does not differentiate between Pfizer and Moderna

[xxxv] Study does not differentiate between Pfizer and Moderna

[xxxvi] Study does not differentiate between Pfizer and Moderna

	*Received BNT162b2 as booster dose	*Received mRNA1273 as booster dose		*Received Ad26.CoV.2 as booster dose		*Heterologous 4:* **CoronaVac/mRNA1273** *Received CoronaVac as initial regimen		
Effectiveness	No new data	No new data	No new data	No new data	No new data	**Heterologous 2:** *Effectiveness against infection:* **92.7% (95% CI, 91.0-94.0)** [Brazil; February 2020-November 2021][30] *Effectiveness against severe outcomes:* **97.3% (95% CI, 96.1-98.1)** [Brazil; February 2020-November 2021][30]	No new data	No new data
Duration of protection	**Heterologous 1:** *Immunogenicity:* **49%** GMLs by week 10 to 14 in mRNA127-extended/BNT162b2 and infection-naïve[27]							

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][xxxvii]	2 doses, 21 days apart	2 doses, 14 days apart	2 doses, 28 days apart	2 doses, 21 days apart

[xxxvii] 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)[xxxviii]; 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[xxxix]	EMA authorised booster dose for people aged 18 years and above[xli] FDA approved third booster dose for individuals >65 and high-risk individuals, 6 months after the 2nd dose[xlii]	-	EMA authorised	-	-	-	-

[xxxviii] 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

[xxxix] 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

[xli] 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

[xlii] 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

	Swissmedic approves booster dose for everyone aged 16 and over[xl]	Swissmedic approves booster dose for adults aged 18 and over[xliii]						
	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] **72%** (pooled meta-analysis) **64%** (95% CI, 59%-68%; United	*Against SARS-CoV-2 infection:* **60%** (95% CI, 57-64; >2 weeks after dose).[xlv] **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 States) [May to July 2021][xlvi]	*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] **41%** (95% CI, 34-48; Spain) [Apr-Aug] **51%** (pooled meta-analysis)	*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 to be **69%** (95% CI, 67-71).	Partial protection.[lvii]	**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. **18.6%** (95% CI, 17.6-19.6) against SARS-CoV-2 infection, **28.1%**	*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] **1%** (95% CI, -30-25); India) at least 7 days after first dose [April-May]	Ongoing studies in South Africa and the United Kingdom

[xl] 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

[xliii] 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

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

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

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

	States) [May to July 2021][xliv] **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%**.	**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).[xlvii]	**46%** (95% CI, 37-54; Spain) [Apr-Aug] *Individuals ≥70:* Symptomatic disease: **58%**.	**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][xlviii] Among individuals with history of infection, VE against symptomatic infection ≥ 14 days from vaccine series completion was 44.0% (95% CI, 31.5-54.2) for Ad26.COV2.S. [Brazil]		(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] **14.5% (95% CI, 11.0-34.2)** 0-13 days after first dose[Indonesia; 13 January 2021 to 30 June 2021][33]	**-1%** (95% CI, -51-33; India) at least 21 days after first dose [April-May]	

[xliv] Results do not disaggregate between mRNA vaccines, BNT162b2 and mRNA-1273.
[xlvii] mRNA-aggregated data (results do not disaggregate between BNT162b2 and mRNA-1273).
[xlviii] Study does not differentiate between Pfizer, Moderna, and Janssen.

				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) *Individuals ≥50:*				

				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][xlix] VE against infection in the general population aged ≥16 years was 86.1% (95%				

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

				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][l] 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][li] *<u>Against Severe Disease -</u>*				

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

				>60% against infection, severe infection, and infection requiring hospitalization[average from systematic review][31] *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][32lii] *Age 60-79:* **96.9 (95% CI, 96.1-97.6)**[Greece; January 2021 to December 2021; pooled effectiveness][32liii] *Age 15-59:* **98.3 (95% CI, 97.6-98.7)**[Greece;					

[lii] Study investigated BNT162b2, mRNA-1273, ChAdOx-1 nCoV-19, and Ad26.COV2.S.
[liii] Study investigated BNT162b2, mRNA-1273, ChAdOx-1 nCoV-19, and Ad26.COV2.S.

				January 2021 to December 2021; pooled effectiveness][32liv] *<u>Against Death - Age 80+</u>* **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][32lv] *<u>Age 60-79:</u>* **94.6 (95% CI, 93.1-95.8)**[Greece; January 2021 to December 2021; pooled effectiveness][32lvi] *<u>Age 15-59:</u>* **96.9 (95% CI, 95.0-98.0)**[Greece; January 2021 to December 2021;					

[liv] Study investigated BNT162b2, mRNA-1273, ChAdOx-1 nCoV-19, and Ad26.COV2.S.
[lv] Study investigated BNT162b2, mRNA-1273, ChAdOx-1 nCoV-19, and Ad26.COV2.S.
[lvi] Study investigated BNT162b2, mRNA-1273, ChAdOx-1 nCoV-19, and Ad26.COV2.S.

				pooled effectiveness][32]				
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 2020 – 24 Mar 2021] 14-21 days	*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] **60%** (95% CI, 50-67; Sweden) [27	Not Applicable (one dose schedule)	Partial protection.[ciii]	**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] Among individuals with history of infection, VE	*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)

[ciii] 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

	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][lxviii] **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][lix] **75%** (95% CI, 73-77; Sweden) [27 Dec 2020-2 Nov 2021] VE was 49% (95% CI 22.0%-67.0%)[England] Higher dose two VE was observed with >6 week interval between	**95%** (95% CI, 93%-96%; United States) [May to July 2021][lxxv] **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][lxxvi] **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]	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][xci] VE against severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) infection was			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 aged ≥16 years was 86.1% (95% CI 77.8–94.4%), for the elderly VE	**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]	

[lviii] Results do not disaggregate between mRNA vaccines, BNT162b2 and mRNA-1273.
[lix] Study does not differentiate between Pfizer, Moderna, and Janssen.
[lxxv] Results do not disaggregate between mRNA vaccines, BNT162b2 and mRNA-1273.
[lxxvi] Study does not differentiate between Pfizer, Moderna, and Janssen.
[xci] Study does not differentiate between Comirnaty and Vaxrevria

	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] For BNT162b2 and AZD1222, VE was higher across all age-groups from 14 days after	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 infection and 86% (95% CI, 82.0% to	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][xcii] 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			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][civ] 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		

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

	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 from literature review and meta-analysis] VE was 69% (95% CI, 67.0% to 70.0%) against	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][lxxvii] 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	average from literature review and meta-analysis][xciii] *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][xciv] VE against symptomatic SARS-CoV-2 infection was estimated at 92% (95% CI, 78–97%)			from literature review and meta-analysis[cv] VE was 94.3% against mild disease and 99.9% against severe infection[Colombia, 24 February 2021 to 10 August 2021][cvi] *In pregnant women*: **41%** (95% CI, 27.1-52.2%; Brazil) against symptomatic COVID-19, **85%** (95% CI, 59.5-94.8; Brazil) against severe COVID-19, and **75%** (95% CI 27.9-91.2; Brazil)		

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

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

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

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

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

	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][lx] VE was approximately **96.7%** (95% CI, 87.9-99.9) 7 days after the second dose [France; December 2020 to June 2021][lxi]	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][lxxviii] 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	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; December 2020 to June 2021][xcv]			*Against any SARS-CoV-2 Infection -* **66.7% (58.1 to 73.5%)** at ≥14 days[Indonesia; 13 January 2021 to 30 June 2021] [33] *Against Death –* **87.4% (95% CI, 65.1-95.4)** ≥14 days[Indonesia; 13 January 2021 to 30 June 2021][33]		

[lx] Study does not differentiate between Moderna or Pfizer-BioNTech.
[lxi] Study does not differentiate between Comirnaty and Vaxrevria.
[lxxviii] Study does not differentiate between Pfizer-BioNTech, Moderna, Oxford-AstraZeneca, CoronaVac, and Janssen.
[xcv] Study does not differentiate between Comirnaty and Vaxrevria.

	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][lxii] VE against infection in the	literature review and meta-analysis][lxxix] 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][lxxx] *Symptomatic disease*: **91%** (95% CI, 89-93; >2 weeks after dose).[lxxxi]	*Against any SARS-CoV-2 Infection -* **62.8% (95% CI, 49.3–72.7)** for all vaccines combined[England][34xcvi] *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][32xcvii] *Age 60-79:* **96.9 (95% CI, 96.1-97.6)**[Greece; January 2021 to December 2021; pooled effectiveness][32xcviii]					

[lxii] Study does not differentiate between Pfizer-BioNTech, Moderna, Oxford-AstraZeneca, CoronaVac, and Janssen.
[lxxix] Study does not differentiate between Pfizer-BioNTech, Moderna, Oxford-AstraZeneca, CoronaVac, and Janssen.
[lxxx] Study does not differentiate between Pfizer, Moderna, and Janssen.
[lxxxi] Results do not disaggregate between BNT162b2 and mRNA-1273.
[xcvi] Study included BNT162b2, mRNA-1273, and ChAdOx-1 nCoV-19.
[xcvii] Study investigated BNT162b2, mRNA-1273, ChAdOx-1 nCoV-19, and Ad26.COV2.S.
[xcviii] Study investigated BNT162b2, mRNA-1273, ChAdOx-1 nCoV-19, and Ad26.COV2.S.

	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][lxiii] 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	**85%** (95% CI, 80-89; Spain) [Apr-Aug] *Asymptomatic SARS-CoV-2 infection:* **90.6%**.[lxxxii] **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.[lxxxiii]	*Age 15-59:* **98.3 (95% CI, 97.6-98.7)**[Greece; January 2021 to December 2021; pooled effectiveness][32xcix] *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][32c] *Age 60-79:* **94.6 (95% CI, 93.1-95.8)**[Greece; January 2021 to December 2021;						

[lxiii] Study does not differentiate between Pfizer-BioNTech, Moderna, Oxford-AstraZeneca, CoronaVac, and Janssen.
[lxxxii] Results do not disaggregate between BNT162b2 and mRNA-1273
[lxxxiii] mRNA-aggregated data (results do not disaggregate between BNT162b2 and mRNA-1273).
[xcix] Study investigated BNT162b2, mRNA-1273, ChAdOx-1 nCoV-19, and Ad26.COV2.S.
[c] Study investigated BNT162b2, mRNA-1273, ChAdOx-1 nCoV-19, and Ad26.COV2.S.

	contact.[United States; February 2021 to September 2021][lxiv] 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] VE against severe disease among older population	*Against any SARS-CoV-2 Infection -* **62.8% (95% CI, 49.3–72.7)** for all vaccines combined[England][34lxxxiv] *Against Severe Disease -* **>80%** against infection, severe infection, and infection requiring hospitalization[average from systematic review][31] *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][32lxxxv]	pooled effectiveness][32ci] *Age 15-59:* **96.9 (95% CI, 95.0-98.0)**[Greece; January 2021 to December 2021; pooled effectiveness][32cii]						

[lxiv] Study does not differentiate between Pfizer, Moderna, and Janssen.
[lxxxiv] Study included BNT162b2, mRNA-1273, and ChAdOx-1 nCoV-19.
[lxxxv] Study investigated BNT162b2, mRNA-1273, ChAdOx-1 nCoV-19, and Ad26.COV2.S.
[ci] Study investigated BNT162b2, mRNA-1273, ChAdOx-1 nCoV-19, and Ad26.COV2.S.
[cii] Study investigated BNT162b2, mRNA-1273, ChAdOx-1 nCoV-19, and Ad26.COV2.S.

	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	*Age 60-79:* **96.9 (95% CI, 96.1-97.6)**[Greece; January 2021 to December 2021; pooled effectiveness][32] [lxxxvi] *Age 15-59:* **98.3 (95% CI, 97.6-98.7)**[Greece; January 2021 to December 2021; pooled effectiveness][32] [lxxxvii] *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][32] [lxxxviii]							

[lxxxvi] Study investigated BNT162b2, mRNA-1273, ChAdOx-1 nCoV-19, and Ad26.COV2.S.
[lxxxvii] Study investigated BNT162b2, mRNA-1273, ChAdOx-1 nCoV-19, and Ad26.COV2.S.
[lxxxviii] Study investigated BNT162b2, mRNA-1273, ChAdOx-1 nCoV-19, and Ad26.COV2.S.

