Literature screening report

COVID-19 vaccines in the WHO's Emergency Use Listing (EUL) Report (10)

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Abstract

This report provides an in-depth review of the **seven**[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), and COVAXIN/ BBV152 (Bharat Biotech, India)]. The current report summarises the latest data on COVID-19 vaccine-related literature as of 13 December 2021, and presents the information in the form of a synoptic table. This report covers vaccine effectiveness, protection against variants, transmissibility, breakthrough infections, booster doses, COVID-19 vaccines for children, and further important information for each vaccine. The latest changes and additions to the synoptic table are highlighted in yellow.

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

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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, 56.1% of the world populations, of which only 7.3% of people in low-income countries, have received at least one dose of a marketed COVID-19 vaccine as of 15 December 2021[2]. Currently, seven 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), and COVAXIN/BBV152 (Bharat Biotech, India)] were assessed and granted an authorization by WHO as of 15 December 2021[3]. **Articles regarding the latest data on vaccine effectiveness, particularly against the omicron variant, vaccine induced immune response, breakthrough infections and transmission, and booster doses were prioritized during the literature search and are the latest additions to the table. Data from clinical trials and observational studies for the seven EUL-accepted vaccines and the vaccine candidate Novavax regarding these highlighted topics were summarized and can be found in the synoptic table below.**

[2] https://ourworldindata.org/covid-vaccinations (accessed on 15.12.2021).

[3] Status of COVID-19 vaccines within WHO EUL/ PQ evaluation process. World Health Organization. https://extranet.who.int/pqweb/sites/default/files/documents/Status_COVID_VAX_11Nov2021.pdf [Last updated 11 November 2021; Accessed 15 December 2021]

Methodology

We screened the data for the EUL-accepted vaccines and the vaccine candidate Novavax as of 13 December 2021 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

As phase III COVID-19 vaccine trials confirmed vaccine efficacy and safety for all seven WHO EUL authorized vaccines, and as the share of fully vaccinated people begin to increase across countries, it is important to assess vaccine effectiveness in real-world conditions, especially in relation to evolving variants of concern (VOC).

The Newest Variant of Concern: Omicron (B.1.1.529)

On 25 November 2021, a new variant of concern, later named Omicron (B.1.1.529), was firstly reported. The Omicron variant was identified to contain several mutations on the spike glycoprotein leading to a higher affinity to the ACE-2 domain of the SARS-CoV-2 virus[5,6]. Although not confirmed, this increased affinity could impact the behavior of the virus in terms of its ability to spread, escape existing immunity, and the severity of illnesses it causes. Even though information on the transmissibility and the severity of disease are not yet clear, few studies and preliminary analyses on the effect of the new variant on the efficacy, effectiveness, and immunogenicity of vaccines and booster doses have been released. Based on results examining the effects of the Omicron variant on the immunogenicity induced by the two-dose COVID-19 vaccines,

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

[5] The Omicron variant increases the interaction of SARS-CoV-2 spike glycoprotein with ACE2. *bioRXiv*. https://www.biorxiv.org/content/10.1101/2021.12.06.471377v2

[6] Structural insights of SARS-CoV-2 spike protein from Delta and Omicron variants. *bioRxiv.* https://www.biorxiv.org/content/10.1101/2021.12.08.471777v1

a **11.4 to 41-fold decrease** in mean neutralization titers was reported in comparison to either the wild-type or the Delta variant[7,8,9]. Regarding the effects of the new variant on the effectiveness of vaccines against symptomatic infection, one study estimated the effectiveness of the BNT162b2 vaccine to be **88.0% (95% CI, 65.9-95.8)** 2-9 weeks following the second dose, **48.5% (95% CI, 24.3-65.0)** 10-14 weeks following the second dose, and **34-37%** from 15 weeks following the second dose[10]. Nevertheless, results based on preliminary laboratory studies demonstrate that three doses of the Pfizer-BioNTech COVID-19 vaccine neutralize the Omicron variant and increase the antibody titers by **25-fold** compared to two doses[8] and to have an effectiveness against symptomatic infection of **75.5% (95% CI, 56.1-86.3)**[9]. Although the booster dose has demonstrated to greatly increase the overall immune response and maintain a high effectiveness, a study reported that, after 3 months, a homologous BNT162b2 booster dose had a **24.5-fold decrease** in neutralization compared to the Delta variant[6]. Similar results can be applied to the administration of heterologous booster doses. Overall, the vaccine-induced immunity of the current COVID-19 vaccines have shown to decrease in comparison to the wild-type and even Delta variant, while the administration of a booster dose has shown to provide a better protection against the new variant.

Latest Data on Vaccine Effectiveness, Duration of Protection & Transmissibility

A study that analysed global vaccine data across 187 countries between 20 December 2020 and 25 April 2021, analysed the correlation between the administration of vaccines and daily COVID-19 cases and deaths. The study concluded that COVID-19

[7] Reduced neutralization of SARS-CoV Omicron B.1.1.529 variant by post-immunization serum. *medRxiv.* https://www.medrxiv.org/content/10.1101/2021.12.10.21267534v1

[8] SARS-CoV-2 Omicron has extensive but incomplete escape of Pfizer BNT162b2 elicited neutralization and requires ACE2 for infection. *medRxiv.* https://www.medrxiv.org/content/10.1101/2021.12.08.21267417v2

[9] Pfizer and BioNTech Provide Update on Omicron Variant. [press release] *Pfizer and BioNTech.* https://www.pfizer.com/news/press-release/press-release-detail/pfizer-and-biontech-provide-update-omicron-variant

[10] Effectiveness of COVID-19 vaccines against the Omicron (b.1.1529) variant of concern. https://khub.net/documents/135939561/430986542/Effectiveness+of+COVID-19+vaccines+against+Omicron+variant+of+concern.pdf/f423c9f4-91cb-0274-c8c5-70e8fad50074

cases and deaths would reduce by **24.43% (95% CI, 18.89-29.59)** and **13.32% (95% CI, 3.81-21.89)** if 10,000 persons become fully vaccinated per day, respectively[11]. However, the study stopped collecting and analysing data in April 2021, a period of mostly Alpha variant predominance, and multiple new variants with mutations able to escape vaccine immunity have emerged since (*see above*). Given the emergence of VOCs such as the Delta (B.1.617.2) and now the Omicron (B.1.1.529) strain, mutations on the SARS-CoV-2 spike protein partially evades vaccine immunity[12], the original vaccine-induced herd immunity threshold must be updated[13].

In line with previous data on vaccine duration of protection, the effectiveness of BNT162b2, mRNA-1273, and Ad26.COV2.S against COVID-19 infection declined with the rise of the more transmissible Delta variant in New York. By the week of 28 August vaccine effectiveness against SARS-COV-2 infection had declined to **72.3% (range: 63.7-77.5**), **77.8% (range: 70.1-86.8)**, and **69.4% (range: 63.4-77.3)** for recipients of BNT162b2, mRNA-1273, and Ad26.COV2.S, respectively[14]. All three vaccines declined by similar percentage points: **20.7**, **19.5**, and **19.0** percentage points, respectively[15]. Likewise, a study in the UK demonstrated that Pfizer-BioNTech's BNT162b2 declined from **81% (95% CI, 68-89**) in the first two months after the administration of the second dose to **46% (95% CI, 22-63**) after six months[16]. Nevertheless, protection remained high for fully vaccinated (two-dose schedule) SARS-CoV-2 recovered persons; adjusted vaccine effectiveness remained consistently over the **90%** effectiveness mark "even in those infected over 15-months

[11] The effect of the COVID-19 vaccine on daily cases and deaths based on global vaccine data. *Vaccines.* https://www.mdpi.com/2076-393X/9/11/1328/htm

[12] Mutations of SARS-CoV-2 spike protein: Implications on immune evasion and vaccine induced-immunity. *Seminars in Immunology.* https://www.sciencedirect.com/science/article/pii/S1044532321000646?via%3Dihub

[13] The herd immunity threshold must be updated for multi-vaccine strategies and multiple variants. *Scientific Reports.* https://www.nature.com/articles/s41598-021-00083-2

[14] COVID-19 Vaccine effectiveness in New York State. *New England Journal of Medicine*. https://www.nejm.org/doi/full/10.1056/NEJMoa2116063?query=featured_home

[15] COVID-19 Vaccine effectiveness in New York State. *New England Journal of Medicine*. https://www.nejm.org/doi/full/10.1056/NEJMoa2116063?query=featured_home

[16] Effectiveness and durability of protection against future SARS-CoV-2 infection conferred by COVID-19 vaccination and previous infection; findings from the UK SIREN prospective cohort study of healthcare workers March 2020 to September 2021. *medRxiv.* https://www.medrxiv.org/content/10.1101/2021.11.29.21267006v1

ago"[17], however further studies would need to confirm whether past COVID-19 infection + two-dose vaccination retains high protection over time against the new Omicron variant. In regards to AstraZeneca/Oxford's ChAdOx1 nCoV-19 vaccine, a large-scale test-negative, case-control study demonstrated that the vaccine remained effective against moderate to severe SARS-CoV-2 infection during the highly transmissible Delta variant surge in India[18]. After a full two-dose vaccination schedule, vaccine effectiveness was estimated to be **63.1%** (**95% CI, 51.5-72.1**) against SARS-CoV-2 infection and **81.5%** (**95% CI, 9.9-99.0**) against moderate-to-severe COVID-19 infection[19].

Despite inactivated viral vaccines (Sinopharm's BBIBP-CorV and Sinovac's CoronaVac) being approved and administered in 72 and 47 countries worldwide, real world evidence on both vaccines continues to remain scare and vaccine effectiveness data are published at a slower rate compared to its other vaccine counterparts. A Brazilian study analysed CoronaVac's effectiveness over the Gamma (P.1) variant predominant months (study period: February to April) and determined the vaccine was effectiveness against symptomatic COVID-19 cases (**80.5%; 95% CI, 75.1-84.7**), severe disease (**95.0%; 95% CI, 86.9-98.1**), and death (**94.9%; 95% CI, 76.4-98.9**)[20]. Additionally, the authors observed an indirect protective effect in unvaccinated persons among higher vaccinated communities (≥52% of the adult population over the age of 18). Given reports of rapidly waning immunity, particularly for the

[17] Effectiveness and durability of protection against future SARS-CoV-2 infection conferred by COVID-19 vaccination and previous infection; findings from the UK SIREN prospective cohort study of healthcare workers March 2020 to September 2021. *medRxiv.* https://www.medrxiv.org/content/10.1101/2021.11.29.21267006v1

[18] Effectiveness of ChAdOx1 nCoV-19 vaccine against SARS-CoV-2 infection during the delta (B.1.617.2) variant surge in India: a test-negative, case-control study and a mechanistic study of post-vaccination immune responses. *The Lancet Infectious Diseases.* https://www.thelancet.com/journals/laninf/article/PIIS1473-3099(21)00680-0/fulltext

[19] Effectiveness of ChAdOx1 nCoV-19 vaccine against SARS-CoV-2 infection during the delta (B.1.617.2) variant surge in India: a test-negative, case-control study and a mechanistic study of post-vaccination immune responses. *The Lancet Infectious Diseases.* https://www.thelancet.com/journals/laninf/article/PIIS1473-3099(21)00680-0/fulltext

[20] Projeto S: A Stepped-Wedge Randomized Trial to Assess CoronaVac Effectiveness in Serrana, Brazil. *SSRN – Preprint*. https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3973422&download=yes

CoronaVac vaccine[21,22,23], these results are quite outdated and may not reflect current vaccine effectiveness. Vaccine effectiveness data covering from April to September 2021 confirm this, as vaccine effectiveness was measured to be **72.0% (95% CI, 69.9-73.9**) against ICU admission and **82.4% (95% CI, 81.0-83.7**) against death[24], demonstrating that CoronaVac is effective at preventing severe COVID-19 related outcomes. Nevertheless, CoronaVac's estimated effectiveness was lower than BNT162b2 (**90.3; 95% CI, 88.8-91.6**) and AZD1222 (**95.6%; 95% CI, 88.3-98.4**) against ICU admission and death (**92.7%** and **95.3%**, respectively)[25]. Likewise, Pfizer-BioNTech's mRNA vaccine demonstrates a higher quantitative efficiency compared to Sinopharm's BBIBP-CorV vaccine; immunoglobulin G (IgG) antibody titres were significantly higher for BNT162b2 (**515.5 BAU/mL; 99.3% of participants had positive IgG titres**) when compared to BBIBP-CorV (**170.0 BAU/mL; 85.7% had positive IgG titres**)[26].