	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][lxv] *Asymptomatic SARS-CoV-2 infection:* **90.6%**.[lxvi] **73.1** (95% CI, 70.3-75.5) *Hospitalization:* **85%** (95% CI, 73-93) [January-July]. **88%** (95% CI, 85-91) [11 March – 15 August].	*Age 60-79:* **94.6 (95% CI, 93.1-95.8)**[Greece; January 2021 to December 2021; pooled effectiveness][32] [lxxxix] *Age 15-59:* **96.9 (95% CI, 95.0-98.0)**[Greece; January 2021 to December 2021; pooled effectiveness][32xc]						

[lxv] Study does not differentiate between Pfizer and AstraZeneca

[lxvi] Results do not disaggregate between BNT162b2 and mRNA-1273

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

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

	89% (95% CI, 87-91) for individuals ≥50 years [1 January-22 June. [lxvii] **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 14–119 days following								

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

	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] *<u>Individuals ≥65:</u>* **61%** (95% CI, 57-65) against SARS-CoV-2 infection and **86%** (95% CI, 82-88) against hospitalizations *<u>Individuals ≥ 80:</u>* 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] *<u>Against any SARS-CoV-2 Infection -</u>*								

	62.8% (95% CI, 49.3–72.7) for all vaccines combined[England][34][lxviii] *<u>Against Severe Disease -</u>* **>90%** against infection, severe infection, infection requiring hospitalization, and mortality[average from systematic review][31] *<u>Age 80+:</u>* **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][32][lxix] *<u>Age 60-79:</u>* **96.9 (95% CI, 96.1-97.6)**[Greece; January 2021 to								

[lxviii] Study included BNT162b2, mRNA-1273, and ChAdOx-1 nCoV-19.
[lxix] Study investigated BNT162b2, mRNA-1273, ChAdOx-1 nCoV-19, and Ad26.COV2.S.

	December 2021; pooled effectiveness][32lxx] *<u>Age 15-59:</u>* **98.3 (95% CI, 97.6-98.7)**[Greece; January 2021 to December 2021; pooled effectiveness][32lxxi] *<u>Against Death - Age 80+</u>* **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][32lxxii] *<u>Age 60-79:</u>* **94.6 (95% CI, 93.1-95.8)**[Greece; January 2021 to December 2021;								

[lxx] Study investigated BNT162b2, mRNA-1273, ChAdOx-1 nCoV-19, and Ad26.COV2.S.
[lxxi] Study investigated BNT162b2, mRNA-1273, ChAdOx-1 nCoV-19, and Ad26.COV2.S.
[lxxii] Study investigated BNT162b2, mRNA-1273, ChAdOx-1 nCoV-19, and Ad26.COV2.S.

	pooled effectiveness][32lxxiii] *Age 15-59:* **96.9 (95% CI, 95.0-98.0)**[Greece; January 2021 to December 2021; pooled effectiveness][32lxxiv]							
	EFFECTIVENESS AGAINST VARIANTS[cvii]							
	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)	*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).	*Single dose:* **48.7%** (95% CI 45.5 to 51.7) **64%** (95% CI, 60-68). *Two doses:* **74.5%** (95% CI, 68.4 to 79.4)	-	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%

[lxxiii] Study investigated BNT162b2, mRNA-1273, ChAdOx-1 nCoV-19, and Ad26.COV2.S.
[lxxiv] Study investigated BNT162b2, mRNA-1273, ChAdOx-1 nCoV-19, and Ad26.COV2.S.
[cvii] Effectiveness data against the latest variant of interest (Mu) will be included in upcoming reports based on data availability.

	92% (95% CI, 90-93). **89%** (95% CI, 86-91). **78%** (95% CI, 68-84) **84.4%** (95 CI, 81.8-86.5)	**98.4%** (95% CI, 96.9-99.1)	**73%** (95% CI, 66-78). 79% (95% CI, 56-90).					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). *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]	*Single dose:* **61.3%** (95% CI, 56.5 to 65.5) **77%** (95% CI, 69-92). *Two doses:* **96.4%** (95% CI, 91.9 to 98.7)	*Single dose:* **48%** (95% CI, 28-63).	-	No published data	Neutralization capacity was decreased by factor **5.27**.	No available data	No available data
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,	No available data	No available data

						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)		
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)	*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].	*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).	**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][cxxii] Prior to the predominance of the delta variant (delta comprising 1.8% of circulating	*Against Infection (One Dose):* **10.7% (95% CI, −41.2-62.6)**[China][36cxxiv] *Against Symptomatic Infection (One Dose):* **6.8% (95% CI, −47.4-61.0)**[China][36cxxv]	*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-	No available data

[cxxii] Study does not differentiate between Pfizer, Moderna, and Janssen.
[cxxiv]Study does not differentiate between inactivated vaccines, Sinopharm or CoronaVac.
[cxxv]Study does not differentiate between inactivated vaccines, Sinopharm or CoronaVac.

	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 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]	**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; elderly Veteran population] **76.5%** (95% CI, 40.9-90.6; USA) [01 Jul 2021 to 30 Sep 2021][cxiv] *10-14 weeks after second dose:* **90.3%** (95% CI, 67.2-97.1). VE against Delta variant-related	**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 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	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 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]	*Against Pneumonia (One Dose):* **11.6% (95% CI, −42.6-65.8)**[China][36cxxvi] *Against Infection (Two Doses):* **51.8% (95% CI, 20.3-83.2)**[China][36cxxvii] **60% (95% CI, 49.0-69.0)** [Thailand; 25 July 2021 to 23 October 2021][35] *Against Symptomatic Infection (Two Doses):* **60.4% (95% CI, 31.8-88.9)**[China][36cxxviii] *Against Pneumonia (Two Doses):*	*Against Infection (One Dose):* **10.7% (95% CI, −41.2-62.6)**[China][36cxxxii] *Against Symptomatic Infection (One Dose):* **6.8% (95% CI, −47.4-61.0)**[China][36cxxxiii] *Against Pneumonia (One Dose):* **11.6% (95% CI, −42.6-65.8)**[China][36cxxxiv] *Against Infection (Two Doses):* **51.8% (95% CI, 20.3-83.2)**[China][36cxxxv] **60% (95% CI, 49.0-69.0)**	76.0) against hospitalization or death 2 weeks after second dose during the delta dominant period. [India]	

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

[cxxvi] Study does not differentiate between inactivated vaccines, Sinopharm or CoronaVac.
[cxxvii] Study does not differentiate between inactivated vaccines, Sinopharm or CoronaVac.
[cxxviii] Study does not differentiate between inactivated vaccines, Sinopharm or CoronaVac.
[cxxxii] Study does not differentiate between inactivated vaccines, Sinopharm or CoronaVac.
[cxxxiii] Study does not differentiate between inactivated vaccines, Sinopharm or CoronaVac.
[cxxxiv] Study does not differentiate between inactivated vaccines, Sinopharm or CoronaVac.
[cxxxv] Study does not differentiate between inactivated vaccines, Sinopharm or CoronaVac.

	76.5% (95% CI, 40.9-90.6; USA) [01 Jul 2021 to 30 Sep 2021][cviii] **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 estimations from a Rapid Review] VE against hospitalization was 93% (95% CI, 90.0-94.0); South Africa)[September 2021 to October 2021]	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 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] [cxx] 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	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][cxxiii] *Individuals ≥50:*	**78.4% (95% CI, 56.9-99.9)**[China][36cxxix] *Against Severe or Critical Illness (Two Doses):* **100% (95% CI, 98.4-100.0)**[China][36cxxx] **88% (95% CI, 0.02-0.45)**[China][37cxxxi]	[Thailand; 25 July 2021 to 23 October 2021][35] *Against Symptomatic Infection (Two Doses):* **60.4% (95% CI, 31.8-88.9)**[China][36cxxxvi] *Against Pneumonia (Two Doses):* **78.4% (95% CI, 56.9-99.9)**[China][36cxxxvii] *Against Severe or Critical Illness (Two Doses):* **100% (95% CI, 98.4-100.0)**[China][36 cxxxviii]		

[cviii] Study does not differentiate between Pfizer, Moderna, and Janssen.
[cxx] Study does not differentiate between Pfizer, Moderna, or AstraZeneca.
[cxxiii] Study does not differentiate between Pfizer, Moderna, Oxford-AstraZeneca, or Janssen.
[cxxix]Study does not differentiate between inactivated vaccines, Sinopharm or CoronaVac.
[cxxx]Study does not differentiate between inactivated vaccines, Sinopharm or CoronaVac.
[cxxxi] Study does not differentiate between the inactivated vaccines CoronaVac or BBIBP-CoRV.
[cxxxvi]Study does not differentiate between inactivated vaccines, Sinopharm or CoronaVac.
[cxxxvii]Study does not differentiate between inactivated vaccines, Sinopharm or CoronaVac.
[cxxxviii]Study does not differentiate between inactivated vaccines, Sinopharm or CoronaVac.

	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 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;	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] [cxv] 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.[cxvi]	≥ 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][cxxi] *<u>Against Infection (Two Doses):</u>* **83% (95% CI, 70.0-90.0)**[Thailand; 25 July 2021 to 23 October 2021][35]	**83% (**95% CI, 81-85)		**88% (95% CI, 0.02-0.45)**[China][37cxxxix]		

[cxv] Study does not differentiate between Pfizer, Moderna, or AstraZeneca.
[cxvi] Study does not differentiate between mRNA vaccines, Pfizer and Moderna.
[cxxi] Study does not differentiate between Pfizer, Moderna, Oxford-AstraZeneca, or Janssen.
[cxxxix] Study does not differentiate between the inactivated vaccines CoronaVac or BBIBP-CoRV.

	November 2021 to December 2021][cix] 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.[cx] Prior to the predominance of 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)	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. 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%).							

[cix] Study does not differentiate between Pfizer, Moderna, or AstraZeneca.
[cx] Study does not differentiate between mRNA vaccines, Pfizer and Moderna.

	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, 37.0-44.0) against Delta.[United States; 01 December 2021 to 31 December 2021][cxi] VE against symptomatic infection was **88.7%** (95% CI], 78.8-93.9) among patients aged 16	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 was 85.3%, and **74.2%** (95% CI, 63.4-86.8) when the prevalence of delta was 99.6%.[United States]							

[cxi] Study does not differentiate between mRNA vaccines.

	to 64 and **90.3%** (95% CI, 73.6-96.4) among patients aged ≥65.[Japan, 01 July to 30 September 2021][cxii] *Against severe COVID-19:* **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, **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	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][cxvii] 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–						

[cxii] Study does not differentiate between BNT162b2 or mRNA-1273.
[cxvii] Study does not differentiate between mRNA vaccines.

	vaccinated ≥ 6 months ago. [Slovenia][cxiii]	54) in those vaccinated ≥ 6 months ago. [Slovenia][cxviii] 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][cxix] 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.							

[cxiii] Study does not differentiate between Pfizer, Moderna, Oxford-AstraZeneca, or Janssen.
[cxviii] Study does not differentiate between Pfizer, Moderna, Oxford-AstraZeneca, or Janssen.
[cxix] Study does not differentiate between BNT162b2 or mRNA-1273.

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[38] If assuming a 25-fold decrease in pseudovirus neutralization **66%** (95% CI, 42-86)[39] VE against the Omicron variant was 55.2% (95% CI, 23.5 to 73.7%) for BNT162b2 in the first month after primary vaccination.	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][43] VE against the Omicron variant was 36.7% (95% CI: -69.9 to 76.4%) for mRNA-1273 in the first month after primary vaccination. [Denmark, November 2021 to December 2021][40] 2 doses of COVID-19	No protective effect of vaccination against symptomatic disease with Omicron from 15 weeks after the second dose[38] 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					

	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][40] 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;	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 December 2021] [41 cxlii] VE was **30.4% (95% CI, 5.0%-49.0%)** 14-90 days after vaccination and declined thereafter.[43] VE was 25% (95% CI, 20.0-30.0)	mRNA vaccine for the third dose.[Canada; November 2021 to December 2021] [41 cxliv]					

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

	November 2021 to December 2021] [41 cxl] VE was 25% (95% CI, 20.0-30.0) against Omicron infection. [United States; 01 December 2021 to 31 December 2021] [42 cxli]	against Omicron infection. [United States; 01 December 2021 to 31 December 2021] [42cxliii]						
	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)	*Single dose:* **73%** (pooled meta-analysis) *Individuals ≥50:*	*Single dose:* **56%** (pooled meta-analysis)	VE against hospitalization or death ≥ 14 days from vaccine series completion was 57.7% (95%	*Two doses:* VE against hospitalization was **71.9%** [95% CI: 70.7-73.1%] for those who	*Against hospitalization:* **71.2%** (95%CI, 70.0-72.4)[Brazil, 18 January 2021 to July 2021]	No available data	No available data

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

[cxli] Study does not differentiate between mRNA vaccines.