A study that analysed the effect of staff vaccination rates on COVID-19 infections in nursing homes observed that nursing homes with low staff vaccination coverage (those in the lowest vaccination quartile among 12,364 selected nursing homes across the U.S) within counties with high COVID-19 prevalence (highest quartile) had **1.56** (**95% CI, 1.05-2.07**) and **0.19 (95% CI, 0.08-0.30**) COVID-19 cases and COVID-19-related deaths of residents per 100 beds when compared to nursing homes in the same county but had higher vaccination coverage[27]. Among staff, an additional **1.50 (95% CI, 1.06-1.94**) COVID-19 cases per 100 beds were observed. Among nursing

[21] Comparison of an inactivated COVID-19 vaccine-induced antibody response with concurrent natural COVID-19 infection. *International Journal of Infectious Diseases.* https://www.ijidonline.com/article/S1201-9712(21)00768-2/fulltext

[22] China's COVID vaccines have been crucial – now immunity is waning. *Nature News*. https://www.nature.com/articles/d41586-021-02796-w

[23] Limited and short-lasting virus neutralizing titers induced by inactivated SARS-CoV-2 vaccine. *Emerging Infectious Diseases*. https://wwwnc.cdc.gov/eid/article/27/12/21-1772_article

[24] PICK-ing Malaysia's epidemic apart: Effectiveness of a diverse COVID-19 vaccine portfolio. *Vaccines*. https://www.mdpi.com/2076-393X/9/12/1381

[25] PICK-ing Malaysia's epidemic apart: Effectiveness of a diverse COVID-19 vaccine portfolio. *Vaccines*. https://www.mdpi.com/2076-393X/9/12/1381

[26] Pfizer-BioNTech and Sinopharm: A Comparative Study on Post-Vaccination Antibody Titers. *Vaccines.* https://www.mdpi.com/2076-393X/9/11/1223/htm

[27] Nursing home staff vaccination and COVID-19 outcomes. *The New England Journal of Medicine.* https://www.nejm.org/doi/10.1056/NEJMc2115674

homes in counties with low COVID-19 prevalence, there was only a small difference in COVID-19 outcomes between nursing homes with low and high vaccination rates[28].

Booster Dose

The characterisation of the durability of protective immunity continues to be one of the toughest challenges many immunologists and vaccinologists are facing. By now, multiple studies and a great deal of evidence have demonstrated that the immunogenicity of fully vaccinated individuals wanes over time, making the implementation of booster vaccination programs crucial for the restoration of immune protection and the reduction of the burden of disease. This issue has been highlighted after the increasing number of breakthrough infections with the Delta variant and the identification of the worrisome new variant of concern Omicron. Multiple countries have approved and started implementing booster vaccination programs to prioritize risk-groups and older individuals, all while expanding the program to include all individuals. Based on recent studies, homologous booster doses for the BNT162b2 vaccine have shown to be highly effective against infection and hospitalization, while increasing the neutralizing antibody count to **9.34** times higher than the second dose and increasing the IgG antibodies to **33-fold higher** than the second dose in adults older than 60 years[29]. Additionally, a homologous booster dose of BNT162b2 demonstrated to protect against COVID-19 across all age groups by decreasing the rate of confirmed infections by **17.2 (95% CI, 15.4-19.2)** in individuals aged 16-29, by **9.0 (95% CI, 8.4-9.7)** in individuals aged 30-39, by **9.7 (95% CI, 9.2-10.3)** in individuals aged 40-49, by **12.2 (95% CI, 11.4-13.0)** in individuals 50-59, and by **12.3 (95% CI, 11.8-12.8)** in individuals aged 60 and over[30]. Heterologous booster doses have also demonstrated to be safe and effective in preventing infections, as demonstrated in a

[28] Nursing home staff vaccination and COVID-19 outcomes. *The New England Journal of Medicine.* https://www.nejm.org/doi/10.1056/NEJMc2115674

[29] Early Immunogenicity and safety of third dose of BNT162b2 mRNA Covid-19 vaccine among adults older than 60years; real world experience. *The Journal of Infectious Diseases.* https://academic.oup.com/jid/advance-article/doi/10.1093/infdis/jiab584/6446235

[30] Protection against Covid-19 by BNT162b2 Booster across Age Groups. *NEJM.* https://www.nejm.org/doi/full/10.1056/NEJMoa2115926

study examining seven different COVID-19 vaccines used as booster doses in people previously vaccinated with AstraZeneca/Oxford or Pfizer-BioNTech vaccines[31]. Based on the study's results, the administration of the Moderna vaccine as a heterologous booster produced the biggest antibody response, followed by the Pfizer-BioNTech vaccine. Although booster doses are becoming more and more crucial in the ongoing battle against COVID-19, the consideration of the substantial geopolitical and ethical implications of booster vaccination programs remain as many individuals in low-income countries have yet to receive the first jabs of COVID-19 vaccines.

Safety and adverse events

In order to build population trust in the newly introduced COVID-19 vaccines, it is important to collect data on and report on Adverse Events Following Immunization (AEFI). Self-reports of adverse events for all 7 WHO EUL approved vaccines confirm that while systemic vaccine adverse events (VAE) can occur (common symptoms include pain at injection site, headache, fatigue, and muscle pain), they are minor, short lived, and self-resolving[32,33,34,35]. Typically, local and systemic VAE occur at higher rates in women[36,37], younger individuals[38,39,40], and persons with allergy

[31] Safety and immunogenicity of seven COVID-19 vaccines as third dose (booster) following two doses of ChAdOx1 nCov-19 or BNT162b2 in the UK (COV-BOOST): a blinded, multicentre, randomized, controlled, phase 2 trial. *The Lancet.* https://www.thelancet.com/journals/lancet/article/PIIS0140-6736(21)02717-3/fulltext

[32] Adverse events following immunization against SARS-CoV-2 (COVID-19) in the state of Minas Gerais. *Revista de Saúde Pública*. https://www.revistas.usp.br/rsp/article/view/191771/176666

[33] Self-reported adverse events of COVID-19 vaccines in Polish Healthcare workers and medical students. Cross-sectional study and pooled analysis of CoVaST project results in Central Europe. *Journal of Clinical Medicine*. https://www.mdpi.com/2077-0383/10/22/5338

[34] Adverse events report of inactivated COVID-19 vaccine from 4040 healthcare workers. *Postgraduate Medicine.* https://www.tandfonline.com/doi/full/10.1080/00325481.2021.1999708

[35] Self-reported adverse events of COVID-19 vaccines in Polish Healthcare workers and medical students. Cross-sectional study and pooled analysis of CoVaST project results in Central Europe. *Journal of Clinical Medicine*. https://www.mdpi.com/2077-0383/10/22/5338

[36] Adverse events report of inactivated COVID-19 vaccine from 4040 healthcare workers. *Postgraduate Medicine.* https://www.tandfonline.com/doi/full/10.1080/00325481.2021.1999708

[37] Reactogenicity within 2 weeks after mRNA COVID-19 vaccines: Findings from the CDC v-safe surveillance system. *Vaccine.* https://pubmed.ncbi.nlm.nih.gov/34763946/

[38] Adverse events report of inactivated COVID-19 vaccine from 4040 healthcare workers. *Postgraduate Medicine.* https://www.tandfonline.com/doi/full/10.1080/00325481.2021.1999708

[39] Reactogenicity within 2 weeks after mRNA COVID-19 vaccines: Findings from the CDC v-safe surveillance system. *Vaccine.* https://pubmed.ncbi.nlm.nih.gov/34763946/

[40] Evaluation of adverse effects with COVID-19 vaccination in Pakistan. *Pakistan Journal of Medical Sciences*. https://pjms.org.pk/index.php/pjms/article/view/4522

histories[41]. mRNA vaccines were observed to lead to higher rates of short-term adverse events (i.e. pain at injection site), while viral vector based vaccines lead to higher incidences of mild systemic side effects (i.e. fatigue and fever)[42]; a study that compared the adverse events of four COVID-19 vaccines (Pfizer-BioNTech, AstraZeneca, Sinopharm, and Sputnik) in Bahrain reported that the Sinopharm's BBIBP-CorV vaccine recipients reported the mildest side effects[43]. Nevertheless, severe adverse events (SAE) post-COVID-19 vaccination can sometimes occur and it is important to properly report on SAE for their timely recognition, diagnosis, and management[44]. Comparisons across the BNT162b2, ChAdOx1 nCoV-19 and Ad26CoV2.S vaccines demonstrated that recipients of the viral-vector-based vaccines had higher SAE frequencies related to coagulation disorders and arterial, cardiac, and nervous system events than Pfizer-BioNTech's mRNA vaccine[45]. The study is corroborated by an Australian study that demonstrated the possible association between immune thrombocytopenia (ITP) and the AstraZeneca vaccine[46]. When comparing across the two viral vector vaccines, higher rates of SAE were reported in younger individuals who had received ChAdOx1 nCov-19 and among older individuals who had received the Janssen's Ad26CoV2.S[47]. Lastly, we would like to highlight that a severe headache and/ or vaccine-induced thrombocytopenia (VIT) [48], in addition to blurred vision, shortness of breath, chest pain, leg swelling and abdominal pain[49],

[41] Adverse events report of inactivated COVID-19 vaccine from 4040 healthcare workers. *Postgraduate Medicine.* https://www.tandfonline.com/doi/full/10.1080/00325481.2021.1999708

[42] Self-reported adverse events of COVID-19 vaccines in Polish Healthcare workers and medical students. Cross-sectional study and pooled analysis of CoVaST project results in Central Europe. *Journal of Clinical Medicine*. https://www.mdpi.com/2077-0383/10/22/5338

[43] Unfolding the mild to moderate short-term side effects of four COVID-19 vaccines used in Bahrain: A cross-sectional study. *Vaccines.* https://www.mdpi.com/2076-393X/9/11/1369/htm

[44] The Diagnostic Process. *Improving Diagnosis in Health Care*. https://www.ncbi.nlm.nih.gov/books/NBK338593/

[45] Cardiovascular, neurological, and pulmonary events following vaccination with the BNT162b2, ChAdOx1 nCoV-19, and Ad26.COV2.S vaccines: An analysis of European data. *Journal of Autoimmunity.* https://www.sciencedirect.com/science/article/pii/S0896841121001505?via%3Dihub

[46] Immune thrombocytopenia following immunization with Vaxzevria ChadOx1-S (AstraZeneca) vaccine, Victoria, Australia. *Vaccine.* https://www.sciencedirect.com/science/article/pii/S0264410X21013505?via%3Dihub

[47] Cardiovascular, neurological, and pulmonary events following vaccination with the BNT162b2, ChAdOx1 nCoV-19, and Ad26.COV2.S vaccines: An analysis of European data. *Journal of Autoimmunity.* https://www.sciencedirect.com/science/article/pii/S0896841121001505?via%3Dihub

[48] Vaccine-induced thrombocytopenia with severe headache. *The New England Journal of Medicine.* https://www.nejm.org/doi/10.1056/NEJMc2112974

[49] CDC recommends use of Johnson & Johnson's Janssen COVID-19 vaccine resume. *Centers for Disease Control and Prevention.* https://www.cdc.gov/coronavirus/2019-ncov/vaccines/safety/JJUpdate.html#symptoms-list

following either ChAdOx1 nCoV-19 or Ad26CoV2.S may be early signs of vaccine-induced immune thrombotic thrombocytopenia (VITT). Patients presenting with these severe headaches, blurred vision, shortness of breath, chest pain, leg swelling, and persistent abdominal pain should "undergo immediate testing for thrombocytopenia and D-dimer levels and, if available, anti-PF4-heparin IgG antibodies"[50]. Despite incidences of SAEs, we would like to emphasize that the benefits of COVID-19 vaccination far outweigh the risks of developing SAEs following vaccination and adverse events related to SARS-CoV-2 infection[51].