[cxliii] Study does not differentiate between mRNA vaccines.

	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. [cxlv] *Two doses:* **91%** (pooled meta-analysis) **91%** (95% CI, 93%-96%; United States) [May to July 2021][cxlvi] **89%** (95% CI, 84-93; Sweden) [27 Dec 2020-2 Nov 2021] *Against ICU admission*: **90.3%** (95% CI, 88.8-91.6;	≥14 days after first dose: **54%** (95% CI, 47-61) [1 Jan-22 Jun.[clii] *Two doses:* **88%** (pooled meta-analysis) **91%** (95% CI, 93%-96%; United States) [May to July 2021][cliii] **79%** (95% CI, 60-89; Sweden) [27 Dec 2020-2 Nov 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 reduction in	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 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	CI, −2.6-82.5) for Ad26.COV2.S. [Brazil] 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][44clx]	received the full vaccination schedule of BBIBP-CorV.[Iran]	*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:* **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]		

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

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

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

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

[clx] Study does not differentiate between Pfizer-BioNTech, AstraZeneca, Moderna, and Johnson & Johnson.

	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 reduction in people aged 75 and older [France] [cxlvii] 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	people aged 75 and older [France] [cliv] 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, February 2021 to	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:* **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]			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) 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		

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

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

	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, February 2021 to November 2021] [cxlviii] 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	November 2021] [clv] 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] [clvi] 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%–	<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] 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][44][clix]			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] *<u>Two Doses:</u>* **71.1% (95% CI, 62.9-77.6)** ≥14 days[Indonesia; 13 January 2021 to 30 June 2021][33]		

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

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

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

[clix] Study does not differentiate between Pfizer-BioNTech, AstraZeneca, Moderna, and Johnson & Johnson.

	COVID-19 infection and 86% (95% CI, 69.0-95.0) for COVID-19-associated hospitalization.[United States] [cxlix] Adjusted VE against hospitalization was 93·4% (CI:91·9–94·7%) and 91·1% (CI:86·5–94·1%) against death.[Israel] 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%**	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] [clvii] 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][44clviii]						

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

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

[clviii] Study does not differentiate between Pfizer-BioNTech, AstraZeneca, Moderna, and Johnson & Johnson.

	risk reduction. [France] [cl] 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.[Lebanon; April to May 2021] 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][44cli]								

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

[cli] Study does not differentiate between Pfizer-BioNTech, AstraZeneca, Moderna, and Johnson & Johnson.

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] *One Dose:* **84.0% (95% CI, 72.6-90.6)** [France; January to June 2021][45clxi] *Two Doses:* **96.2% (95% CI, 86.8-98.9**)[France;	*One Dose:* **84.0% (95% CI, 72.6-90.6)** [France; January to June 2021][45clxiii] *Two Doses:* **96.2% (95% CI, 86.8-98.9**)[France; January to June 2021][45clxiv]	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] *One Dose:* **84.0% (95% CI, 72.6-90.6)** [France; January to June 2021][45clxv] *Two Doses:* **96.2% (95% CI, 86.8-98.9**)[France;	***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

[clxi] Study does not differentiate between BNT162b2, mRNA-1273, ChAdOx1 nCoV-19, and Ad26.COV2-S.
[clxiii] Study does not differentiate between BNT162b2, mRNA-1273, ChAdOx1 nCoV-19, and Ad26.COV2-S.
[clxiv] Study does not differentiate between BNT162b2, mRNA-1273, ChAdOx1 nCoV-19, and Ad26.COV2-S.
[clxv] Study does not differentiate between BNT162b2, mRNA-1273, ChAdOx1 nCoV-19, and Ad26.COV2-S.

	January to June 2021][45clxii]		January to June 2021][45clxvi]					
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)	*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)	*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)	**71%** **85%** (95% CI, 73-91) **91%** (95% CI, 88-94) **93.5%** (95% CI, 89.6-96.1; New York) [Aug 2021]	*Single dose:* Does not offer clinically meaningful protection against severe illness[clxvii] *Two doses:* **88%** (95% CI, 55-98) adjusted risk reduction in developing severe illness[clxviii]	*Single dose:* Does not offer clinically meaningful protection against severe illness[clxix] *Two doses:* **88%** (95% CI, 55-98) adjusted risk reduction in	No available data	No available data

[clxii] Study does not differentiate between BNT162b2, mRNA-1273, ChAdOx1 nCoV-19, and Ad26.COV2-S.
[clxvi] Study does not differentiate between BNT162b2, mRNA-1273, ChAdOx1 nCoV-19, and Ad26.COV2-S.
[clxvii] Study does not differentiate between the two inactivated vaccines, BBIBP-CorV and CoronaVac.
[clxviii] Study does not differentiate between the two inactivated vaccines, BBIBP-CorV and CoronaVac.
[clxix] Study does not differentiate between the two inactivated vaccines, BBIBP-CorV and CoronaVac.

	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] **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] *<u>Individuals ≥65:</u>*	**97.3%** (95% CI, 95.9-98.4; New York) [Aug 2021] *<u>Individuals ≥65:</u>* **93.7%** (95% CI, 92.9-94.4; New York) [Aug 2021] *<u>Against ICU admission:</u>* **86%** (95% CI, 79-90) **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)	**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) *<u>Against moderate to severe disease:</u>* **81.5%** (95% CI, 9.9-99.0; India) (Apr – May 2021) *<u>Against ICU admission:</u>* *Single dose:* **92%** (95% CI, 84-96) *Two doses*: **96%** (95% CI, 94-98) *<u>Against death:</u>* **91%** (95% CI, 86-94) [≥2 weeks after second dose] *All ages:* **91%** (95% CI, 86-94)	**85%** effective at preventing severe disease and hospitalization *<u>Individuals ≥50:</u>* **84% (**95% CI, 81-85) *<u>Individuals ≥65:</u>* **81.8%** (95% CI, 77.8-85.3; New York) [Aug 2021] *<u>Against ICU admission:</u>* **94%** (95% CI, 88-98)		developing severe illness[clxx]		

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

	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 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		*40-59*: **88%** (95% CI, 76-93) *60+:* **90%** (95% CI, 84-94)						

	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 hospitalization **4 to 5-fold increased** compared to Delta[46]* **84.9%** (95% CI, 83.0-86.6) against Omicron variant for recently vaccinated Pfizer[46] *No differention between mRNA vaccines	Estimated VE against hospitalization **4 to 5-fold increased** compared to Delta[46]* *No differention between mRNA vaccines Length hospital stay was significantly shorter than for Delta (**confounding-adjusted difference -4.0**	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][49clxxv] Odds of death were **0.14** (95% CI, 0.0011-1.12), representing a reduction in the					

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

	VE against hospitalization was 70% (95% CI, 62.0-76.0; South Africa)[November 2021 to December 2021][47] 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 months after two doses.[United States, 01 Dec 2021 to 11 Jan 2022] [48] 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] [48]	**days** (95%CI -7.2 to -0.8).[Portugal, 01 December 2021 to 29 December 2021][49clxxiii] 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][49clxxiv]	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][49clxxvi]						

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

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

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

	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] [49clxxi] 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][49clxxii]								

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

	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)** *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)	*Preliminary phase I results:* Antibody activity remained high in all age groups at **day 209** (approximately 6 months) GMT were lower in ≥56 years old *Anti-S antibody titre* 1500.8 AU/mL after 8.4 months[53] *Neutralizing antibodies:* At peak immunity, NAb titre was **5,848**, after 8 months titre was **133**	*Antibody Response:* After single dose, antibody response declined within one year, but remained above 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)**	*Neutralizing antibodies:* Remained largely stable for **8-9 months** 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.[50clxxix] *Pseudovirus neutralizing antibodies:*	*Antibody Response:* **Unexposed subjects:** After 1st dose: **43.6 IU/mL** (95% CI, 30.3-62.8) 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)	A phase I/II clinical trial found that NAbs titres dropped below the seropositive cut-off of 8, **6 months** after the 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)	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 concentration of **1,299.5 AU/mL** (IQ: 517.9-5,019.07). [India; January to July 2021]	No available data

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

	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** *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):**	VLP neutralization titers were **reduced 2.7-fold** to Delta and **reduced 15.4-fold** to Omicron.[50clxxviii] *Pseudovirus neutralizing antibodies:* At peak immunity, pseudovirus NAb titre was **1,569**, 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	**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):** 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)	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** 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	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 *Binding Antibodies:* Decreased **82.1%** 7 months after second dose	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% 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:*		

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

	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) 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	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][54]	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]	*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**		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 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		

	Immunosuppression: **65% to 70%** decrease compared to non-immunosuppressed **Obesity (BMI ≥30):** **31%** increase in neutralizing antibody 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					quantitative titer (IQR 5.5-13.92) and the maximum titer was 29.92 BAU/mL (p <0.001).[Brazil]		

	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.[50clxxvii] 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][51] *Neutralizing activity of Anti-Spike IgG:* **78.37%** for vaccinated HCWs and **88.82%** for HCWs vaccinated								

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

	after infection[Romania; January 2021 to August 2021][52]							
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	**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	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	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)	*Against Hospitalization:* **64% (95% CI, 59.0-69.0)** beyond the sixth month. [Morocco; February 2021 to October 2021][60]	*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

	States) [May to August][clxxx] 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][clxxxi] 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.	**80.0%** (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	Review and Meta-Regression][ccxvi] 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] [ccxvii] 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]	[Overall average from Systematic Review and Meta-Regression][ccxxiv] 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				

[clxxx] Study does not differentiate between the two mRNA vaccines, Pfizer and Moderna.

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

[ccxvi] 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 Moderna, and AstraZeneca.

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

	Protection **against hospitalization decreased less with a VE of 91.7% (95% CI 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,	**64%** (95% CI, 62-66) in August 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][cxcviii] 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	Risk of infection decreased 4-6 months after the second vaccine dose, but markedly increased after.[ccxviii] 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,	month 5+, 1.31 [1.18, 1.47]). No 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)				

[cxcviii] Study does not differentiate between COMIRNATY/BNT162b2 and SPIKEVAX/ mRNA-1273.
[ccxviii] Study does not differentiate between BNT162b2, mRNA-1273, and ChAdOX-S.

	January 2021 to September 2021] Estimated results show that vaccine effectiveness significantly wanes from 60 days after the second dose [Japan; February 2020 to December 2021] [clxxxii] 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.[clxxxiii]	States) [May to August][cxcix] 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][cc] 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	11.0-69.0) among older individuals [Overall average from Systematic Review and Meta-Regression][ccxix] **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	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][ccxxv] *Against severe COVID-19:* VE decreased by **8.0%** (95% CI, 3.6-15.20) among				

[clxxxii] Study does not differentiate between Pfizer Moderna, and AstraZeneca.
[clxxxiii] Study does not differentiate between BNT162b2, mRNA-1273, and ChAdOX-S.
[cxcix] Study does not differentiate between the two mRNA vaccines, Pfizer and Moderna.
[cc] Study does not differentiate between Pfizer/BioNTech-Comirnaty, Moderna-mRNA-1273, Janssen-Ad26.COV2.S and AstraZeneca-Vaxrevria.
[ccxix] Study does not differentiate between Pfizer/BioNTech-Comirnaty, Moderna-mRNA-1273, Janssen-Ad26.COV2.S and AstraZeneca-Vaxrevria.
[ccxxv] Study does not differentiate between Pfizer/BioNTech-Comirnaty, Moderna-mRNA-1273, Janssen-Ad26.COV2.S and AstraZeneca-Vaxrevria.