Further (biweekly) updated data on the seven WHO EUL vaccines and the vaccine candidate Novavax are synthesized in the synoptic table and new data has been highlighted in yellow

[50] Vaccine-induced thrombocytopenia with severe headache. *The New England Journal of Medicine.* https://www.nejm.org/doi/10.1056/NEJMc2112974

[51] Adverse effects after BNT162b2 vaccine and SARS-CoV-2 infection, according to age and sex. *The New England Journal of Medicine.* *https://www.nejm.org/doi/full/10.1056/NEJMc2115045*

Synoptic Table

Synoptic table about SARS-CoV-2 vaccines accepted in the WHO's Emergency Use Listing and Novavax Vaccine (as of 15 December 2021)

	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, (Sinopharm, China)	CoronaVac (Sinovac, China)	COVAXIN / BBV152 (Bharat Biotech, India)	AWAITING APPROVAL FROM WHO EUL: Novavax/ NVX-CoV2373
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][i]	2 doses, 21 days apart	2 doses, 14 days apart	2 doses, 28 days apart	2 doses, 21 days apart
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

[i] 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

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)[ii]; EMA (21.12.20); WHO EUL (31.12.20); and list of 112 countries (including Switzerland – approved on 20.12.20)	FDA (18.12.20); EMA (06.01.21); WHO EUL (30.04.21); and list of 79 countries (including Switzerland – approved 12.01.21)	FDA (awaiting on approval); EMA (29.01.21); WHO EUL (15.02.21); and list of 127 countries (Switzerland awaiting on approval)	FDA (27.02.21); EMA (11.03.21), WHO EUL (12.03.21), and list of 85 countries (including Switzerland – approved 22.03.21)	WHO EUL (07.05.21); and list of 72 countries (including Argentina, Bahrain, Brazil, China, Indonesia, United Arab Emirates, Zimbabwe)	WHO EUL (01.06.21), and list of 47 countries (including Albania, Chile, Egypt, Hong Kong, Malaysia, Tunisia, Turkey, Ukraine)	WHO EUL (03.11.21) and list of 12 countries (including Guyana, Inidia, Iran, Mauritius, Mexico, Nepal, Paraguay, Philippines & Zimbabwe)	Waiting on approval (Not-yet-approved by countries or WHO for emergency use)
Booster shot approving authorities	EMA approved booster for those aged 18 and above, 6 months after the 2nd dose[1] FDA approved booster for those ages 16 and above, 6 months after the 2nd dose[iii] Swissmedic approves booster	EMA authorised booster dose for immunocompromised individuals[v] FDA approved third booster dose for individuals >65 and high-risk individuals, 6 months after the 2nd dose[vi] Swissmedic approves booster	-	-	-	-	-	-

[ii] 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

[iii] 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

[v] 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

[vi] 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

	dose for everyone aged 16 and over[iv]	dose for adults aged 18 and over[vii]						
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**	**BBIBP-CorV,**	**CoronaVac**	**COVAXIN / BBV152**	**Novavax/ NVX-CoV2373** (Awaiting approval from WHO EUL)
Effectiveness single dose	*Against any SARS-CoV-2 infection:* **70%**[2]. **77.6%** (95% CI, 70.9-82.7)[3] **36.8%** (95% CI, 33.2-40.2) [3 weeks after first dose][4] **57%** (95% CI, 52-61; Spain) [Apr-Aug][5] **72%** (pooled meta-analysis)[6] **64%** (95% CI, 59%-68%; United	*Against SARS-CoV-2 infection:* **60%** (95% CI, 57-64; >2 weeks after dose)[10].[ix] **88.9%** (95% CI, 78.7-94.2)[3] **66%** (95% CI, 56-73; Spain) [Apr-Aug][5] **69%** (pooled meta-analysis)[6] **64%** (95% CI, 59%-68%; United States) [May to July 2021][7x] **39.6%** (95% CI, 36.3-42.8;	*Against SARS-CoV-2 infection:* **31.4%** (95% CI, 25.7-36.7; Norway) [Jan-Sep][8] *Symptomatic disease:* **67%**[11] **49%** (95% CI, 32.0-62.0; India) [Apr-Jun][12] **41%** (95% CI, 34-48; Spain) [Apr-Aug][5] **51%** (pooled meta-analysis)[6]	*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][13]; **79%** (95% CI, 77-80) (when corrected for under-recording, VE was estimated to be **69%** (95% CI, 67-71)[14].	Partial protection[23].[xiii]	**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[24]. **18.6%** (95% CI, 17.6-19.6) against SARS-CoV-2 infection, **28.1%** (95% CI, 26.3-	*Against symptomatic disease*: **45%** (95% CI,6.0-68.0; India) [Apr-Jun][12] **40%** (95% CI, -21-71; India) less than 7 days after first dose [April-May][26] **1%** (95% CI, -30-25); India) at least 7 days after first dose [April-May][26]	Ongoing studies in South Africa[27] and the United Kingdom[28]

[iv] 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

[vii] 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

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

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

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

	States) [May to July 2021][7viii] **19.6%** (95% CI, 17.3-21.9; Norway) [Jan-Sep][8] *Against symptomatic disease*: **66%** (95% CI, 60-71; Spain) [Apr-Aug][5] *Individuals ≥70:* Symptomatic disease: **58%**[9].	Norway) [Jan-Sep][8] *Against symptomatic disease*: **71%** (95% CI, 61-79; Spain) [Apr-Aug][5] *Individuals ≥70:* Symptomatic disease: **64%** (95% CI, 46-78; >2 weeks after dose)[10].[xi]	**46%** (95% CI, 37-54; Spain) [Apr-Aug][5] *Individuals ≥70:* Symptomatic disease: **58%**[9].	**71%** (95% CI, 56-81) [11 March – 15 August][15]. **61%** (95% CI, 29-84) [January-June][16] **50.9%** (95% CI, 35.1-63.0) [June-September; Brazil][17] **50.0%** (95% CI, 42.0-57.0; Spain) [Apr-Aug][5] **73.6%** (95% CI, 65.9-79.9; US) [Feb-Jul][18] **82.3%** (95% CI, 75.1-87.4%; USA) [16 Dec 2020 to 30 Sep 2021][19xii] *Symptomatic disease*: **54%** (95% CI, 45-62; Spain) [Apr-Aug][5] **81%** (95% CI, 79-84) for preventing hospitalization when corrected for under-recording,		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][25]	**-1%** (95% CI, -51-33; India) at least 21 days after first dose [April-May][26]	

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

				VE was estimated to be **73%** (95% CI, 69-76)[14]. **75%** (95% CI, 65-82) against severe critical COVID-19[20] **66.1%** against moderate to severe-critical COVID-19 cases after 28 days [ENSEMBLE study; Sep 2020-Nov 2021)[21] **85.4%** against severe COVID-19 cases after 28 days [ENSEMBLE study; Sep 2020-Nov 2021)[21] *Individuals ≥50:* 68% (95% CI, 50-79)[22].				
Effectiveness of two doses	*SARS-Cov-2 infection:* **85%**[2].	*SARS-Cov-2 infection:* **100%**[29].	*Asymptomatic efficacy:* 61.9%[39]	Not Applicable (one dose schedule)	Partial protection[23].[xxiii]	**65.9%** for preventing COVID-19; **87.5%**	*Against symptomatic disease*:	Ongoing studies in South Africa[27]

[xxiii] 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

	94.6%[29]. **94.5%**[30]. **76%** (95% CI, 69-81) [Jan-Jul][31]. **88.8%** (95% CI, 84.6-91.8) [Dec 2020-May][3] **74%** (95% CI, 72-76) [Jan-Jun][16] **77.5%** (95% CI, 76.4-78.6) [first month after second dose][4] **47%** (95% CI, 43-51) [5 months after second dose][32] **56%** (95% CI, 53-59) [4 months after second dose][33] **69%** (95% CI, 66-72; Spain) [Apr-Aug][5] **88%** (pooled meta-analysis)[6] **84%** (95% CI, 40-96; Italy) [27 Dec 2020 – 24 Mar 2021] 14-21 days from the first dose and **95%** (95% CI, 62-99; Italy) [27 Dec 2020 – 24	**86%** (95% CI, 81-90.6) [January-July][31]. **96.3%** (95% CI, 91.3-98.4) [December-May][3] **85%** (95% CI, 80-90) [January-June][16] **71%** (95% CI, 68-74) [4 months after second dose][33] **63%** (95% CI, 44-76) [June-August][38] **82%** (95% CI, 78-86; Spain) [Apr-Aug][5] **80%** (pooled meta-analysis)[6] **95%** (95% CI, 93%-96%; United States) [May to July 2021][7xviii]	*SARS-CoV-2 infection*: **53%** (95% CI, 12-84) [January-June][16] **27%** (95% CI, 17-37) [4 months after second dose][33] **88%** (95% CI, 79.0-94.0; India) [Apr-Jun][12] **54.0%** (95% CI, 48-60; Spain) [Apr-Aug][5] **43.4%** (95% CI, 4.4-66.5; Norway) [Jan-Sep][8] **80%** (95% CI; 73-86; India) [May - July 2021][40] **60%** (95% CI, 50-67; Sweden) [27 Dec 2020-2 Nov 2021][35] *Symptomatic disease*: **90%**[11].			for preventing hospitalization; **90.3%** for preventing ICU admission; and **86.3%** for preventing COVID-19 related death[24]. **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][25] *In pregnant women*: **41%** (95% CI, 27.1-52.2%; Brazil) against symptomatic COVID-19, **85%** (95% CI, 59.5-	**71%** (95% CI, 41-85; India) [Apr-Jun][12] *Effectiveness of full vaccination:* **69%** (95% CI; 54-79; India) [May - July 2021][40] **50%** (95% CI, 33-62; India) 14 days after second dose [April-May][26] **47%** (95% CI, 29-61; India) 14 days after second dose – excluding participants with previous SARS-CoV-2 infections [April-May][26] **46%** (95% CI, 22-62; India) 28 days after second dose [April-May][26] **57%** (95% CI, 21-76; India) 42 days after second dose [April-May][26]	and the United Kingdom[28] **89.7%** protection against SARS-CoV-2 infection (95% CI, 80.2-94.6; United Kingdom)[42]

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

	Mar 2021] at least 7 days from the second dose[34] **95%** (95% CI, 93%-96%; United States) [May to July 2021][7xiv] **69.7%** (95% CI, 68.6-70.8; Norway) [Jan-Sep][8] **82.3%** (95% CI, 75.1-87.4%; USA) [16 Dec 2020 to 30 Sep 2021][19xv] **75%** (95% CI, 73-77; Sweden) [27 Dec 2020-2 Nov 2021][35] *Symptomatic disease*: **72%** (95% CI, 69-75; Spain) [Apr-Aug][5] *Asymptomatic SARS-CoV-2 infection:*	**78.2%** (95% CI, 76.7-79.6; Norway) [Jan-Sep][8] **82.3%** (95% CI, 75.1-87.4%; USA) [16 Dec 2020 to 30 Sep 2021][19xix] **85%** (95% CI, 82-87; Sweden) [27 Dec 2020-2 Nov 2021][35] *Symptomatic disease*: **91%** (95% CI, 89-93; >2 weeks after dose)[10].[xx] **85%** (95% CI, 80-89; Spain) [Apr-Aug][5] *Asymptomatic SARS-CoV-2 infection:* **90.6%**[36].[xxi]	**56%** (95% CI, 48-63; Spain) [Apr-Aug][5]			94.8; Brazil) against severe COVID-19, and **75%** (95% CI 27.9-91.2; Brazil)[41]		

[xiv] Results do not disaggregate between mRNA vaccines, BNT162b2 and mRNA-1273.
[xv] Study does not differentiate between Pfizer, Moderna, and Janssen.
[xix] Study does not differentiate between Pfizer, Moderna, and Janssen.
[xx] Results do not disaggregate between BNT162b2 and mRNA-1273.
[xxi] Results do not disaggregate between BNT162b2 and mRNA-1273

	90.6%[36] [xvi] **73.1** (95% CI, 70.3-75.5)[4] *Hospitalization:* **85%** (95% CI, 73-93) [January-July][31]. **88%** (95% CI, 85-91) [11 March – 15 August][15]. **89%** (95% CI, 87-91) for individuals ≥50 years [1 January-22 June[22]. [xvii] **90%** (95% CI, 89-92) [Dec 2020 – Aug 2021][32] *Individuals ≥65:* **61%** (95% CI, 57-65) against SARS-CoV-2 infection and **86%** (95% CI, 82-88) against hospitalizations[32] *Individuals ≥ 80:* VE of **68.3%** (95% CI, 65.5-70.9) for	**71%** (95% CI, 61-78) [January-August][38] *Hospitalization:* **91.6%** (95% CI, 81-97) [January-July][31]. **93%** (95% CI, 91-95) [11 March – 15 August)[15]. **89%** (95% CI, 87-91) for individuals ≥50 years [1 January-22 June[22]. [xxii]							

[xvi] Results do not disaggregate between BNT162b2 and mRNA-1273
[xvii] mRNA-aggregated data (results do not disaggregate between BNT162b2 and mRNA-1273).
[xxii] mRNA-aggregated data (results do not disaggregate between BNT162b2 and mRNA-1273).