	Adjusted estimated VE against infections **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	80.3% (95% CI 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]	from Systematic Review and Meta-Regression][ccxx] 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	all ages and **9.7%** (95% CI; 5.9-14.7) among older individuals [Overall average from Systematic Review and Meta-Regression][ccxxvi] VE after 8.4 months was estimated at **33%** (95% CI, 0-86)				

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

	deaths were comparable. [Malaysia] 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][clxxxiv] 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][clxxxv]	Estimated results show that vaccine effectiveness significantly wanes from 60 days after the second dose [Japan; February 2020 to December 2021][cci] 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. [ccii] Adjusted estimated VE against infections	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]ccxxi *Against Severe Disease:* **Stable around 90%** across the entire follow up period irrespectively of which VOC that dominated. [Sweden; December 2020 to					

[clxxxiv] Study does not differentiate between BNT162b2 or mRNA-1273.
[clxxxv] Study does not differential between mRNA-based vaccines.
[cci] Study does not differentiate between Pfizer Moderna, and AstraZeneca.
[ccii] Study does not differentiate between BNT162b2, mRNA-1273, and ChAdOX-S.
[ccxxi] 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[clxxxvi] 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)	peaked after 2 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][cciii] VE declined from **82% (95% CI,**	January 2022][56ccxxii] *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][56ccxxiii]						

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

	91-180 days after the second dose [27 Dec 2020 – 26 Oct 2021; Finland][clxxxvii] 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-	**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][cciv] 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						

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

	93) 14-73 days 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][clxxxviii] *Against Hospitalization and Death:* After reaching peak VE (96.8%) 2 months after 2nd dose, **VE did not decline over**	Review and Meta-Regression)[ccv] *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][ccvi] *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 **persons 65 years**							

[clxxxviii] Study does not differentiate between Pfizer/BioNTech-Comirnaty, Moderna-mRNA-1273, Janssen-Ad26.COV2.S and AstraZeneca-Vaxrevria.
[ccv] Study does not differentiate between Pfizer/BioNTech-Comirnaty, Moderna-mRNA-1273, Janssen-Ad26.COV2.S and AstraZeneca-Vaxrevria.
[ccvi] 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-	**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 December 2021] ccvii							

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

	94%) ≥7 days after receiving an mRNA vaccine for the third dose.[Canada; November 2021 to December 2021]clxxxix 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	VE after 8.4 months was estimated at **89%** (95% CI, 67-96) *Against Severe Disease:* **Stable around 90%** across the entire follow up period irrespectively of which VOC that dominated. [Sweden; December 2020 to January 2022][56ccviii] **High at >60%** after the second dose [Qatar; 23 December 2021 to 02 February 2022][57] *Against Infection with Variants:* **67%** during the Delta period, and showed a declining trend. By end of follow up when Omicron							

[clxxxix] Study does not differentiate between Pfizer, Moderna, or AstraZeneca.
[ccviii] Study does not differentiate between Pfizer, Moderna, and AstraZeneca

	estimated at **87%** (95% CI, 60-96) *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][55] *Against Severe Disease:* **Stable around 90%** across the entire follow up period irrespectively of which VOC that dominated. [Sweden; December 2020 to January 2022][56cxc] **Maintained at >70%** after second dose with no evidence for	dominated, **no vaccine protection** against infection remained. [Sweden; December 2020 to January 2022][56ccix] *Against Symptomatic Infection (DELTA):* **Declined to 80% (95% CI, 74.0-84.0)** after ≥240 days.[Canada; 06 December 2021 to 26 December 2021][58ccx] *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][58ccxi]						

[cxc] Study does not differentiate between Pfizer, Moderna, and AstraZeneca
[ccix] Study does not differentiate between Pfizer, Moderna, and AstraZeneca
[ccx] Study does not differentiate between mRNA-based vaccines.
[ccxi] Study does not differentiate between mRNA-based vaccines.

	declining effectiveness over time.[Qatar; 23 December 2021 to 02 February 2022][57] *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][56cxci] *Against Symptomatic Infection (DELTA):* **Declined to 80% (95% CI, 74.0-84.0)** after ≥240 days.[Canada; 06 December 2021 to	Peaked at **44.8% (95% CI, 16.0-63.8)** in the first three months after the second dose and **declined to negligible levels**.[Qatar; 23 December 2021 to 02 February 2022][57] *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][59ccxii] *Against Emergency Department or Urgent Care (OMICRON):* From **52% (95% CI, 46.0-58.0)** at							

[cxci] Study does not differentiate between Pfizer, Moderna, and AstraZeneca.
[ccxii] Study does not differentiate between mRNA-based vaccines.

	26 December 2021][58cxcii] *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][58cxciii] **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][57] *Against Emergency*	14-179 days to **38% (95% CI, 32.0-43.0)** ≥180 days after 2nd dose[USA; August 2021 to January 2022][59ccxiii] *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][59ccxiv] *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						

[cxcii] Study does not differentiate between mRNA-based vaccines.
[cxciii] Study does not differentiate between mRNA-based vaccines.
[ccxiii] Study does not differentiate between mRNA-based vaccines.
[ccxiv] Study does not differentiate between mRNA-based vaccines.

	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][59cxciv] *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][59cxcv] *Against Hospitalization (DELTA):* From **90% (95% CI, 89-90)** at 14-	2021 to January 2022][59ccxv]							

[cxciv] Study does not differentiate between mRNA-based vaccines.
[cxcv] Study does not differentiate between mRNA-based vaccines.
[ccxv] Study does not differentiate between mRNA-based vaccines.

	179 days to **81% (95% CI, 80-82)** ≥180 days after 2nd dose[USA; August 2021 to January 2022][59cxcvi] *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][59cxcvii]							
Transmission prevention	*Prior Delta Variant:* Vaccine effectiveness against infectiousness given infections **41.3%** VE against transmission **88.5%**	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)	**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	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	Unknown	Unknown	No available data	No available data

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

	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) 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	and **40%** (95% CI, 20-54) to a vaccinated contact.[ccxxviii] 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 **6.2%** (95% CI, 2.8-13.0)	case to unvaccinated contact is **63%** (95% CI, 46-75) and **40%** (95% CI, 20-54) to a vaccinated contact.[ccxxix] Evidence of fully vaccinated individuals infecting other fully vaccinated individuals 81 breakthrough infections among 1100 HCWs; 32 breakthrough 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	Estimated SAR to fully vaccinated household contact was **42.7%** (95% CI, 13.6-77.9)				

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

	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 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		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 **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)						

	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 vaccinated contact.[ccxxvii] 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%**		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						

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

	(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 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	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	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	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	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%)	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. [65ccxlv]	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	No available data

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

	the 1,120 cases, 126 (12%) were hospitalized. Of the 126 breakthrough admissions, 59 were vaccinated with BNT162b2 Individuals vaccinated in January and 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	Delta variant). Of the 1,120 cases, 126 (12%) were hospitalized. Of the 126 breakthrough admissions, 36 were vaccinated with mRNA-1273. 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 (1.0%) among fully vaccinated	received two doses of Covishield) were identified. Of these, 199 (83.3%) were symptomatic, 24 (10.0%) were hospitalized - 59 individuals had comorbidities 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,	Delta variant). Of the 1,120 cases, 126 (12%) were hospitalized. Of the 126 breakthrough admissions, 10 were vaccinated with Ad26.COV2.S **4.2%** of fully vaccinated HCWs developed breakthrough infections – all cases were symptomatic but mild, only one case required hospitalization[ccxlii] 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	developed PCR positive COVID-19 infection two weeks after the second dose while 3 (0.29%) had re-infection. [Pakistan]	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 individuals. [Turkey]	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 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 [ccxlvi] In a study of 614 of HCW, 13% (81 of 614) had breakthrough infections – within breakthrough infections, 63%	

[ccxlii] Study does not differentiate between Covishield (*n*=62.4%) and Covaxin (*n*=37%).
[ccxlvi] Study does not differentiate between Covishield (*n*=62.4%) and Covaxin (*n*=37%).

	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][ccxxx] 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%	individuals and 198 (2.3%) among partially vaccinated. [United States; December 2020 to September 2021][ccxxxv] 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][ccxxxvi]	respectively). NAbs were measured for 10 breakthrough cases, all 10 cases had lower NAbs at day 14 and 90 post second vaccination 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.	the breakthrough rate of mRNA vaccines) 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][ccxliii] From 126,586 vaccine recipients, 492 (0.39%) were found to have breakthrough infections during the 10-month			(51 of 81**)** were Covaxin 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]	

[ccxxx] Study does not differentiate between Pfizer, Moderna, or Johnson & Johnson.
[ccxxxv] Study does not differentiate between Pfizer, Moderna, or Johnson & Johnson.
[ccxxxvi] Study does not differentiate between Pfizer, Moderna, AstraZeneca, or Janssen.
[ccxliii] Study does not differentiate between Pfizer, Moderna, or Johnson & Johnson.

	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 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][ccxxxi]	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	[Switzerland; December 2021 to October 2021][ccxl] In a study of 614 of HCW, 13% (81 of 614) had breakthrough infections – within 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	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][ccxliv] 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				

[ccxxxi] Study does not differentiate between Pfizer, Moderna, AstraZeneca, or Janssen.
[ccxl] ***Study does not differentiate between Pfizer, Moderna, AstraZeneca, or Janssen.
[ccxliv] Study does not differentiate between Pfizer, Moderna, AstraZeneca, or Janssen.

	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 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	these, 293 (32%) received the Moderna 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**	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 reduction compared to delta variants. [65] [ccxli] *BTI with Delta:* Of 164 fully vaccinated people, 162 (99%) were infected. **Case-fatality ratio was 1.2%** (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	(77 in the Beta, 1,429 in the Delta, and 408 in the Omicron periods). During Omicron, 91% hospitalized HCWs required 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 &				

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

	vaccine. Characteristics of breakthrough infection cases were similar across Pfizer, Moderna, and 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	(95%CI. 1.22-3.14][Portugal, 17 May 2021 to 04 July 2021] [ccxxxvii] *Omicron (B.1.1529):* 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][62][ccxxxviii] Over a period of 8.4 months, **13 out of 387** (3.4%) of vaccinated followed up individuals developed a breakthrough infection [53]	unvaccinated). [Korea][66]	Johnson vaccine. Characteristics of breakthrough infection cases were similar across Pfizer, Moderna, and Johnson & Johnson vaccines.				

[ccxxxvii] Study does not differentiate between mRNA vaccines.
[ccxxxviii] Study does not differentiate between mRNA vaccines.

	unvaccinated persons. [France] Cumulative incidence of breakthrough infection was **0.84%** (95% CI, 0.79-0.89) 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] [ccxxxii] *Omicron (B.1.1529):*	**0.011 to 0.0001 (per 100 individuals)** incidence of BTIs among HCWs(systematic review)[63ccxxxix] *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][64]							

[ccxxxii] Study does not differentiate between mRNA vaccines.

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

	Breakthrough cases described symptoms as mild or moderate, had viral loads ranging from 15,011.2 to over 40,000 AU.mL[61] 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][62] ccxxxiii Over a period of 8.4 months, **8 out of 212** (3.8%) of vaccinated followed up individuals developed a breakthrough infection [53]								

ccxxxiii Study does not differentiate between mRNA vaccines.