	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][37]							
	EFFECTIVENESS AGAINST VARIANTS[xxiv]							
	BNT162b2/ COMIRNATY	**Spikevax/ Moderna COVID-19 Vaccine/ mRNA-1273**	**Vaxzevria/ ChAdOx1 nCoV-19/ AZD1222/ Covishield**	**Janssen COVID-19 vaccine/Johnson & Johnson**	**BBIBP-CorV,**	**CoronaVac**	**COVAXIN / BBV152**	**Novavax/ NVX-CoV2373** (Awaiting approval from WHO EUL)
Alpha (B.1.1.7)	*Single dose:* **48.7%** (95% CI, 45.5 to 51.7)[43] **66%** (95% CI,64-68)[44]. **54.5%** (95 CI, 50.4-58.3)[45] *Two doses:* **93.7%** (95% CI, 91.6 to 95.3)[43] **92%** (95% CI, 90-93)[46]. **89%** (95% CI, 86-91)[44]. **78%** (95% CI, 68-84)[47]	*Single dose:* **88.1%** (95% CI, 83.7 to 91.5)[48] **83%** (95% CI, 80-86)[44]. *Two doses:* **100%** (95% CI, 91.8 to 100)[48] **92%** (95% CI, 86-96)[44]. **98.4%** (95% CI, 96.9-99.1)[49]	*Single dose:* **48.7%** (95% CI 45.5 to 51.7)[43] 6**4%** (95% CI, 60-68)[44]. *Two doses:* **74.5%** (95% CI, 68.4 to 79.4)[43] **73%** (95% CI, 66-78)[46]. 79% (95% CI, 56-90)[47].	-	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[27] and the United Kingdom[28] Post hoc analysis showed efficacy of **86.3%** (95% CI, 71.3-93.5; United Kingdom) **against B.1.1.7 variants** and **96.4%** (95% CI, 73.8-99.5; United Kingdom) **against non-**

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

	84.4% (95 CI, 81.8-86.5)[45]							**B.1.1.7 variants.**[42]
Beta (1.351)	*Against SARS-CoV-2 infection:* *Single dose:* **60%** (95% CI, 52-67)[44]. *Two doses:* **84%** (95% CI, 69-92)[44]. **72%** (95% CI, -5-97; Israel) [Dec 2020-Mar 2021][50] *Against symptomatic infection:* **100%** (95% CI, 19-100; Israel) [Dec 2020-Mar 2021][50]	*Single dose:* **61.3%** (95% CI, 56.5 to 65.5)[48] **77%** (95% CI, 69-92)[44]. *Two doses:* **96.4%** (95% CI, 91.9 to 98.7)[48]	*Single dose:* **48%** (95% CI, 28-63)[44].	-	No published data	Neutralization capacity was decreased by factor **5.27**[51].	No available data	No available data
Gamma (P.1)	Neutralization activity reduced by **3.3-fold**[52].	No available data	No available data	No available data	No published data	Demonstrated **42%** vaccine effectiveness in a setting with high P.1 transmission, in individuals aged 70 and above[53]. **50.2%** against P.1 (>14 days after 2nd dose)[54].	No available data	No available data

						Neutralization was decreased by factor **3.92**[51]. *Against symptomatic COVID-19:* **80.5%** (95% CI, 75.1-84.7)[55]		
Delta (1.617.2)	*Single dose:* **30.7%** (95% CI, 25.2 to 35.7)[43]; **57%** (95% CI, 50-63)[47] **22.5%** (95 CI, 17.0-27.4)[45] **22%** (95% CI, 10-32; France) [May-August 2021][56] *Two doses:* **88.0%** (95% CI, 85.3 to 90.1)[43]; **80%** (95% CI, 77-83)[47] **79%** (95% CI,75-82)[46]. **80%** (95% CI, 77-83)[47] **40.5%** (95% CI, 8.7-61.2)[57].	*Single dose:* **72%** effective against symptomatic SARS-Cov-2 infection[61]. *≥14 days after second dose:* **76%** (95% CI, 58-87)[31]. **94.5%** (95% CI, 94.1-95) [2-9 weeks after second dose][58]. **50.6%** (95% CI, 45.0-55.7) [among nursing home residents][59]. **86.7%** (95% CI, 84.3-88.7)[49]	*Single dose:* **30.7%** (95% CI 25.2 to 35.7)[43] **73%** (95% CI, 64-80; India) [May – July 2021][40] *Two doses:* **67.0%** (95% CI, 61.3 to 71.8)[43] **67%** (95% CI, 62-71)[47]. **60%** (95% CI, 53-66)[46]. **66.7%** (95% CI, 45-49.6) [2-9 weeks after second dose][58]. **47.3%** (95% CI, 66.3-67.0) [≥20 weeks after second dose][58].	**78%** (95% CI, 73-82) against SARS-CoV-2 infection[14]. **3%** (95% CI, -7-12) [August][60] **76.5%** (95% CI, 40.9-90.6; USA) [01 Jul 2021 to 30 Sep 2021][19xxvii] *Individuals ≥50:* **83% (**95% CI, 81-85)[14]	No available data	*Single dose:* **13.8%** (95% CI, -60.2-54.8)[64]. *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[64].	*Single dose*: **44%** (95% CI, 0-71; India) [May – July 2021][40] *Two doses:* **64%** (95% CI, 40-79; India) [May – July 2021][40]	No available data

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

	42% (95% CI, 13-62)[31]. **89.8%** (95% CI, 89.6-90.0) [2-9 weeks after second dose][58]. **69.7%** (95% CI, 68.7-70.5) [≥20 weeks after second dose][58]. **64.6%** (95 CI, 60.6-68.2)[45] **52.4%** (95% CI, 48.0-56.4) [among nursing home residents][59]. **53%** (95% CI, 39-65) [4 months after second dose][32] **50%** (95% CI, 47-52) [August; elderly Veteran population][60] **76.5%** (95% CI, 40.9-90.6; USA) [01 Jul 2021 to 30 Sep 2021][19xxv] **67%** (95% CI, 63-71; France) [May-August 2021][56]	**56.6%** (95% CI, 42.0-67.5) *against infection*[62] **84.2%** (95% CI, 56.4-94.3) *against symptomatic infection*[62] **64%** (95% CI, 62-66) [August; elderly Veteran population][60] **76.5%** (95% CI, 40.9-90.6; USA) [01 Jul 2021 to 30 Sep 2021][19xxvi] *10-14 weeks after second dose:* **90.3%** (95% CI, 67.2-97.1)[58].	**81%** (95% CI, 71-88; India) [May – July 2021][40] 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 [63].					

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

	Against severe COVID-19: **91.4%** (95% CI, 82.5-95.7)[57].							
Mu (B.1.621)	Mu variant is 9.1 times more resistant than the wild type strain when vaccinated with BNT162b2[65]	*Two doses:* **90.4%** (95% CI, 73.9-96.5)[49] (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[66] If assuming a 25-fold decrease in pseudovirus neutralization **66%** (95% CI, 42-86)[67]	No available data	No protective effect of vaccination against symptomatic disease with Omicron from 15 weeks after the second dose[66]					
	EFFECTIVENESS AGAINST HOSPITALIZATION							
	BNT162b2/ COMIRNATY	**Spikevax/ Moderna COVID-**	**Vaxzevria/ ChAdOx1 nCoV-**	**Janssen COVID-19**	**BBIBP-CorV,**	**CoronaVac**	**COVAXIN / BBV152**	**Novavax/ NVX-CoV2373**

		19 Vaccine/ mRNA-1273	**19/ AZD1222/ Covishield**	**vaccine/Johnson & Johnson**				(Awaiting approval from WHO EUL)
Any SARS-CoV-2 infection	*Single dose:* **85%** (pooled meta-analysis)[6] Hospitalization risk reduced by 35-**45%**[9]. Risk of death reduced by **54%**[9]. *Individuals ≥50:* ≥14 days after first dose: **54%** (95% CI, 47-61) [1 Jan-22 Jun[22].[xxviii] *Two doses:* **91%** (pooled meta-analysis)[6] **91%** (95% CI, 93%-96%; United States) [May to July 2021][7xxix] **89%** (95% CI, 84-93; Sweden) [27 Dec 2020-2 Nov 2021][35]	*Single dose:* **73%** (pooled meta-analysis)[6] *Individuals ≥50:* ≥14 days after first dose: **54%** (95% CI, 47-61) [1 Jan-22 Jun[22].[xxx] *Two doses:* **88%** (pooled meta-analysis)[6] **91%** (95% CI, 93%-96%; United States) [May to July 2021][7xxxi] **79%** (95% CI, 60-89; Sweden) [27 Dec 2020-2 Nov 2021][35]	*Single dose:* **56%** (pooled meta-analysis)[6] Hospitalization risk reduced by **35-45%**[9]. *Two doses:* **91%** (pooled meta-analysis)[6] **92%** (95% CI, 80-97; Sweden) [27 Dec 2020-2 Nov 2021][35] *Against ICU admission*: **95.6%** (95% CI, 88.3-98.4; Malaysia) [Apr-Sep 2021][68] *Against death:* **95.3%** (95% CI, 91.3-97.4;	No available data	No available data	*Against ICU admission*: **72.0%** (95% CI, 69.9-73.9; Malaysia) [Apr-Sep 2021][68] *Against death:* **82.4%** (95% CI, 81.0-83.7; Malaysia) [Apr-Sep 2021][68]	No available data	No available data

[xxviii] mRNA-aggregated data (results do not disaggregate between BNT162b2 and mRNA-1273).
[xxix] Results do not disaggregate between mRNA vaccines, BNT162b2 and mRNA-1273.
[xxx] mRNA-aggregated data (results do not disaggregate between BNT162b2 and mRNA-1273).
[xxxi] Results do not disaggregate between mRNA vaccines, BNT162b2 and mRNA-1273.

	Against ICU admission: **90.3%** (95% CI, 88.8-91.6; Malaysia) [Apr-Sep 2021][68] *Against death:* **92.7%** (95% CI, 91.7-93.6; Malaysia) [Apr-Sep 2021][68]		Malaysia) [Apr-Sep 2021][68]					
Alpha	Single dose: **83%** (95% CI, 62-93) **53%** (95% CI, 7-83; England) [Feb-Sep 2021][69] Two doses: **95%** (95% CI, 78-99)[70]. **71%** (95% CI, 12-95; England) [Feb-Sep 2021][69] *Against death:* **98.2%** (95% CI, 95.9-99.2) [2-9 weeks][58]. **90.4%** (95% CI, 85.1-93.8) [≥20 weeks][58].	No available data	Single dose: **76%** (95% CI, 61-85) **3%** (95% CI, -38 – 39; England) [Feb-Sep 2021][69] Two doses: **86%** (95% CI, 53-96)[70]. **26%** (95% CI, -39 – 73; England) [Feb-Sep 2021][69] *Against death:* **94.1%** (95% CI, 91.8-95.8) [2-9 weeks][58]. **78.7%** (95% CI, 52.1-90.4) [≥20 weeks][58].	***Beta*** **67%** effective at preventing hospitalizations[71]. *Against death:* 96% effective at preventing death[71].	No available data	No available data	No available data	No available data
Gamma	No available data	No available data	No available data	**72.9%** (95% CI, 35.1-91.1)[17]	No available data	*Against hospitalization:*	No available data	No available data

				Against ICU admission: **92.5%** (95% CI, 54.9-99.6)[17] *Against death:* **90.5%** (95% CI, 31.5-99.6)[17]		**95%** (95% CI, 86.9-98.1)[55] *Against death:* **94.9%** (95% CI, 76.4-98.9)[55]		
Delta	*Single dose:* **94%** (95% CI, 46-99)[70]. **91%** (95% CI, 90-93)[72] **4%** (95% CI, -21 – 44; England) [Feb-Sep 2021][69] *Two doses*: **96%** (95% CI, 86-99)[70]. **88%** (95% CI, 78.9-93.2)[57]. **75%** (95% CI, 24-93.9)[31]. **84%** (95% CI, 79-89)[73]. **98.4%** (95% CI, 97.9-98.8) [2-9 weeks][58].	*Single dose:* **81%** (95% CI, 81-90.6)[31]. *Two doses:* **84%** (95% CI, 80-87)[72] **95%** (95% CI, 92-97) [Jun-Aug 2021][74] **96.7%** (95% CI, 93.9-98.2)[8] **97.3%** (95% CI, 95.9-98.4; New York) [Aug 2021][76] *Individuals ≥65:* **93.7%** (95% CI, 92.9-94.4; New York) [Aug 2021][76]	*Single dose*: **71%** (95% CI, 51-83)[70] **88%** (95% CI, 83-91)[72] **2%** (95% CI, -19 – 31; England) [Feb-Sep 2021][69] *Two doses*: **92%** (95% CI, 75-97)[70]. **95.2%** (95% CI, 94.6-95.6) [2-9 weeks][58]. **77.0%** (95% CI, 70.3-82.3) [≥20 weeks][58]. **94%** (95% CI, 92-95)[72]	**71%** [71] **85%** (95% CI, 73-91)[14]. **91%** (95% CI, 88-94)[72] **93.5%** (95% CI, 89.6-96.1; New York) [Aug 2021][76] **85%** effective at preventing severe disease and hospitalization[81]. *Individuals ≥50:* **84% (**95% CI, 81-85)[14]	*Single dose:* Does not offer clinically meaningful protection against severe illness [82,xxxii] *Two doses:* **88%** (95% CI, 55-98) adjusted risk reduction in developing severe illness.[82,xxxiii]	*Single dose:* Does not offer clinically meaningful protection against severe illness [82,xxxiv] *Two doses:* **88%** (95% CI, 55-98) adjusted risk reduction in developing severe illness.[82,xxxv]	No available data	No available data

[xxxii] Study does not differentiate between the two inactivated vaccines, BBIBP-CorV and CoronaVac.
[xxxiii] Study does not differentiate between the two inactivated vaccines, BBIBP-CorV and CoronaVac.
[xxxiv] Study does not differentiate between the two inactivated vaccines, BBIBP-CorV and CoronaVac.
[xxxv] Study does not differentiate between the two inactivated vaccines, BBIBP-CorV and CoronaVac.

	92.7% (95% CI, 90.3-94.6) [≥20 weeks][58]. **96%** (95% CI, 95-96)[72] **80%** (95% CI, 73-85) [June-August][74] **93%** (95% CI, 84-96)[75] **96.8%** (95% CI, 93.9-98.3)[2 months after the second dose][4] **93%** (95% CI, 84-96)[32] **91.5%** (95% CI, 89.5-93.2)[8] **24%** (95% CI, -2 – 64; England) [Feb-Sep 2021][69] **95.2%** (95% CI, 93.6-96.5; New York) [Aug 2021][76] *Individuals ≥65:* **88.6%** (95% CI, 87.4-89.6; New York) [Aug 2021][76] *Against death:* **90%** (95% CI, 83-94) [≥2 weeks after second dose][77] *All ages:* **90%** (95% CI, 83-94)[78]	*Against ICU admission:* **86%** (95% CI, 79-90)[72] **96%** against severe COVID-19 infection[61]. Estimated risk of SARS-CoV-2 infection is **4.52 events per 1000** persons (95% CI, 4.17-4.84)[79]	**14%** (95% CI, -5 – 46; England) [Feb-Sep 2021][69] **63.1%** (95% CI, 51.5-72.1; India) (Apr – May 2021)[80] *Against moderate to severe disease:* **81.5%** (95% CI, 9.9-99.0; India) (Apr – May 2021)[80] *Against ICU admission:* *Single dose:* **92%** (95% CI, 84-96)[72] *Two doses*: **96%** (95% CI, 94-98)[72] *Against death:* **91%** (95% CI, 86-94) [≥2 weeks after second dose][77] *All ages:* **91%** (95% CI, 86-94)[78] *40-59*: **88%** (95% CI, 76-93)[78] *60+:* **90%** (95% CI, 84-94)[78]	*Individuals ≥65:* **81.8%** (95% CI, 77.8-85.3; New York) [Aug 2021][76] *Against ICU admission:* **94%** (95% CI, 88-98)[72]				

	40-59: **95%** (95% CI, 79-99)[78] *60+*: **87%** (95% CI, 77-93)[78] Estimated risk of SARS-CoV-2 infection is **5.75 events per 1000** persons (95% CI, 5.39-6.23)[79]							
Omicron	Estimated VE against hospitalization **4 to 5-fold increased** compared to Delta[83]* **84.9%** (95% CI, 83.0-86.6) against Omicron variant for recently vaccinated Pfizer[83] *No differention between mRNA vaccines	Estimated VE against hospitalization **4 to 5-fold increased** compared to Delta[83]* *No differention between mRNA vaccines						
DURATION OF PROTECTION, TRANSMISSION & BREAKTHROUGH INFECTIONS								
	BNT162b2/ COMIRNATY	**Spikevax/ Moderna COVID-19 Vaccine/ mRNA-1273**	**Vaxzevria/ ChAdOx1 nCoV-19/ AZD1222/ Covishield**	**Janssen COVID-19 vaccine/Johnson & Johnson**	**BBIBP-CorV,**	**CoronaVac**	**COVAXIN / BBV152**	**Novavax/ NVX-CoV2373** (Awaiting approval from WHO EUL)

Duration of protection (antibodies)	Median time between second dose and infection: **146 days (IQR, 121-167)**[84] *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)**[85] No health worker had antibodies BELOW method-dependent cut-off (0.8 KU/L) *Neutralizing antibodies:* At peak immunity, NAb titre was **1,789**, after 8 months titre was **53**[86] *Pseudovirus neutralizing antibodies:*	*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[89] *Neutralizing antibodies:* At peak immunity, NAb titre was **5,848**, after 8 months titre was **133**[86] *Pseudovirus neutralizing antibodies:* At peak immunity, pseudovirus NAb titre was **1,569**, after 8 months titre was **273**[86] *Anti-spike Protein RBD IgG Antibodies:* At peak immunity, RBD titre was **25,677**, after 8 months titre was **1,546**[86]	*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)[90] *Cellular Immune Response:* **Day 182** after first dose: median of **237 SFUx10^6 PBMC (IQR, 109-520)**[90] **6 months** after second dose: **(median 1240, IQR 432-2002**) in groups with 15-25 week interval between doses[90] *Anti-spike Protein RBD IgG Antibodies:*	*Neutralizing antibodies:* Remained largely stable for **8-9 months**[91] Remained **stable for 8 months**; At 4 weeks after immunization NAb titre was **146**, after 8 months titre was **629**[86] *Pseudovirus neutralizing antibodies:* Remained **stable for 8 months**; At 4 weeks after immunization pseudovirus NAb titre was **391**, after 8 months titre was **185**[86] *Binding antibodies:* Remained stable **6 months** irrespective of age group[91] *Humoral & Cellular Immune Response:*	*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)[93] **Exposed subjects:** Before 1st dose: **203.2 UI/mL** (95% CI: 42.9-962.4) After 1st dose: **761.7 UI/mL** (95% CI: 381.1-1522) After 2nd dose: **719.9 UI/mL** (95% CI : 264.6-1959) 3 months after 2nd dose: **484.4 IU/mL** (95% CI: 147.3-1593)[93] *Anti-RBD IgG*: Decreased up to **41.8%** 2 months after second dose and dropped to	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[95]. **80-90%** of anti-S IgG and Nab titers against wild type waned **6 months** after second vaccination[96] *Anti-spike Protein RBD IgG Antibodies:* **Younger age groups (<60):** 1 month after 2nd dose: 97% seropositivity, **11.3** (IQR, 6.2-20.7) 3 months after 2nd dose: 76% seropositivity, **2.4** (IQR, 1.0-5.0)[87] **Older age groups (≥60)**: 1 month after 2nd dose: 88% seropositivity, **6.4** (IQR, 2.5-13.6)	No available data	No available data

	At peak immunity, pseudovirus NAb titre was **700**, after 8 months titre was **160**[86] *Anti-spike Protein RBD IgG Antibodies:* At peak immunity, RBD titre was **21,564**, after 8 months titre was **755**[86] **Younger age groups (<60):** 1 month after 2nd dose: 100% seropositivity, **35.3** (IQR, 27.6-40.0) 3 months after 2nd dose: 100% seropositivity, **19.2** (IQR, 8.2-23.1)[87] **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)[87]	*Humoral & Cellular Immune Response:* CD8+ T cell response was **0.017%** 8 months after full vaccination[86]	**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)[87] **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)[87]	Antibody responses were detected in all vaccine recipients on **day 239** (stable response for at least 8 months)[92] CD8+ T cell response was **0.12%** 8 months after vaccination[86] *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**[86]	**42.9%** decrease after 7 months[94] *Binding Antibodies:* Decreased **82.1%** 7 months after second dose[94]	3 months after 2nd dose: 60% seropositivity, **1.3** (IQR, 0.5-3.3)[87]		

	Sub-populations: **Older age (≥65):** **38%** to **42%** decrease of humoral antibodies compared to 18- to 45-year-old[88] **Older age (≥65) AND men:** **37%** to **46%** decrease compared to 18- to 45-year-old women[88] **Immunosuppression:** **65% to 70%** decrease compared to non-immunosuppressed[88] **Obesity (BMI ≥30):** **31%** increase in neutralizing antibody compared with nonobese[88] *Humoral & Cellular Immune Response:*								

	CD8+ T cell response was **0.016%** 8 months after full vaccination[86]							
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[97] VE reduced from **87%** (95% CI, 85-89) to **56%** (95% CI, 53-59) after 4 months.[33] VE reduced from **91%** (95% CI, 91-92) in March to **50%** (95% CI, 47-52) in August[60] 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.[103] **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.[103] VE against the Delta variant declined from **94.1%** (95% CI,	VE reduced by 7% (95% CI, -18 - 2) for every 30 days from the second dose for those aged 18 to 64 years[47]. VE reduced from **58%** (95% CI, 51-65) to **27%** (95% CI, 17-37) after 4 months.[33] VE reduced from **88%** (95% CI, 87-89) in March to **3%** (95% CI, -7-12) in August[60] 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[14]. VE decreased from **89.4%** in May to **51.7%** in July[38] 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[101] VE decreased by **18.5% points** (95% CI 8.4-33.4) among all ages and **19.9% points** among older	No available data	No available data	No available data	No available data

	States) [May to August][98xxxvi] 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][99xxxvii] 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[76]. *Against symptomatic COVID-19:* VE decreased by **25.4%** (95% CI,	90.5-96.3) 14-60 days after vaccination to **80.0%** (95% CI, 70.2-86.6) 151-180 days after vaccination.[49] **91%** [January-March] **71%** (95% CI, 53-83) [April-May] **63%** (95% CI, 44-76)[38] VE reduced from **90%** (95% CI, 88-91) to **71%** (95% CI, 68-74) after 4 months[33] 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[38]	Review and Meta-Regression][99xlvi] 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[76] *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][99xlvii] **50%** (95% CI, 16-69)14-73 days after second dose.	individuals (95% CI; 9.2-36.7) [Overall average from Systematic Review and Meta-Regression][99xlix] 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[76]. *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				

[xxxvi] Study does not differentiate between the two mRNA vaccines, Pfizer and Moderna.
[xxxvii] Study does not differentiate between Pfizer/BioNTech-Comirnaty, Moderna-mRNA-1273, Janssen-Ad26.COV2.S and AstraZeneca-Vaxrevria.
[xlvi] Study does not differentiate between Pfizer/BioNTech-Comirnaty, Moderna-mRNA-1273, Janssen-Ad26.COV2.S and AstraZeneca-Vaxrevria.
[xlvii] Study does not differentiate between Pfizer/BioNTech-Comirnaty, Moderna-mRNA-1273, Janssen-Ad26.COV2.S and AstraZeneca-Vaxrevria.
[xlix] Study does not differentiate between Pfizer/BioNTech-Comirnaty, Moderna-mRNA-1273, Janssen-Ad26.COV2.S and AstraZeneca-Vaxrevria.