	0.011 to 0.0001 (per 100 individuals) incidence of BTIs among HCWs(systematic review)[63ccxxxiv] *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][64]							
	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**

[ccxxxiv] Study does not differentiate between mRNA-based 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 non-anaphylaxis reasons	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 papilomavirus 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

	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 adverse event[ccxlvii]	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				

[ccxlvii] Values with a * were deemed significant in the report

	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)[ccxlviii]	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)[ccl]	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)[cclii] Thrombosis with thrombocytopenia syndrome Reporting rate of **3.83** per million vaccine doses				

[ccxlviii] Study does not differentiate between vaccines.
[ccl] Study does not differentiate between vaccines.
[cclii] Study does not differentiate between vaccines

	Thrombosis with thrombocytopenia syndrome Reporting rate of **0.0085** per million vaccine doses[ccxlix]	Thrombosis with thrombocytopenia syndrome Reporting rate of **0.0085** per million vaccine doses[ccli]						
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 reactivation,	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 pustulosis,	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 bullous fixed drug	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[74] adver	Cutaneous reactions, herpes zoster, CNS demyelination, eosinophilic panniculitis[80] 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-like reaction,	Subacute thyroiditis, herpes zoster	Cutaneous reactions Myocarditis was reported in one vaccine recipient, occurring 3 days after second dose

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

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

	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, glomerulonephritis, Ramsay-Hunt	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[74]	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 polyradiculoneuropathy, cutaneous reactions,	97% of reported reactions after vaccine administration were non-serious.		cutaneous reactions, neuromyelitis optica spectrum disorders (transverse myelitis or optic neuritis), bullous pemphigoid, CNS demyelination, deafness, glomerulonephritis		

	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, reactivation of BCG scars, CNS demyelination,		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[76], takotsubo cardiomyopathy[77], Kawasaki[78], acute vertigo[74], chilblain-like lesions[79]					

	urticarial reactions, transverse myelitis, thyrotoxicosis, acquired haemophilia A (AHA)[67,68], transient lymphedema[69], anti-LGI1 encephalitis[70], eosinophilic granulomatosis[71], rarepyoderma gangrenosum[72], transverse myelitis[73], acute vertigo[74], leukocytoclastic vasculitis[75] Systemic allergic symptoms were more common in BNT162b2 than mRNA-1273, however, anaphylaxis rates were similar for both mRNA vaccines, could potentially worsen 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, lichenoid cutaneous skin eruption, acute	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 , pleuropericardial diffusion	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 inflammatory syndrome, parosmia,	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

	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, autoimmune acquired factor XIII/13 deficiency, Still's disease,	One case developed IgA Nephropathy after receiving the second dose of mRNA-1273.	encephalopathy, reactivation of bipolar mania						

	cranial nerve palsy, inflammatory bowl disease, pancreatitis, lupus nephritis[81]							
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]:* Incidence rate ratio of **1.66** (95% CI, 1.14-2.41)	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]:* Incidence rate ratio of **2.34** (95% CI, 1.03-5.34)	*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

	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 100,000 vaccinated <u>Female patients</u>	*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 <u>*12–39-year-olds (within 28 days of vaccination:*</u> <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>Disease severity</u> Mild: **1.62** (95% CI, 1.12-2.11)	**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							

	Intermediate: **0.47** (95% CI, 0.21-0.74) Fulminant: **0.04** (95% CI, 0-0.12) <u>Risk per 100,000 persons</u> 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** <u>*12–39-year-olds (within 28 days of vaccination:*</u> <u>Female patients</u> **1.3** (95% CI, 0.8-1.9) per 100,000 vaccinated <u>Male patients</u> **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)** *Children (Under 5 years):* Ongoing trials	*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)** 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)**	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[cciii] * * 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[cciv] expanded to assess efficacy, safety, and immunogenicity in 12–17-year-old adolescents

[cciii] 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

[cciv] 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

		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:* **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]	No available data	No available data	No available data	No available data	No available data	No available data	No available data

	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**	*Adolescents (12-17):* Neutralizing antibody titer after 2nd dose was **1401.7 GMN_{50}**	No available data	No available data	*Children (3-17):* Neutralizing antibodies after 28 days after 2nd dose ranged from **105.3-180.2 GMT**	*Children (3-17):* Neutralizing antibody response after 2nd dose **(100%)**	Ongoing clinical trial[88] Neutralizing antibodies after 56 days after 2nd	Ongoing clinical trial[89]

	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 (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	**(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 *Children (6012) Against Omicron:* **22.1 fold reduction** in GMT compared to wild-type[87]			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 **102.9 BAU/mL (95%CI; 91.0-116.4)** after 4 weeks since 2nd dose	with GMT ranging from **45.9-212.6** clinical trial pending	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	

	Omicron, was **39** (range 25-64) *AGAINST OMICRON:* **38.2%** of BNT162b2 vaccine recipients showed serum neutralization titer at or above detection threshold GMT: **7.2 (95% CI, 6-8.6)**							
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%)** Fatigue **(67.8%)**	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	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] *Myocarditis, Males 18-24:* **56.31 (95%CI, 47.08-67.34)** cases per million doses			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	*Myocarditis:* Incidence of 0.31 **(95% CI, 0.13-0.66)** per 100,000 doses		

	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**. *Adverse events cases:* 15-year old boy developed nephrotic syndrome *Myocarditis:* Incidence of **0.57 (95% CI, 0.36-0.90)** per 100,000 doses. Adjusted OR of **3.57 (95% CI, 1.93-6.6)**								

	compared to unvaccinated. *<u>CASES PER MILLION DOSES</u>* *<u>Myocarditis, Males 12-15:</u>* **70.7 (95% CI, 61.68-81.11)** *<u>Myocarditis, Males 16-17 :</u>* **105.9 (95% CI, 91.65-122.27)** *Myocarditis, Males 18-24 :* **52.43 (95% CI, 45.56-60.33)**							
Myocarditis Data	Few reported cases of acute myocarditis and pericarditis in 16-25 year olds (mainly in males) From large VAERS cohort, 11 verified reports of myocarditis **4.3 cases per 100,000** (95% C.I. 2.6–6.7) 18 year	Few reported cases of acute myocarditis and pericarditis (mainly in males) *<u>16-17 year old boys in US</u>*: *Second dose*: 31.2 cases per million doses administered	No available data	No available data	No available data	No available data	No available data	No available data

	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 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 first dose was Sinovac[cclv] **CoronaVac/Convidecia**	**ChAdOx1/BBV152** Administration of Covaxin as second/booster dose	Ongoing trial[90] (Com-Cov2)[cclvi]
Immunogenicity	*GMCs of SARS-CoV-2 anti-spike IgG at 28 days post booster:* Heterologous **(7133 ELU/mL, CI 6415-7932)** vs.	**Spike-specific IgG antibodies:* Heterologous **(3602 BAU/mL)** vs. Homologous **(4189 BAU/mL)**	*RBD antibody titres:* Heterologous **(7756.68 BAU/mL, CI 7371.53-8161.96)** 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.	*RBD antibody titres:* Heterologous **(1866 GMT; 95% CI, 1003-3472)** vs.	No available data Ongoing trial[90]

[cclv] 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/

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

	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)	**Neutralizing antibodies:* Heterologous **(100%)** vs. Homologous **(100%)** ***Heterologous mRNA:*** **84.7%** effectiveness (95% CI, 83.1-86.1) *Results based on immunosuppressed population	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. Homologous **(30%)** at day 14 Heterologous **(median 99%)** vs. Homologous (BNT162b2/BNT162b2) **(median 62%)**			Homologous CoronaVac **(94.4 U/mL; 95% CI : 76.1-122.1)** vs. Homologugous 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 **12.8 GMT** (95% CI, 9.3-17.5)	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. 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):* **13/20 seropositive** against Omicron[91]	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**:* **151 GMT (95% CI, 80.21-284.3)** *Neutralizing antibody titres **Delta**:* **241.2 GMT (95% CI, 74.99-775.9)**	No available data
Reactogenicity	Observed increase in systemic reactogenicity after boost in heterologous	*Adverse events in heterologous and homologous vaccination groups were very similar	*Adverse events in heterologous:* Headache **(44%)**, Myalgia **(43%)**, Malaise **(42%)**, Fever **(2%)**,	Not Applicable (one dose schedule)	Unknown (on-going clinical trial)[92]	**CoronaVac/ChAdOx1:** Unknown **CoronaVac/Convidecia:**	*Most common local adverse events:* Pain at injection site **(11.1%)**	No available data Ongoing trial[90]

	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 **(81)** Grade 1 **(59.3%)** Grade 2 **(39.5%)** Grade 3 **(1.2%)** Grade 4 **(0%)**	*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	Injection site pain **(88%)**, Induration **(35%)**, Erythema **(31%)** *Severity of adverse events in heterologous:* Mild **(68%)**, Moderate **(30%)**, Severe **(2%)**	For more information refer to booster section		Convidecia recipients reported more adverse reactions and reported higher occurrence of solicited injection-site pain)	*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	
	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	Phase II booster trial of three booster doses are ongoing[93]	Preliminary results on tolerability and immunogenicity of third dose of ChAdOx1	Johnson & Johnson has said it will submit all of their new data to the FDA for	*UAE:* Offering booster doses of Pfizer and Sinopharm to people who	**Turkey** and the **United Arab Emirates** began	**India** has started administering homologous booster doses	Ongoing phase II trials[95]

	months after full jab[cclvii] *United States:* Starting September, adults who received mRNA vaccine 8 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[cclviii]	Moderna sought FDA approval of its COVID-19 vaccine booster[cclix] *United States:* Starting September, adults who received mRNA vaccine 8 months ago are eligible for booster	vaccines showed strong boost to the immune response[94]	potential consideration for adding a booster dose and consideration to authorize two-dose regimen[cclx]	received full Sinopharm jab ≥6 months ago	homologous booster shots **Indonesia** and **Thailand** are considering giving homologous booster shot to HCW[cclxi]		Results below are based on ongoing phase II trial

[cclvii] 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/

[cclviii] 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/

[cclix] 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/

[cclx] 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

[cclxi] 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/

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 new Omicron variant[cclxii]	**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]
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	*Against Moderate to Severe/critical Infection:* **75.2% (95% CI, 54.6-87.3)** *Against Asymptomatic Infections:* **75.6% (95% CI, 55.5-99.9)** *Against Severe/Critical Infection:*	No available data	No available data	Ongoing clinical trials[xxxvii]	No available data

[cclxii] 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

				100% (95% CI, 32.6-100)				
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 **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	*Effectiveness against infection:* **94%** (95% CI, 91-95) **91%** (95% CI, 90-92) **87%** (95% CI, 83-91) *Effectiveness against hospitalization:* **86%** (95% CI, 82-89)	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%** *Effectiveness against ICU admission:* **92.2%** *Effectiveness against COVID-19 related death:* **86.7%**	No available data	No available data

	symptomatic COVID-19 **94.0%** (93.4-94.6) against symptomatic COVID-19 compared with unvaccinated *Effectiveness against hospitalization:* **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):** *Against Symptomatic Infection:* **77%** (95% CI, 75.0-79.0) against infection [USA; 01-31 December 2921] **92.3% (95% CI, 91-93)** compared to unvaccinated [USA; December	**Delta (B.1.617.2):** *Against Symptomatic Infection:* **95.2%** (93.4%-96.4%) **92.3% (95% CI, 91-93)** compared to unvaccinated [USA; December 2021-January 2022]		***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				

	2021-January 2022] **83% (95% CI, 81-84)** compared to 2 doses [USA; December 2021-January 2022] *Against Emergency Department and Urgent Care:* **94% (95% CI, 93-94)** [USA; August 2021-January 2022][cclxiii] *Against Hospitalization:* **94% (95% CI, 93-95)** [USA; August 2021-January 2022][cclxiv] ***Omicron (B.1.1.529):*** *Against Symptomatic Infection:*	**83% (95% CI, 81-84)** compared to 2 doses [USA; December 2021-January 2022] *Against Emergency Department and Urgent Care:* **94% (95% CI, 93-94)** [USA; August 2021-January 2022][cclxvii] *Against Hospitalization:* **94% (95% CI, 93-95)** [USA; August 2021-January 2022][cclxviii] **Omicron (B1.1.529):** *Against Symptomatic Infection:* **62.5%** (95% CI 56.2-67.9%)[43]		**85%** (95% CI, 54-95) against hospitalization 1-2 months post booster[98]				

[cclxiii] Study does not differentiate between mRNA-based vaccines.
[cclxiv] Study does not differentiate between mRNA-based vaccines.
[cclxvii] Study does not differentiate between mRNA-based vaccines.
[cclxviii] Study does not differentiate between mRNA-based vaccines.