	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[99xxxviii] VE reduced by 22% (95% CI, 6-41) for every 30 days from the second dose for those aged 18 to 64 years[47]. 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	VE reduced from **92%** (95% CI, 92-93) in March to **64%** (95% CI, 62-66) in August[60] 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][100xli] 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[101]	Effectiveness did not fall significantly after longer intervals, however this could be influenced by the study's small number of participants[102] *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][99xlviii]	Review and Meta-Regression][99l] *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][99li]				

[xxxviii] Study does not differentiate between Pfizer/BioNTech-Comirnaty, Moderna-mRNA-1273, Janssen-Ad26.COV2.S and AstraZeneca-Vaxrevria.
[xli] Study does not differentiate between COMIRNATY/BNT162b2 and SPIKEVAX/ mRNA-1273.
[xlviii] Study does not differentiate between Pfizer/BioNTech-Comirnaty, Moderna-mRNA-1273, Janssen-Ad26.COV2.S and AstraZeneca-Vaxrevria.
[l] Study does not differentiate between Pfizer/BioNTech-Comirnaty, Moderna-mRNA-1273, Janssen-Ad26.COV2.S and AstraZeneca-Vaxrevria.
[li] Study does not differentiate between Pfizer/BioNTech-Comirnaty, Moderna-mRNA-1273, Janssen-Ad26.COV2.S and AstraZeneca-Vaxrevria.

	Oct 2021; Finland][100xxxix] 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[101] 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].[102] VE declined from **86%** (95% CI, 73-93) 14-73 days	VE reduced from **89.0%** (95% CI, 84.6-92.1; United States) [May to August] to **62.7%** (95% CI, 62.4-63.1; United States) [May to August][98xlii] 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][99xliii] 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[76].							

[xxxix] Study does not differentiate between COMIRNATY/BNT162b2 and SPIKEVAX/ mRNA-1273.
[xlii] Study does not differentiate between the two mRNA vaccines, Pfizer and Moderna.
[xliii] Study does not differentiate between Pfizer/BioNTech-Comirnaty, Moderna-mRNA-1273, Janssen-Ad26.COV2.S and AstraZeneca-Vaxrevria.

	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][102] *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][99xl] *Against Hospitalization and Death:* After reaching peak VE (96.8%) 2 months after 2nd dose, **VE did not decline over**	*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)][99xliv] *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][99xlv]							

[xl] Study does not differentiate between Pfizer/BioNTech-Comirnaty, Moderna-mRNA-1273, Janssen-Ad26.COV2.S and AstraZeneca-Vaxrevria.
[xliv] Study does not differentiate between Pfizer/BioNTech-Comirnaty, Moderna-mRNA-1273, Janssen-Ad26.COV2.S and AstraZeneca-Vaxrevria.
[xlv] 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[97]							
Transmission prevention	*Prior Delta Variant:* Vaccine effectiveness against infectiousness given infections **41.3%**[104] VE against transmission **88.5%**[104] VE against onwards transmission of Alpha **57% (95% CI, 5-85)**[69] *During Delta Variant:* Similar Ct values (<25) were found in both vaccinated and unvaccinated groups[105]	VE against onwards transmission: **52%** (95% CI, 33-69)[16] 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. [108liii]	**48%** (limited data) May not be able to block the transmission of the alpha variant as efficiently as the wild type[109]. 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. [108liv] Evidence of fully vaccinated individuals infecting other fully vaccinated individuals[110]	Limited data	Unknown	Unknown	No available data	No available data

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

	Studies from Scotland and England demonstrated reductions in secondary infections among families of vaccinated individuals compared to families of unvaccinated individuals[106,107]. VE against onwards transmission: **62%** (95% CI, 57-67)[16] 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. [108lii] VE against onwards		81 breakthrough infections among 1100 HCWs; 32 breakthrough infections among 4000 HCWs[110] VE against onwards transmission of Alpha **35% (95% CI, -26 – 74**)[69] VE against onwards transmission of Delta **42% (95% CI, 14-69**)[69]						

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

	transmission of Delta **31% (95% CI, -3 – 61**)[69] VE against infection [within a ten-day window] when having a confirmed household exposure **80.4%** (95% CI, 73.6-85.5)[56] 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][56]							
Breakthrough infections	From 6,161 patients with a positive nasopharyngeal SARS-CoV-2 PCR, 1,120 (18%) were breakthrough	From 6,161 patients with a positive nasopharyngeal SARS-CoV-2 PCR, 1,120 (18%) were	As of 10 June, 1.5 million individuals have been fully vaccinated with Covishield in Odisha Province, India. Between 1	From 6,161 patients with a positive nasopharyngeal SARS-CoV-2 PCR, 1,120 (18%) were	No available data	No available data	As of 10 June, 380,000 individuals have been fully vaccinated with Covaxin in Odisha Province, India.	No available data

	infections – 97% of these occurred after 2 May (emergence of Delta variant). Of the 1,120 cases, 126 (12%) were hospitalized. Of the 126 breakthrough admissions, 59 were vaccinated with BNT162b2[111]. 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[112] Breakthrough infections remained under 1% for fully vaccinated individuals (no	breakthrough infections – 97% of these occurred after 2 May (emergence of Delta variant). Of the 1,120 cases, 126 (12%) were hospitalized. Of the 126 breakthrough admissions, 36 were vaccinated with mRNA-1273. Breakthrough infections remained under 1% for fully vaccinated individuals (no difference between Pfizer or Moderna recipients between May and August 2021.[98]	March to 10 June, 239 breakthrough infections (SARS-CoV-2 positive after having received two doses of Covishield) were identified. Of these, 199 (83.3%) were symptomatic, 24 (10.0%) were hospitalized - 59 individuals had comorbidities[114] Median antibody titer: 647.5 AU/ml[114] <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	breakthrough infections – 97% of these occurred after 2 May (emergence of Delta variant). Of the 1,120 cases, 126 (12%) were hospitalized. Of the 126 breakthrough admissions, 10 were vaccinated with Ad26.COV2.S[111]. **4.2%** of fully vaccinated HCWs developed breakthrough infections – all cases were symptomatic but mild, only one case required hospitalization[lv] [116] Rate of breakthrough infections was comparable to Pfizer and Moderna			Between 1 March to 10 June, 35 breakthrough infections (SARS-CoV-2 positive after having received two doses of Covishield) were identified. Of these, 29 (82.9%) were symptomatic, 3 (8.6%) were hospitalized. 5 individuals had comorbidities[114] Median antibody titer: 213.5 AU/ml[114] **4.2%** of fully vaccinated HCWs developed breakthrough infections – all cases were symptomatic but mild, only one case required hospitalization [lvi] [116]	

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

	difference between Pfizer or Moderna recipients between May and August 2021.[98] *Omicron (B.1.1529):* Breakthrough cases described symptoms as mild or moderate, had viral loads ranging from 15,011.2 to over 40,000 AU.mL[113]		were higher than that of asymptomatic cases (IQR: 16.5 log10/mL vs 30.8 log10/mL, respectively). NAbs were measured for 10 breakthrough cases, all 10 cases had lower NAbs at day 14 and 90 post second vaccination compared to controls[115]	recipients during the initial stages of the study, but increased to 1.96% (2 times the breakthrough rate of mRNA vaccines).[98]				
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**	**BBIBP-CorV,**	**CoronaVac**	**COVAXIN / BBV152**	**Novavax/ NVX-CoV2373** (Awaiting approval from WHO EUL)
Common side effects	Pain at the injection site, fatigue, headache, myalgia, chills and fever[117], arthralgia[118] Optimal safety for asthma patients[119].	Pain at injection site, headache, fatigue, myalgia, arthralgia[121], Covid arm (cutaneous hypersensitivity)[122] .	Fatigue, myalgia, arthralgia, headache[123], lethargy, fever, & nausea[124].	Headache, fever, chills, fatigue, myalgia, and nausea[125].	Pain at the injection site, dizziness, fever, headache, fatigue, nausea, vomiting, & allergic dermatitis[124,126].	Pain at injection site, headache, fatigue, tremors, & flushing[127], inflammatory reaction, urticaria[128], myalgia[129]	Pain at injection site, headache, pyrexia, fatigue, myalgia[130]	Pain at injection-site, headache, muscle pain, fatigue[42]

	The vaccine is considered safe for cancer patients undergoing treatments[120].	The vaccine is considered safe for cancer patients undergoing treatments[120].						
Rare adverse events	Myocarditis & myopericarditis[131-133], anaphylaxis and swelling of the lips, face, and tongue related to anaphylaxis[134] (11 anaphylaxis cases per million doses administered)[135], axillary aadenopathy, paroxysmal ventricular arrhythmia, leg paresthesia[136], pityriasis rosea[137] (lesions improved completely after ~8 weeks)[138], lymphocytic vasculitis[139], varicella-zoster reactivation [140-142], Kikuchi-Fujimoto disease[143],	Myocarditis & myopericarditis [131-133], orofacial swelling & anaphylaxis[134]. Potential risk factor for Bell's palsy[154] (most improve upon follow-up)[183], herpes zoster reactivation[141], varicella zoster reactivation[141], herpes zoster ophtalmicus[184], eczema & urticaria[185], transverse myelitis[186], Guillain-Barré syndrome[187,188], acute generalized exanthematous pustulosis[189], rhabdomyolysis[190],	Transverse myelitis, high fever[123,198], cutaneous hypersensitivity[198], vasculitis[199], thromboembolism[200], vaccine induced immune thrombotic thrombocytopenia[201, 202-204], intracerebral haemorrhage[205], small vessel vasculitis[202-204], psoriasis[206], rosacea, raynaud's phenomenon[185], Ischaemic stroke[207], anaphylaxis[208], recurrent herpes zoster[209,lvii], generalized	Thrombosis, thrombocytopenia[230],increased risk of developing Guillain-Barré syndrome post vaccination[231], herpes zoster ophtalmicus[184], pseudothrombocytopenia[232], vaccine induced thrombocytopic thrombosis[233], cutaneous reactions[173], optic neuritis[234], subacute thyroiditis[235] 97% of reported reactions after vaccine administration were non-serious[125].	Cutaneous reactions[173] Rare adverse events were similar among the vaccine groups and control group within 7 days[236]. Pityriasis rosea[237], uveitis[238]	Myalgia, fever[127], pityriasis rosea (lesions improved completely after ~8 weeks)[138], reactivation of herpes zoster and herpes simplex[128]. Most reactions improved without treatment within a few weeks[128], Guillain-Barré syndrome[239], subacute thyroiditis[240], erythema multiforme[241], uveitis[238], vaccine induced thrombotic thrombocytopenia[242], serum sickness-like reaction[243], cutaneous	Subacute thyroiditis[246]	Cutaneous reactions[173] Myocarditis was reported in one vaccine recipient, occurring 3 days after second dose[42]

[lvii] All cases occurred in patients with chronic urticaria and were being treated with cyclosporine.

	thrombotic thrombocytopenic purpura[144,145], IgA nephropathy flare-up[146], Guillain-Barré syndrome [147,148], pustural psoriasis[149], immunoglobulin A vasculitis[150], immune complex vasculitis[151], Rhabdomyolysis[152], subacute thyroiditis[153], Bell's Palsy[154], erythema multiforme[155], vaccine induced interstitial lung disease[156], macular neuroretinopathy[157], brachial neuritis[158], thyroid eye disease[159], exacerbation of subclinical hyperthyroidism[160], rhabdomyolysis[161], internal jugular vein thrombosis[162], herpes simplex virus keratitis[163], cervical lymphadenopathy[1	[191], herpes zoster ophtalmicus[184], eczema & urticaria[185], transverse myelitis[186], Guillain-Barré syndrome[187,188], acute generalized exanthematous pustulosis[189], rhabdomyolysis[190, 191], cervical lymphadenopathy[192], glomerulonephritis[165], Behçet's disease[193], neurological autoimmune disease[168], axillary adenopathy[169], multiple sclerosis[170], cutaneous reactions[173], Löfgren's syndrome[194], erythema multiforme major[195]. Pemphigus vulgaris[196], graft rejection (corneal)[197]	bullous fixed drug eruption[210], Guillain-Barré syndrome[148,211], pityriasis rosea[212,213]. Vaccination in individuals with adrenal insufficiency can lead to adrenal crises[148,211], Dariers disease[212,213], vaccine induced acute localized exanthematous pustulosis[214], Henoch-Schönlein Purpura[215], rhabdomyolysis[216], Grave's disease[217], acute demyelinating polyradiculoneuropathy[218], erythema nodosum [219], polyarthralgia[220], recurrence of cutaneous T-cell lymphoma[221], neurological autoimmune disease[168], multiple sclerosis[170], sudden			reactions[173], neuromyelitis optica spectrum disorders (transverse myelitis or optic neuritis)[244], bullous pemphigoid[245]		

	[64],glomerulonephritis[165], Ramsay-Hunt syndrome[166], Sweet's syndrome[167], neurological autoimmune disease[168], axillary adenopathy[169], multiple sclerosis[170], meningoencephalitis[171], intracerebral haemorrhage due to vasculitis[172], cutaneous reactions[173], pigmented purpuric dermatosis[174] Systemic allergic symptoms were more common in BNT162b2 than mRNA-1273, however, anaphylaxis rates were similar for both mRNA vaccines[175], could potentially worsen migraines in people who already suffer from migraines[176], graft rejection		sensorineural hearing loss[222], acute-onset polyradiculoneuropathy[223], cutaneous reactions[173], leukocytoclastic vasculitis[224], Löfgren's syndrome[194], acute eosinophilic pneumonia[225], bullous sweet syndrome[226], neuralgic amyotrophy of the lumbosacral plexus[227], sudden sensorineural hearing loss[228], graft rejection (corneal) [197], erythema annulare centrfugum[229]					

	(corneal)[177], flexural exanthema[178], severe non-anaphylatic allergic reaction[179], uveitis[180], erythroderma[181] Having adverse reactions is associated with enhanced SARS-CoV-2 IgG antibody response[182]							
Potential associated adverse events (causal links not yet proven)	Cerebral venous sinus thrombosis and intracranial haemorrhage[247], aseptic meningitis[248], autoimmune hepatitis[249,250], multiple sclerosis relapse[251], myeloperoxidase anti-neutrophil cytoplasmic antibody-positive optic perineuritis[252], central retinal vein occlusion[253], paracentral acute	Cerebral venous sinus[271], Autoimmune hepatitis[249], myocardial infarction[272], autoimmune haemolytic anaemia[273], hypophysitis & panhypopituitarism[274], erythema nodosum-like rash[274], pulmonary embolism[275], minimal change disease[276], encephalomyelitis[277], lupus	Autoimmune hepatitis[249,281,282], Acute hyperglycaemic crisis[283], Facial nerve palsy, cervical myelitis[207], alopecia areata[284], takotsubo (stress) cardiomyopathy[285], acute disseminated encephalomyelitis[286], cerebral venous sinus thrombosis[287,271] (higher risk for women)[201], ophthalmic vein	Facial Diplegia[293], acute macular neurotinopathy[294], cerebral venous sinus thrombosis[271,295], oral lichen planus[296]	Longitudinally extensive transverse myelitis[297]	Likely vaccine associated disease enhancement (VADE)[298], autoimmune hepatitis[299]	No available data	No available data

	middle maculopathy & acute macular neurotinopathy[254], Stevens-Johnson syndrome/ toxic epidermal necrolysis[255,256], lichenoid cutaneous skin eruption[257], acute mania and psychotic features[258], acute psychosis due to anti-N-methyl-D-aspartate receptor (anti-NMDAR) encephalitis[259], alopecia areata[260], rhombencephalitis [261], multisystem inflammation and organ dysfunction[262], aplastic anaemia[263], bullous pemphigoid[264], minimal change disease[265], miller fisher syndrome[266], unilateral acute foveolitis[267], encephalomyelitis[268], acute posterior	nephritis[278], retinal vein occlusion[279] One case developed IgA Nephropathy after receiving the second dose of mRNA-1273[280].	thrombosis[288], retinal vein occlusion[289], Still's disease[290], autoimmune encephalitis[291], acute abducens palsy[292]						

	multifocal placoid pigment epitheliopathy[269], trigeminal neuralgia[270]							
Myocarditis data	Mainly reported in young adults and adolescents [300] Israeli study: 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)[301] Male patients Incidence of **4.12** (95% CI, 2.99-5.26) per 100,000 vaccinated[301] **3.19** cases (95% CI, 2.37-4.02) per 100,000 vaccinated[302] Female patients Incidence of **0.23** (95% CI, 0-0.49)	Mainly reported in young adults and adolescents [300] 5.8 cases per 1 million second dose administrations[303]	No available data	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[42]

	per 100,000 vaccinated[301] **0.39** cases (95% CI, 0.10-0.68) per 100,000 vaccinated[302] <u>≥30 years</u> Incidence of **1.13** (95% CI, 0.66-1.60) per 100,00 vaccinated[301] 5.8 cases per 1 million second dose administrations[303] 4.8 cases 5.07 cases per 100,000[304] <u>Disease severity</u> Mild: **1.62** (95% CI, 1.12-2.11) Intermediate: **0.47** (95% CI, 0.21-0.74) Fulminant: **0.04** (95% CI, 0-0.12)[301] <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**[302]							
	CHILDREN VACCINATION							
	BNT162b2/ COMIRNATY	**Spikevax/ Moderna COVID-19 Vaccine/ mRNA-1273**	**Vaxzevria/ ChAdOx1 nCoV-19/ AZD1222/ Covishield**	**Janssen COVID-19 vaccine/Johnson & Johnson**	**BBIBP-CorV,**	**CoronaVac**	**COVAXIN / BBV152**	**Novavax/ NVX-CoV2373** (Awaiting approval from WHO EUL)
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)**[305]. *Children (5-11):*	*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)**[308] ***Against SARS-CoV-2 Infection:***	No available data Paused ongoing trials in children aged 6-17 due to concerns over rare blood clots reported in adult population[310].	No available data Announced at begging of April ongoing study in adolescents but paused to investigate blood clots in adult population[310].	*Children (3-17):* Unknown. Ongoing clinical trial only looked at safety, tolerability, and immunogenicity[lviii] * * The study design administered **three**	*Children (3-17):* Unknown. Clinical trial only looked at safety, tolerability and immunogenicity[311].	No available data	*Adolescents (16-17):* PREVENT-19 clinical trial[lix] expanded to assess efficacy, safety, and immunogenicity in 12–17-year-old adolescents[312]

[lviii] 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

[lix] 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

	After second dose efficacy of **90.7% (CI, 67.7-98.3)**[306] *Children (Under 5 years):* Ongoing trials[307]	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)**[308] ***Against asymptomatic:*** 14 days after first dose efficacy of **59.5% (95% CI, 28.4-77.3)** 14 days after second dose efficacy of **39.2 (95% CI, -24.7-69.7)**[308] *Children (6month-11):* Ongoing trials[309]			**doses** of 2 µg, 4 µg, or 8 µg of vaccine			
Effectiveness	*Adolescents Against SARS-CoV-2 infection:* **91.5%** (95% CI, 88.2-93.9)[313] **91%** (95% CI, 88-93)[314] *Adolescents Against hospitalisation:*	No available data	No available data	No available data	No available data	No available data	No available data	No available data

	81% (95% CI, -55-98)[314] **93%** (95% CI,83-97)[315]							
Immunogenicity	*Adolescents (12-15) serum-neutralizing titer:* 1 month after 2nd dose had **1283.0 GMN_{50} (CI, 1095.5-1402.5)**[305]. *Adolescents/young adult (16-25) serum-neutralizing titer:* 1 month after 2nd dose had **705.1 GMN_{50} (CI, 621.4-800.2)**[305]. *Children (5-11):* 1 month after 2nd dose had **1,197.6 GMT (95% CI, 1106.1-1296.6)** SARS-CoV-2-neutralizing antibody[306] *Children (Under 5):* Ongoing trials[307]	*Adolescents (12-17):* Neutralizing antibody titer after 2nd dose was **1401.7 GMN_{50} (CI, 1276.3-1539.4)** Serological response was **98.8% (CI, 97.0-99.7)**[308] *Children (6-11):* Seroreponse of **99.3%**[316] *Children (6month-11):* Ongoing trials[309]	No available data	No available data	*Children (3-17):* Neutralizing antibodies after 28 days after 2nd dose ranged from **105.3-180.2 GMT** in 3-5 years cohort, **84.1-168.6 GMT** in 6-12 years cohort, and **88.0-155.7 GMT** in 13-17 years cohort Neutralizing antibodies after 28 days after 3rd dose ranged from **143.5-224.5 GMT** in 3-5 years cohort, **127-184.8 GMT** in 6-12 years cohort, and **150.7-199 GMT** in 13-17 years cohort[317]	*Children (3-17):* Neutralizing antibody response after 2nd dose **(100%)** with GMT ranging from **45.9-212.6**[311]	Ongoing clinical trial[318]	Ongoing clinical trial[319]

Safety and Adverse events	*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%)** Severe adverse events **(0.6%)**[305]. *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%)**[305]. *Children (5-11):* Pain at injection site, fatigue, headache, chills were reported. Overall, the	*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%)** Grade 3 adverse events **(6.8%)**)[322] 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**[308] *Children (6-11):* Vaccine was generally well tolerated[316] *Children (6month-11):*	No available data	No available data	*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** Adverse events were mostly mild to moderate in severity[317]	*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%)**[311]	Ongoing clinical trial[318]	Ongoing clinical trial[319]

	vaccine is safe and tolerable[306] *Children (Under 5):* Ongoing trials[307] Multisystem inflammatory syndrome (causal link not yet proven)[320] *Adverse events cases:* 15-year old boy developed nephrotic syndrome[321]	Ongoing trials[309]						
Myocarditis Data	Few reported cases of acute myocarditis and pericarditis in 16-25 year olds (mainly in males)[322] 16-29 years Incidence of **5.49** (95% CI, 3.59-7.39) per 100,00 vaccinated[301] Male patients (16-29 years)	Few reported cases of acute myocarditis and pericarditis (mainly in males)[322] *16-17 year old boys in US*: *Second dose*: 31.2 cases per million doses administered[323]	No available data	No available data	No available data	No available data	No available data	No available data

	Incidence of **10.69** (95% CI, 6.93-14.46) per 100,000 vaccinated[301] Incidence of **13.6 cases** (95% CI, 9.30-19.20) per 100,000 vaccinated[302] *12-15 year old boys in US*: *First dose*: 4.8 cases per million doses administered[323] *Second dose*: 42.6 cases per million doses administered[323] *12-15 year old girls in US*: *First dose*: 0.5 cases per million doses administered[323] *Second dose*: 4.3 cases per million doses administered[323] *16-17 year old boys in US*:									

	First dose: 5.2 cases per million doses administered[323] *Second dose*: 71.5 cases per million doses administered[323] *16-17 year old girls in US*: *First dose*: 0.0 cases per million doses administered[323] *Second dose*: 8.1 cases per million doses administered[323]							
HETEROLOGOUS VACCINATION								
Vaccine Schedule	**BNT162b2/ChAdOx1** Administration of ChAdOx1 as second/booster dose	**ChAdOx1/mRNA-1273** Administration of mRNA-1273 as second/booster dose	**ChAdOx1/BNT162b2** Administration of BNT162b2 as second/booster dose	Not Applicable (one dose schedule) For more information refer to booster section	**BBIBP/BNT162b2**	**CoronaVac/ChAdOx1** Press releases have confirmed that Thailand will use the AstraZeneca vaccine as the second dose for individuals whose	**ChAdOx1/BBV152** Administration of Covaxin as second/booster dose	Ongoing trial[324] (Com-Cov2)[lxi]