	75.5% (95% CI, 56.1-86.3)[38] **54.6%** (95% CI, 30.4-70.4) in ≥60-year-old[40] **62%** (95% CI, 59.0-65.0) against infection [USA; 01-31 December 2021][42] **65% (95% CI, 62-68)** compared to unvaccinated [USA; December 2021-January 2022][97] **65% (95% CI, 63-68)** compared to 2 doses [USA; December 2021-January 2022][97] *Against Emergency Department and Urgent Care:* **82% (95% CI, 79-84)** [USA; August 2021-January 2022][59cclxv]	**65% (95% CI, 62-68)** compared to unvaccinated [USA; December 2021-January 2022][97] **65% (95% CI, 63-68)** compared to 2 doses [USA; December 2021-January 2022][97] *Against Emergency Department and Urgent Care:* **82% (95% CI, 79-84)** [USA; August 2021-January 2022][59cclxix] *Against Hospitalization:* **90% (95% CI, 80-94)** [USA; August 2021-January 2022][59cclxx] **90% (95% CI, 80-94)** [USA; August 2021-January 2022][59cclxxi]						

[cclxv] Study does not differentiate between mRNA-based vaccines.
[cclxix] Study does not differentiate between mRNA-based vaccines.
[cclxx] Study does not differentiate between mRNA-based vaccines.
[cclxxi] Study does not differentiate between mRNA-based vaccines.

	Against Hospitalization: **91%** (95 CI, 85.0-94.0) against hospitalization [USA; 01-31 December][42] **90% (95% CI, 80-94)** [USA; August 2021-January 2022][59cclxvi] *Against Death:* **96%** (95% CI, 91.0-98.0) against death [USA; 01-31 December][42]							
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 one month after booster	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) *Anti-RBD IgG:* **246.4 GMT (95% CI, 92.11-259.47)** *Spike Cellular Immune Response:* Increased from **200 SFUx10^6**	$5X10^{10}$ 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 dose after 29 days	*Neutralizing Antibodies:* **263.9 GMT (95% CI, 223.7-311.3)**[cclxxii] *Specific Antibodies:* **99.66%** participants had detectable antibodies 28 days after the booster	*Neutralizing Antibodies:* **263.9 GMT (95% CI, 223.7-311.3)**[cclxxiii] *Seropositivity:* **Adults (≥18): 98%** (95% CI, 90.76-99.96) in participants who received their 2nd dose 14 days apart and 3rd dose	*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) 4 weeks after booster dose	*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:* Increase of **4.3-fold** compared to peak response

[cclxvi] Study does not differentiate between mRNA-based vaccines.
[cclxxii] Study does not differentiate between inactivated vaccines.
[cclxxiii] Study does not differentiate between inactivated vaccines.

	18104 GMT (95% CI, 13911-23560) **1704 GMT** **891.4 GMT** *IgG Antibodies:* **1.7-fold increase** (95% CI, 1.6-1.9) following booster compared to 2-initial doses *Anti-S Spike IgG:* **22185 U/mL (95% CI, 21406-22990)** 14 days after booster ***≥ 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		**PBMC (IQR, 127-389)** after the second dose to **399 SFUx10^6** **PBMC (IQR, 314-662)** after the third one	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	*IgG Seroconversion:* **175/176** vaccinees were 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%)**	2 months afterwards **100%** (95% CI, 93.51-100.00) in 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	*Anti-RBD & Anti-nucleocapsid IgG:* **Increase** in IgG antibodies 4 weeks after booster dose	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

							compared to 2-doses **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	**<u>Beta (B.1.351):</u>** Elicits **15-21** more neutralizing titers for Beta variant after 6 months after 2nd dose *<u>Neutralizing Antibodies (FRNT50):</u>* **651 GMT** **152.2 GMT** **<u>Delta (B.1.671.2):</u>** **>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	Preliminary results of booster doses of mRNA-1273 vaccine show robust antibody response against Delta variant **<u>Beta (B.1.351):</u>** **6.7-fold** increase in neutralization against Beta compared to 2-initial doses **<u>Omicron (B.1.1.529):</u>** *<u>Neutralizing Antibodies:</u>* **38-fold** increase in neutralization compared to 2 doses[cclxxv103]	Third dose provided higher antibody titters against Alpha, Beta, and Delta variants	No available data	**<u>Alpha (B.1.1.7):</u>** *<u>Neutralizing Antibodies:</u>* **319.1 GMT (95% CI, 274.1-371.5)** **10.8x higher** than 2 doses[cclxxvi] **<u>Beta (B.1.351):</u>** *<u>Neutralizing Antibodies:</u>* **194.9 GMT (95% CI, 160.9-236.1)** **17.9x higher** than 2 doses[cclxxvii] **71.6%** plasma inhibitions against Beta variant **215.7 pVNT** neutralizing antibodies against Beta variant 14 days after booster[105]	**<u>Alpha (B.1.1.7):</u>** *<u>Neutralizing Antibodies:</u>* **319.1 GMT (95% CI, 274.1-371.5)** **10.8x higher** than 2 doses[cclxxix] **<u>Beta (B.1.351):</u>** *<u>Neutralizing Antibodies:</u>* **194.9 GMT (95% CI, 160.9-236.1)** **17.9x higher** than 2 doses[cclxxx] **3.0-fold** decrease in neutralizing antibodies compared to wild type **<u>Gamma (P.1):</u>** **3.1-fold** decrease in neutralizing antibodies	**<u>Alpha (B.1.1.7):</u>** **161-fold increase** with **338 GMT** (95% CI, 188-607) 4 weeks after booster dose **<u>Beta (B.1.351):</u>** **265-fold increase** with **147.3 GMT** (95% CI, 75-289) 4 weeks after booster dose **<u>Delta (B.1.671.2):</u>** **32.6-fold increase** with **252 GMT** (95% CI, 133-482) 4 weeks after booster dose **<u>Delta Plus:</u>** **174-fold increase** with **174 GMT** (95% CI, 64-474)	High levels of functional antibodies against Alpha (B.1.1.7), Beta (B.1.351), and Delta (B.1.671.2) **<u>Alpha (B.1.1.7):</u>** **21.9-fold increase** in anti-S IgG compared to 2-initial doses **<u>Beta (B.1.351):</u>** **40.6-fold increase** in serum IgG[107] **24.5-fold increase** in anti-S IgG compared to 2-initial doses **<u>Delta (B.1.671.2):</u>**

[cclxxv] Study does not differentiate between Pfizer and Moderna
[cclxxvi] Study does not differentiate between inactivated vaccines.
[cclxxvii] Study does not differentiate between inactivated vaccines.
[cclxxix] Study does not differentiate between inactivated vaccines.
[cclxxx] Study does not differentiate between inactivated vaccines.

	2 titers in 65–85-year-olds *Neutralizing Antibodies (FRNT50):* **881 GMT** **430.5 GMT** **Omicron (B.1.1.529):** Neutralizing Antibodies *(FRNT50):* **37.0-fold decrease** in neutralization compared to Delta after 0.5 months after booster **24.5-fold decrease** in neutralization compared to Delta after 3 months after booster **17-fold increase** in neutralization titer compared to 2-initial doses[99] **41-fold increase** (95% CI, 30-56) in	**12-fold increase** in neutralization titer (GMT) against Omicron compared to 2-initial doses[104]			**Lambda:** **89.0%** plasma inhibitions against Lambda variant **Delta (B.1.671.2):** *Neutralizing Antibodies:* **202.1 GMT (95% CI, 171.3-238.4)** **7.7x higher** than 2 doses[cclxxviii] **83.4%%** plasma inhibitions against Delta variant **250.8 pVNT** neutralizing antibodies against Delta 14 days after booster **Omicron (B.1.1.529):** **4-fold increase** in neutralization titer against Omicron compared to 2-dose vaccination[104] **11-fold decrease** in neutralization titer 14 days after booster dose	compared to wild type **Delta (B.1.671.2):** *Neutralizing Antibodies:* **202.1 GMT (95% CI, 171.3-238.4)** **7.7x higher** than 2 doses[cclxxxi] **2.3-fold** decrease in neutralizing antibodies compared to wild type **2.5-fold** higher neutralizing potency than 2-dose vaccination	4 weeks after booster dose	Increase of **6.6-fold** in antibody response compared to Delta response observed with primary vaccination **24.4-fold increase** in anti-S IgG compared to 2-initial doses **Omicron (B.1.1.529):** **20.1-fold increase** in anti-S IgG compared to 2-initial doses[107]

[cclxxviii] Study does not differentiate between inactivated vaccines.
[cclxxxi] Study does not differentiate between inactivated vaccines.

	neutralizing antibodies compared to 2-initial dose in **younger participants**[100] **43-fold increase** (95% CI, 32-58) in neutralizing antibodies compared to 2-initial doses in **middle-aged**[100] **27-fold increase** (95% CI, 20-36) in neutralizing antibodies compared to 2-initial doses in **older participants**[100] **200 GMT** **9.9-fold decrease** compared to Delta[101] **107.6 GMT**[102] **38-fold** increase in neutralization compared to 2 doses[cclxxiv103]				compared to wild type[104] **3.3-fold increase** in neutralizing activity 28 days after booster compared to 2-initial doses against Omicron[106] **48.73 pVNT** neutralizing antibodies against Omicron 14 days after booster[105]			

[cclxxiv] Study does not differentiate between Pfizer and Moderna

Reactogenicity	Preliminary results show consistent tolerability **25%** reported at least one adverse event *Common solicited AE:* Injection site pain, injection site redness, injection site swelling, fatigue, 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	Similar safety and tolerability compared to second dose *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)**	Lower reactogenicity after third dose compared to first dose	No available data	Ongoing trial	The third shot is considered to be safe *Common side effects:* Pain at the injection site. *Adverse events:* Unrelated to the vaccination	Most reported adverse events were **mild and resolved within 24 hours** *Solicited Adverse Events:* **8** solicited adverse events were reported **5.4%** care of pain, **2.1%** itching **1%** redness	Booster dose was **well tolerated** 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	No available information	No available information	No available information	No available information	No available information	Ongoing clinical trials[xxxvii]	No available information

	symptomatic infection (hazard ratio: 0.07; 95% CI, 0.02-0.20)[108] **92% relative reduction** in asymptomatic infection (hazard ratio: 0.08; 95% CI, 0.01-0.48)[108] <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	*Half-life:* **44 days** (steeper than 2 doses [54 days]) *≥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

4th Dose	*Confirmed Infections:* **2.0 lower rate (95% CI, 2.0-2.1)** than 3 doses[109] *Severe Illness:* **4.3 lower rate** than 3 doses[109]	No new data	No new data	No new data	No new data	No new data	No new data	No new data
Other	Detailed report from Pfizer regarding booster doses can be found here: https://www.fda.gov/media/152161/download 14-20 days after booster, marginal effectiveness increases to **70-84%** ***Incidence Rate:*** Infection in individuals <60: **0.22 (95% CI, 0.22-0.23) incidence rate** in booster compared to non-booster					For more detailed information regarding immunogenicity of third dose refer to study[cclxxxii]		

[cclxxxii] 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

	Infection in individuals ≥60: **0.16 (95% CI, 0.15-0.17) incidence rate** in booster compared to non-booster Severe illness in individuals <60: **0.33 (95% CI, 0.21-0.52) incidence rate** in booster compared to non-booster Severe illness in individuals ≥60: **0.12 (95% CI, 0.10-0.14) incidence rate** in booster compared to non-booster							
Vaccine Schedule	**HETEROLOGOUS BOOSTER DOSES**							
	Heterologous 1: **mRNA1273/BNT162b2** *Heterologous 2:* **Ad26.CoV.2.S/BNT162b2** *Heterologous 3:*	*Heterologous 1:* **BNT162b2/mRNA1273** *Heterologous 2:* **Ad26.CoV.2.S/mRNA1273** *Heterologous 3:*	*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:*	*Heterologous 1:* **SinoPharm/BNT162b2** *Heterologous 2:* **ChAdOx1/SinoPharm***	*Heterologous 1:* **CoronaVac/ChAdOx1** *Heterologous 2 :* **CoronaVac/BNT162b2** *Heterologous 3 :*	No available data	*Heterologous 1:* **BNT162b2/NVX-CoV2373** *Heterologous 2:* **ChAdOx1/NVX-CoV2373**

	ChAdOx1/BNT162b2 ***Received BNT162b2 as booster dose	**ChAdOx1/mRNA1273** ***Received mRNA1273 as booster dose**		**ChAdOx1/Ad26.CoV.2.S.** ***Received Ad26.CoV.2 as booster dose**	***Received SinoPharm as booster dose**	**CoronaVac/SinoPharm** *Heterologous 4:* **CoronaVac/mRNA1273** ***Received CoronaVac as initial regimen**		***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:* **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	No available data	**6 months** after initial two-dose regimen
Effectiveness	**Heterologous 1:** *Incidence of Infection:*	**Heterologous 1:** *Incidence of Infection:*	No available data	**Heterologous 1:** *Incidence of Infection:*	No available data	**Heterologous 1:** *Against Symptomatic Infection:*	No available data	No available data

15% higher than mRNA1273 homologous booster (Adjusted rate ratio: **1.15** [95% CI, 0.87-1.52])* *Results not statically significant *Against Infection:* **94%** (95% CI, 91-96) effectiveness against infection **Heterologous 2:** *Incidence of Infection:* **42% lower** than Ad26.COV2.S homologous booster (Adjusted rate ratio: **0.58** [95% CI, 0.43-0.78]) *Results not statically significant *Effectiveness in ≥50:* **87.4%** (95% CI, 84.9-89.4) against	**14% lower** than BNT162b2 homologous booster (Adjusted rate ratio: **0.86** [95% CI, 0.63-1.17])* *Results not statically significant *Against Infection:* **92%** (95% CI, 88-95) **Heterologous 2:** *Incidence of Infection:* **55% lower** than Ad26.COV2.S homologous booster (Adjusted rate ratio: **0.45** [95% CI, 0.35-0.57]) *Results not statically significant **Heterologous 3:** **91%** (95% CI, 63-98) effectiveness against infection		**146% higher** than BNT162b2 homologous booster (Adjusted rate ratio: **2.46** [95% CI, 1.07-5.66])* *Results not statically significant **Heterologous 2:** *Incidence of Infection:* **22% lower** than mRNA1273 homologous booster (Adjusted rate ratio: **0.78** [95% CI, 0.32-1.90])* *Results not statically significant		**93.2%** (95% CI, 92.9-93.6) against symptomatic infections **86% (95% CI, 74.0-93.0)** [Thailand; July-October 2021] *Against Hospitalization:* **97.7%** *Against ICU Admission* **98.9%** *Against Death:* **98.1%** **Heterologous 2:** *Against Symptomatic Infection:* **96.5%** (95% CI, 96.2-96.7) **98% (95% CI, 87.0-100.0)** [Thailand; July-October 2021] *Against Hospitalization:* **96.1%**		

	symptomatic COVID-19 **93.1%** (95% CI, 91.7-94.3) against symptomatic COVID-19 compared to unvaccinated **<u>Heterologous 3:</u>** **82%** (95% CI, 68-90) effectiveness against infection		***<u>Omicron (B.1.1.529):</u>*** *<u>Heterologous 1:</u>* **71.4%** (95% CI, 41.8-86.0) against symptomatic infection[38]			*<u>Against ICU Admission:</u>* **96.2%** *<u>Against Death:</u>* **96.8%**		
Effectiveness against Variants	No available data	No available data		No available data	No available data	No available data	No available data	No available data
Immunogenicity	***<u>Heterologous 1:</u>*** *<u>Binding Antibody Responses:</u>* **2-fold or greater rise** in bAb noted in **98-100%** of BNT162b2 recipients *<u>Neutralizing Antibody Responses:</u>*	***<u>Heterologous 1:</u>*** *<u>Binding Antibody Responses:</u>* **2-fold or greater rise** in bAb noted in **96-100%** of mRNA1273 recipients *<u>Neutralizing Antibody Responses:</u>*	***<u>Heterologous 1:</u>*** *<u>Anti-spike IgG:</u>* In individuals <70: **12440 ELU/mL** (95% CI, 10420-14852) In individuals ≥70: **14961 ELU/mL** (95% CI, 12065-18551) *<u>Cellular Response :</u>*	***<u>Heterologous 1:</u>*** **14.8 to 32.4-fold** increase in neutralization titers against wild-type virus *<u>Binding Antibody Responses (bAb):</u>* **2-fold or greater rise** in bAb noted in **98-100%** of	***<u>Heterologous 2:</u>*** *<u>Anti-RBD IgG:</u>* **128.1 GMT (95% CI, 93.5-175.4)** 14 days after booster	***<u>Heterologous 1:</u>*** Heterologous vaccination had a **9-fold greater GMT** (7,947 U/mL) than fully patients fully vaccinated with AZD1222 and the highest antibody response, IgA, and neutralizing	No available data	**<u>Heterologous 1:</u>** *<u>Anti-spike IgG:</u>* In individuals <70: **14961 ELU/mL** (95% CI, 12065-18551) In individuals ≥70: **9130 EUL/mL** (95% CI, 6783-12289) *<u>Cellular Response:</u>*

	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 ***Heterologous 3:***	**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. *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:*** *S-binding Antibodies:*	In individuals <70 : **105** (95% CI, 67-164) In individuals ≥70: **84** (95% CI, 45-156)	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:* In individuals <70: **5582 ELU/mL** (95% CI, 4415-7057) In individuals ≥70:		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 **1358.0 GMT (95% CI, 1141.8-1615.1)** 14 days after booster *Anti-S1-IgA:*		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)

	Neutralizing Antibodies (FRNT50): **1543 GMT** *Anti-RBD IgG:* **2363 GMT (95% CI, 2005.6-2786.1)** 14 days after booster *Anti-S Spike IgG:* **19203 U/mL (95% CI, 18094-20377)** 14 days after booster 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:	**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-y:* **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) *Cellular Response:* In individuals <70: **228** (95% CI, 177-294)		**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)		**5.25 OD/CO** (IQR, 3.94-9.00) 14-days after booster *T Cell (IFN-y CD4+/IFN-y CD4+ and CD8+):* **86%/93% seropositivity** 28 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:*		

	113 (95% CI, 64-200) sport forming cells per 10^6 peripheral blood mononuclear cells	In individuals ≥70: **101** (95% CI, 54-187)				Single booster dose of BNT162b2 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 **5152.2 GMT (95% CI, 4491.7-5909.8)** 14 days after booster *T Cell (IFN-γ CD4+/IFN-γ CD4+ and CD8+):* **96%/100% seropositivity** (95% CI, 190-402) 28 days after booster ***Heterologous 3:*** *Anti-spike RBD:* **1073 U/mL** 14 days after booster **154 BAU/mL** 14 days after booster		

						154.1 GMT (95% CI, 92.11-259.47) 14 days after booster *T Cell (IFN-γ CD4+/IFN-γ CD4+ and CD8+):* **43%/47% seropositivity** ***Heterologous 4:*** *Total RBD Ig:* **33519 U/mL** 28 days after booster *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 *T Cell (IFN-γ CD4+/IFN-γ CD4+ and CD8+):* **90%/93% seropositivity**		
Immunogenicity against variants	*Binding Antibody Responses:* Baseline bAb levels for **Delta**	*Binding Antibody Responses:* Baseline bAb levels for **Delta**	*AZD1222/ BNT162b2* Demonstrated **80%** response	***Heterologous 1:*** **10.9 to 21.2-fold** increase in pseudo virus	No available data	***Heterologous 1:*** *Neutralizing antibodies*:	No available data	***Heterologous 1:*** *Pseudotype neutralizing antibody NT_{50}:*

	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}:* **651 GMT** against **Beta** variant **315 GMT** (95% CI, 1314–1998) against **Delta** **470 $PRNT_{50}$** 14 days after booster against **Delta** variant **881 GMT** against **Delta** variant	**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:*** *Pseudotype virus neutralizing antibody NT_{50}:* **559.7 GMT** (95% CI, 441.3-709.9) against **Delta**	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**	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** compared to 2-initial doses ***Heterologous 3:*** *Pseudotype virus antibody NT_{50}:*		**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 ($p<0.0001$)[110] **271 $PRNT_{50}$** 14 days after booster against **Delta** variant[111] **250 GMT** (95% CI, 169-368) 28 days after booster **4.0-fold decrease** against **Omicron** compared to **Delta**[112] ***Heterologous 2:*** **6.3-fold increase** in neutralization titers against **Delta** 28 days after booster dose compared to 2-initial doses **6.3-fold decrease** in neutralization		**165 GMT** (95% CI, 131-209) against **Delta** ***Heterologous 2:*** *Pseudotype neutralizing antibody NT_{50}:* **124 GMT** (95% CI, 99-156) against **Delta**

	200 GMT **9.9-fold decrease** against **Omicron** variant compared to Delta[101] **521 PRNT$_{50}$** 14 days after booster against **Omicron** variant			**125 GMT** (95% CI, 99-159) against **Delta**		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[111] **277 GMT** (95% CI, 190-402) 28 days after booster **4.6-fold decrease** against **Omicron** compared to **Delta**[112] ***Heterologous 3:*** *Neutralizing Antibodies:* **61.3 PRNT$_{50}$** 14 days after booster against **Delta** variant **24.6 GMT** (95% CI, 18.1-33.5) 28 days after booster **2.8-fold decrease** against **Omicron**		

						compared to **Delta**[112] ***<u>Heterologous 4:</u>*** <u>*NAbs titers:*</u> **512 GMT** (95% CI, 359-732) 28 days after booster **4.2-fold decrease against Omicron** compared to **Delta**[112]		
Reactogenicity	<u>*Adverse Events:*</u> **72-92%** participants reported local pain or tenderness Malaise, myalgias, and headaches were commonly reported **14.4%** of the participants reported unsolicited adverse events	<u>*Adverse Events:*</u> **75-86%** participants reported local pain or tenderness Malaise, myalgias, and headaches were commonly reported **15.6%** of participants reported unsolicited adverse events	No available data	<u>*Adverse Events:*</u> **71-84%** participants reported local pain or tenderness Malaise, myalgias, and headaches were commonly reported **12%** of participants reported unsolicited adverse events	No available data	Similar results to homologous booster administration Reactogenicity of mRNA1273 booster was acceptable and better tolerated with increasing age and shorter time since booster dose	No available data	No available data

Duration of Protection	*Half-life:* **40 days** (steeper than 2 doses [80 days])							
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[cclxxxiii]		
IMMUNOGENICITY								
Immunogenicity	*Single Dose (≥4 weeks):* **79.4% IgG seropositivity** (95% CI, 75.7-83.1)[113] *Second dose (≥4 weeks):* **96.5% IgG seropositivity** (95% CI, 94.9-98.1) to **92% IgG**	*14 days after second dose:* *18-55 years*: $PRNT_{80}$ GMT **654.3 (95% CI, 460.1-930.5**). *56-70 years:* $PRNT_{80}$ GMT **878 (95% CI, 516-1494**).	*28 days after second dose median antibody titres:* *18–55 years*: **20,713 AU/mL [IQR 13,898 - 33,550**] *56–69 years*: 1**6,170 AU/mL**	*IgG Antibodies:* **1299.5 AU/mL** highest median *29 days after vaccination:* *18-55 years:* GMC **586 (95% CI, 445-771**); GMT **224 (95% CI, 168-298**).	*14 days after second dose:* *18-55 years:* GMT ***211.2*** **(95% CI, 158.9-280.6**). *≥60 years: GMT* ***131.5*** **(95% CI, 108.2-159.7**). **5.6-fold** decrease in seropositivity rate at 6-months post- 2 doses[cclxxxiv]	*Single dose (≥4 weeks)*: **37.7±57.08 IU/ml (min: 0, max: 317.25);** 57.02% of participants did not develop sufficient antibody titres (<25.6 IU ml) **28.1% IgG seropositivity**	*IgG Antibodies:* **342.7 AU/mL** highest median *Single dose (≥4 weeks:* **43.8%** seropositive for anti-spike antibody > 15 AU/mL GMT **16.8 (95% CI, 15.80-17.88)**	

[cclxxxiii] 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

[cclxxxiv] Study does not distinguish between Covishield and Covaxin

	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) *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** *IgG and IgA :*	≥*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) *IgG and IgA:* IgG: **618.6(95% CI 492.4 – 672.9)** IgA: **3.9 (95% CI 0.9 – 6.0)**	**[IQR 10,233 - 40,353]**. ≥*70 years*: **17,561 AU/mL [IQR 9,705 - 37,796]**. *IgG and IgA:* IgG: **259.5 (95% CI 181.3 – 337.9)** IgA: **0.7 (95% CI 0.6 – 1.4)**	≥*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	*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	(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 median antibody titer :**63.58 U/ml** *anti-S IgG:*	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	

	IgG: **679.0 (95% CI,626.1 – 733.7)** IgA: **5.3 (95% CI 3.9 – 7.1)**					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)**		
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:* GMT of **480**[114] **5.6-fold** decrease in seropositivity rate at 6-months post- 2 doses[115]	

	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)	<u>Fully vaccinated</u> **17-fold** decrease in neutralization against Omicron when compared to wild type[116] <u>Boosted (3-dose schedule)</u> **7-fold** decrease in neutralization against Omicron when compared to wild type[116]							
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[117]	**20-fold decrease** in neutralization 6 months after vaccination compared to Delta[117] **1/10 seropositive** against Omicron[91] Plasma specimens one	Mean neutralizing titres drop to below the detectable threshold in all but one participant[117] **0/20 seropositive** against Omicron[91] The mean Omicron titre	Vaccine lacked detectable neutralizing activity against Omicron.[103] Demonstrated **9%** response rate against Omicron serum sample[120]	<u>*Hybrid immunity:*</u> GMT: **52 (95% CI, 36-75) (p = 0.0011)** [126]	Not a single serum sample demonstrated neutralizing antibodies against the Omicron VOC among 25 blood samples[127]	Only 5/20 live virus samples exhibited neutralization titres above the lower limit of quantification.[125] GMT of **75** compared to 706 for D614G (wild-type)[114]	

	Plasma specimens one month after full mRNA vaccination, NT_{50} values were 127±66 times lower for Omicron than the wild type (Wuhan) strain. After 5 months, the neutralization potency was 27±17 lower for Omicron.[103] 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[103] A third booster dose increased the neutralization capacity against	month after full mRNA vaccination, NT_{50} values were 127±66 times lower for Omicron than the wild type (Wuhan) strain. After 5 months, the neutralization potency was 27±17 lower for Omicron.[103] 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[103] A third booster dose increased the neutralization capacity against Omicron by **38** times.[103]	estimate in the infected + double vaccinated group suggests protection against symptomatic Omicron disease is **80%**[116] Demonstrated **50%** response rate against Omicron serum sample & **12.8-fold** decrease in GMT[120] Only 5/20 live virus samples exhibited neutralization titres above the lower limit of quantification.[125] No neutralizing antibodies were observed in serum samples obtained 1 months after the receipt of the second dose[121]	**15-fold** reduction in neutralization[cclxxxix] 122				

[cclxxxix] Study does not distinguish between Pfizer, Moderna, or Janssen.

	Omicron by **38** times.[103] **11.4-fold decrease** in neutralization 6 months after vaccination compared to Delta **25-fold decrease** in neutralization titers against Omicron variant compared to wild-type[118] **41-fold decrease** in neutralization level against Omicron[119] **9/20 seropositive** against Omicron [91] Demonstrated **33%** response rate against Omicron serum sample[120] **9/20 participants** neutralized Omicron variant 1 month after 2nd dose[121]	The mean Omicron titre estimate in the infected + double vaccinated group suggests protection against symptomatic Omicron disease is **91%**[116] Demonstrated **100%** response rate against Omicron serum sample & **15.8-fold** decrease in GMT[120] No neutralizing antibodies were observed in serum samples obtained 4-6 months after the receipt of the second dose[121] Nabs below LLQQ against Omicron at 1 month post-primary series[124] **15-fold** reduction in						

	15-fold reduction in neutralization[cclxxxv] 122 **34-fold** reduction in efficiency of neutralization compared to B.1. **12-fold** lower efficiency compared to Delta[123] **27-fold** reduction in efficiency of neutralization compared to wild type[cclxxxvi]103	neutralization[cclxxxvii] 122 **27-fold** reduction in efficiency of neutralization compared to wild type[cclxxxviii]103						
EFFICACY								
Single dose[ccxc]	**52%** (95% CI, 29.5 to 68.4; starting at 12 days) or 82.2% (75.1 to 87.3; starting at ≥14 days).	**95.2%** (95% CI, 91.2.8 to 97.4; starting at >14 days).	**72.8%** (starting at 22 days up to 60 days). **88%** (95% CI, 75-94).[ccxcii] ≥80 years :	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

[cclxxxv] Study does not distinguish between Pfizer, Moderna, or Janssen.
[cclxxxvi] Study does not distinguish between Pfizer and Moderna
[cclxxxvii] Study does not distinguish between Pfizer, Moderna, or Janssen.
[cclxxxviii] Study does not distinguish between Pfizer and Moderna
[ccxc] Against SARS-COV-2 infection
[ccxcii] Conducted between 8 December 2020 and 8 February 2021. Study sample = ≤1 million participants.

	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] [ccxci]		**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] [ccxciii]					
Two doses[ccxciv]	**95.0%** (95% CI, 90.3-97.6) starting at ≥7 days in population without prior SARS-CoV-2 infection	**94.1%** (95% CI, 89.3-96.8) after median follow-up of less than 63 days **93.2%** (95% CI, 91.0-94.8)	**63.1% (**95% CI, 51.8-71.7) starting at ≥14 days for two standard doses **80.7%** (95% CI, 62.1-90.2) starting	**66.9%** (95% CI 59.0-73.4) after 14 days and **66.1%** (95% CI 55.0-89.1) after 28 days for VE against moderate-	After 14 days, efficacy against symptomatic cases was **72.8%** (95% CI 58.1-82.4; 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).	*Symptomatic SARS-CoV-2 infection:* **77.8%** (95% CI, 65.2-86.4) *Severe symptomatic*	*Against SARS-CoV-2 Infection:* **90.4% (95% CI, 82.9-94.6)** ≥7 days after 2nd dose [Phase 3 Trial: USA & Mexico]

[ccxci] Does not differentiate between BNT162b2 and ChAdOx1 nCoV-19.
[ccxciii] Does not differentiate between BNT162b2 and ChAdOx1 nCoV-19.
[ccxciv] Against SARS-CoV-2 infection.

	94.6% (95% CI, 89.9-97.3) starting at ≥7 days in population with or without prior infection	Against severe disease: **98.2%** (95% CI, 92.8-99.6) *Prevention against COVID-19 illness:* **93.2%** (95% CI, 91.0-94.8; United States) *Prevention against severe disease:* **98.2%** (95% CI, 92.8-99.6; United States) *Prevention against asymptomatic infection starting 14 days after second infection:* **63.0%** (95% CI, 56.6-68.5; United States)	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 *Against mild-to-moderate symptomatic COVID-19 >14 days after second injection*: **21.9%** (95% CI, -49.9 to 59.8; South Africa) [24 June – 09 November 2020]	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	86.3; in HBO2 vaccine).	99.17% of NAb titres were above or equal to the Nab positivity cut-off (20 units) against wild-type.	*SARS-CoV-2 infection:* **93.4** (95% CI, 57.1-99.8) *Symptomatic COVID-19 in ≥60 years old:* **67.8%** (95% CI, 65.2-86.4) against symptomatic COVID-19 *Symptomatic COVID-19 in 18-59 years old:* **79.4%** (95% CI, 66.0-88.2) against symptomatic COVID-19	**90%** (95% CI, 80-95) (≥7 days after second dose) *Against moderate-severe disease:* **100% (95% CI, 87.0-100)** ≥7 days after 2nd dose [Phase 3 Trial: USA & Mexico] **89.7%** (95% CI, 80.2-94.6) starting at ≥7 days *Against severe disease:* **100%** (95% CI, 34.6-100) against severe COVID-19
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 -9.9 to 45.0) for asymptomatic cases **61.9%** efficacy	At day 71, vaccine efficacy against asymptomatic infections was **65.5%** (95% CI 39.9 to 81.1).	Efficacy against symptomatic and asymptomatic cases was **64%** (95% CI 48.8 to 74.7; in WIV04 vaccine) or 73.5% (95% CI 60.6 to	Unknown	**63.6** (95% CI, 29.0-82.4) efficacy against asymptomatic cases	Unknown

					82.2; in HBO2 vaccine).			
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)	*Against any variant of concern:* **92.6% (95% CI, 83.6-96.7)** ≥7 days after 2nd dose [Phase 3 Trial: USA & Mexico] *Against non-B.1.1.7 variant* **96%** (95% CI, 74-99.5) (≥7 days after second dose) *Alpha (B.1.1.7):* **93.6% (95% CI, 81.7-97.8)** ≥7 days after 2nd dose [Phase 3 Trial: USA & Mexico] **86%** (95% CI, 71-94) (≥7 days after second dose) **93.6%** (95% CI, 81.7-97.8) against the Alpha variant **86.3%** (95% CI, 71.3-93.5)

Beta (B.1.351)	Neutralization was **diminished by a factor of 5**. Despite this, the BNT162b2 mRNA vaccine still provides some protection against B.1.351 **100%** (95% CI, 53.5-100).	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). *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]	Efficacy against moderate-severe-critical Covid-19 due to the variant was **52.0%** (>14 days) and **64.0%** (>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**.	No published data	NT_{GM} **35.03 (95% CI, 27.46-44.68**); **8.75-fold** reduction in neutralization capacity when 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.	GMT **61.57 (95% CI, 36.34-104.3)** against Beta variant with significant reduction in neutralization titre	**51.0%** (95% CI, -0.6-76.2) efficacy against B.1.351 variant
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	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

			doses]: **69%** (95% CI, 55-78)					
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. Neutralization titres were decreased by **5.4-fold**.	Demonstrated **reduced neutralizing capacity**. However, there 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.	NT_{GM} **24.48** (95% CI,19.2-31.2). **69.17%** of NAb titres were above or equal to the Nab positivity cut-off (20 units) against wild-type.	**65.2** (95% CI, 33.1-83.0) estimated efficacy GMT **68.97** (95% CI, 24.72-192.4) against Delta variant with significant reduction in neutralization titre	No available data
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 [ccxcv]								
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, 89.9 to 97.3) in	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 adolescents (12 to <18 years old).	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 efficacy was	VE against moderate-severe-critical Covid-19 was **66.9%** (95% CI 59.0 to 73.4) after 14 days post vaccine administration, and **66.1%** (95%	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 at ≥7 days after second dose

[ccxcv] 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.

	population with or without prior infection. **100%** among adolescents (12-15 years old).		**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).	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).			
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 general population.	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 similar proportion in both groups	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 to the experimental or	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 to be related to the vaccine:	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	<u>Phase II:</u> Nine serious adverse events were reported, only one of which was assessed as related to the vaccine: acute colitis.

		(0.6%). 3 Bell's Palsy cases occurred in the vaccine group and one Bell's Palsy case occurred in the placebo group.	control vaccine (out of 11 636 vaccine recipients): transverse myelitis, haemolytic anaemia and a case of fever higher than 40°C.	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.		**2-DOSE EFFICACY** *Efficacy against symptomatic (moderate to severe/ critical) SARS-CoV-2 infection* **94%** (95% CI, 58-100) in the US. **75%** (95% CI, 55-87) globally. *Efficacy against severe SARS-CoV-2 infection* **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)[ccxcvi]	**Spikevax/ Moderna COVID-19 Vaccine/ mRNA-1273 (Moderna, USA)**[ccxcvii]	**Vaxzevria/ ChAdOx1 nCoV-19/ AZD1222/ Covishield (AstraZeneca/Oxford, UK, India)**[ccxcviii]	**Janssen COVID-19 vaccine/Johnson & Johnson (Janssen, USA)**[ccxcix]	**Sinopharm/BBIBP-CorV, China**[ccc]	**Sinovac CoronaVac, China**[ccci]	**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 Marburg	Lonza Biologics, Inc., (USA) Moderna TX, Inc. (USA) Lonza AG (Switzerland)	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)

[ccxcvi] 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

[ccxcvii] 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

[ccxcviii] 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

[ccxcix] 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

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

[ccci] 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, Germany) Rentschler Biopharma SE (Laupheim, Germany) Wyeth BioPharma Division of Wyeth Pharmaceuticals (USA)		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 (Brehna, Germany)	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)

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

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