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

						first dose was Sinovac[lx] **CoronaVac/Convidecia**		
Immunogenicity	*GMCs of SARS-CoV-2 anti-spike IgG at 28 days post booster:* Heterologous **(7133 ELU/mL, CI 6415-7932)** vs. Homologous **(14080 ELU/mL, CI 12491-15871)**[325]. *SFC frequency (T0cell ELISpot):* Heterologous **(99 SFC/10^6 PBMCs)** vs. Homologous **(80 SFC/10^6 PBMCs)**[325]. ***Heterologous mRNA:*** **84.7%** effectiveness (95% CI, 83.1-86.1)[8]	**Spike-specific IgG antibodies:* Heterologous **(3602 BAU/mL)** vs. Homologous **(4189 BAU/mL)**[48] **Neutralizing antibodies:* Heterologous **(100%)** vs. Homologous **(100%)**[326]. ***Heterologous mRNA:*** **84.7%** effectiveness (95% CI, 83.1-86.1)[8] *Results based on immunosuppressed population	*RBD antibody titres:* Heterologous **(7756.68 BAU/mL, CI 7371.53-8161.96)** vs. Homologous **(99.84 BAU/mL, CI 76.93-129.59)** at day 14[327]. *IgG antibody titres:* Heterologous **(3684 BAU/mL)** vs. Homologous **(101.2 BAU/mL)** at day 14[327]. *Neutralizing antibodies:* Heterologous **(100%)** at day 14 vs.	Not Applicable (one dose schedule) For more information refer to booster section	Unknown (on-going clinical trial)[49]	**CoronaVac/ChAdOx1 :** *Anti-S Antibodies:* Heterologous **(797 U/mL; 95% CI, 598.7-1062)** vs. Homologous CoronaVac **(94.4 U/mL; 95% CI : 76.1-122.1)** vs. Homolougous ChAdOx1 **(818 U/mL; 95% CI: 662.5-1010)**[329] **CoronaVac/Convidecia** *Neutralizing antibodies :* Heterologous **54.4 GMT** (95% CI, 37.9-78) vs. Homologous CoronaVac	*RBD antibody titres:* Heterologous **(1866 GMT; 95% CI, 1003-3472)** vs. Homologous Covishield **(2260 GMT; 95% CI, 1881-2716)** vs. Homologous Covaxin **(710 GMT, 95% CI, 461-1092)**[331] *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**	No available data Ongoing trial[324]

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

			Homologous **(30%)** at day 14[327]. Heterologous **(median 99%)** vs. Homologous (BNT162b2/BNT162b2) **(median 62%)**[328]			**12.8 GMT** (95% CI, 9.3-17.5)[330]	**GMT; 95% CI, 485.8-1134)**[331] *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)**[331]	
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[328] *Omicron (B.1.1.529):* **13/20 seropositive** against Omicron[332]	No available data	No available data	No available data	*Neutralizing antibody titres **B.1**:* **539.4 GMT (95% CI, 263.9-1103)**[331] *Neutralizing antibody titres **Alpha**:* **396.1 GMT (95% CI, 199.1-788)**[331] *Neutralizing antibody titres **Beta**:* **151 GMT (95% CI, 80.21-284.3)**[331]	No available data

							Neutralizing antibody titres ***Delta***: **241.2 GMT (95% CI, 74.99-775.9)**[331]	
Reactogenicity	Observed increase in systemic reactogenicity after boost in heterologous schedules in comparison with homologous schedules[325] *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[325]. *Adverse events in homologous:* Adverse events **(81)** Grade 1 **(59.3%)** Grade 2 **(39.5%)** Grade 3 **(1.2%)**	*Adverse events in heterologous and homologous vaccination groups were very similar[326]. *Majority of adverse events self-reported were Pain at injection site, Swelling at injection site, Fever, Headaches, Fatigue, Chills, GI effects, Myalgia, Arthralgia[326]. *Results based on immunosuppressed population	*Adverse events in heterologous:* Headache **(44%)**, Myalgia **(43%)**, Malaise **(42%)**, Fever **(2%)**, Injection site pain **(88%)**, Induration **(35%)**, Erythema **(31%)**[327]. *Severity of adverse events in heterologous:* Mild **(68%)**, Moderate **(30%)**, Severe **(2%)**[327].	Not Applicable (one dose schedule) For more information refer to booster section	Unknown (on-going clinical trial)[333]	**CoronaVac/ChAdOx1:** Unknown **CoronaVac/Convidecia:** Convidecia recipients reported more adverse reactions and reported higher occurrence of solicited injection-site pain)[330]	*Most common local adverse events:* Pain at injection site **(11.1%)**[331] *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[331]	No available data Ongoing trial[324]

	Grade 4 **(0%)**[325].							
BOOSTER DOSES								
Vaccine Schedule	**BNT162b2/BNT162b2**	**mRNA-1273/mRNA-1273**	**ChAdOx1/ChAdOX1**	**Ad26.CoV.2.S/ Ad26.CoV.2.S**	**SinoPharm/SinoPharm**	**CoronaVac/CoronaVac**	**Covaxin/Covaxin**	**NVX-CoV2373/NVX-CoV2373**
Approved Administration	*Israel:* 12-year-old and over can received homologous booster shot 5 months after full jab[lxii] *United States:* Starting September, adults who received mRNA vaccine 8 months ago are eligible for booster	Phase II booster trial of three booster doses are ongoing[334] Moderna sought FDA approval of its COVID-19 vaccine booster[lxiv] *United States:* Starting September, adults who received mRNA vaccine 8 months ago are	Preliminary results on tolerability and immunogenicity of third dose of ChAdOx1 vaccines showed strong boost to the immune response[335]	Johnson & Johnson has said it will submit all of their new data to the FDA for potential consideration for adding a booster dose and consideration to authorize two-dose regimen[lxv]	*UAE:* Offering booster doses of Pfizer and Sinopharm to people who received full Sinopharm jab ≥6 months ago	**Turkey** and the **United Arab Emirates** began homologous booster shots **Indonesia** and **Thailand** are considering giving homologous booster shot to HCW[lxvi]	Ongoing clinical trials[lxvii]	Ongoing phase II trials[336] Results below are based on ongoing phase II trial

[lxii] 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/

[lxiv] 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/

[lxv] 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

[lxvi] 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/

[lxvii] Bharat Biotech to initiate trials of booster dose of Covid-19 vaccine. *Clinical Trials Arena*. https://www.clinicaltrialsarena.com/news/bharat-biotech-booster-dose/

	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[lxiii]	eligible for booster.						
Time-to-booster dose	**6 months to 8 months** after initial two-dose regimen Israel offers up to **5 months** after initial two-dose regimen UK has shortened time interval up to **3 months** after initial two-dose regimen due to new Omicron variant[lxviii]	**6 months to 8 months** after initial two-dose regimen	**6-9 months** after initial two-dose regimen	**6 months** after one dose regimen[91]	**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	Ongoing clinical trials[xxxvii]	**6 months** after initial two-dose regimen (**189 days**)[336]

[lxiii] 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/

[lxviii] 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

Efficacy	*Symptomatic COVID-19:* **95.6%** during Delta prevalent period[337] **95.3% (**95% CI, 89.5-98.3)[338] **96.5%** (95% CI, 89.3-99.3) in *16-55 year old*[338] **93.1%** (95% CI, 78.4-98.6) in *≥55 year old*[338]	No available data	No available data	No available data	No available data	No available data	Ongoing clinical trials[xxxvii]	No available data
Effectiveness	*Effectiveness against testing positive:* **12%** (95% CI, 8-17) in first 7 days after booster **58%** (95% CI, 56-61) 14 days after booster **85%** (95% CI, 83-86) 28 days after booster[339] *Effectiveness against infection:* **92%** (95% CI, 91-92)[340] *Effectiveness in ≥50:*	*Effectiveness against infection:* **94%** (95% CI, 91-95)[340]	No available data	No available data	No available data	No available data	No available data	No available data

	84.4% (95% CI, 82.8-85.8) against symptomatic COVID-19[341] **94.0%** (93.4-94.6) against symptomatic COVID-19 compared with unvaccinated[341] *Effectiveness against hospitalization:* **87%** 0-6 days after receiving booster dose **92% to 97% lower** than those who received 2 doses[339]								
Effectiveness against Variants	*Omicron (B.1.1.529):* **75.5%** (95% CI, 56.1-86.3) effectiveness against symptomatic infection[66] If assuming 25-fold decrease compared to wild-type, **81%** (95% CI, 59-95)[67]								

Immunogenicity	*Neutralizing titers:* Elicits **>5-8 more** for wild type after 6 months after 2nd dose[342] ***≥ 60 years:*** *Neutralizing antibody:* **9.34 times higher** than second dose[343] *IgG Antibodies in* **97%** seroconversion with increase in IgG antibody titers[344] **33-fold increase** in IgG after booster dose[343]	Booster doses (mRNA1273 or mRNA1273.351) increased neutralizing antibody titers against wild-type[345]	*Antibody Levels:* Higher levels after third dose (tIgG EU **3746**; IQR: 2047-6420) [335] *Spike Cellular Immune Response:* Increased from **200 SFUx10^6 PBMC (IQR, 127-389)** after the second dose to **399 SFUx10^6 PBMC (IQR, 314-662)** after the third one[335]	5X10^{10} vp booster dose elicited **9-fold** increase at day 7 compared to first dose after 29 days in 18-55-year-olds[91] 1.25X10^{10} vp booster dose elicited **6-7.7-fold** increase at day 28 compared to first dose after 29 days in 18-55 and ≥65-year-old[91]	Ongoing trial[333] *IgG Seroconversion:* **175/176** vaccinees were seropositive for IgG 14 days after receiving third dose[94] Mean IgG value increased **8.00-fold** compared to before third vaccination[94] *Anti-RBD IgG:* Increased by **8.14-fold** higher than before third vaccine[94] *Memory B cells:* Third dose increased the percentage of RBD-specific memory B cells **(0.96%)[94]**	Neutralizing Antibodies: **60%** higher NAbs activity against wild-type compared to 2-doses[96] Anti-S IgG and NAbs: **20-fold** increase 4 weeks post booster vaccination NAbs were maintained **60** to **180 days** post booster[96]	Ongoing clinical trials[xxxvii]	*Anti-spike IgG:* Increase of **4.6-fold** compared to peak response after 2nd dose (**Day 217 GMEU = 200408**; 95% CI: 159796-251342)[336] *Wild-type Neutralizing Response:* Increase of **4.3-fold** compared to peak response after 2nd dose **(IC50 = 6231; 95% CI: 4738-8195)** [336] *Older Participants (60-84):* **5.4-fold** increase in antibody response[336] *Younger Participants (18-59):*

								3.7-fold increase in antibody response[336]
Immunogenicity against variants	*Beta (B.1.351):* Elicits **15-21** more neutralizing titers for Beta variant after 6 months after 2nd dose[342] *Delta (B.1.671.2):* **>5-fold** increase in neutralizing titers against Delta compared to dose 2 titers in 18–55-year-olds **>11-fold** increase in neutralizing titers against Delta compared to dose 2 titers in 65–85-year-olds[342] *Omicron (B.1.1.529):* **37.0-fold decrease** in neutralization compared to Delta after 0.5 months after booster **24.5-fold decrease** in neutralization compared to Delta	Preliminary results of booster doses of mRNA-1273 vaccine show robust antibody response against Delta variant[334]	Third dose provided higher antibody titters against Alpha, Beta, and Delta variants[335]	No available data	Ongoing trial[333] **Beta (B.1.351):** **71.6%** plasma inhibitions against Beta variant[94] **Delta (B.1.671.2):** **83.4%%** plasma inhibitions against Delta variant[94] **Lambda:** **89.0%** plasma inhibitions against Lambda variant[94]	**Beta (B.1.351):** **3.0-fold** decrease in neutralizing antibodies compared to wild type[96] **Gamma (P.1):** **3.1-fold** decrease in neutralizing antibodies compared to wild type[96] **Delta (B.1.671.2):** **2.3-fold** decrease in neutralizing antibodies compared to wild type **2.5-fold** higher neutralizing potency than 2-dose vaccination[96]	Ongoing clinical trials[xxxvii]	High levels of functional antibodies against Alpha (B.1.1.7), Beta (B.1.351), and Delta (B.1.671.2)[336] *Delta (B.1.671.2):* Increase of **6.6-fold** in antibody response compared to Delta response observed with primary vaccination[336]

	after 3 months after booster[346]							
Reactogenicity	Preliminary results show consistent tolerability[342] **25%** reported at least one adverse event[338] *Common solicited AE:* Injection site pain, injection site redness, injection site swelling, fatigue, muscle pain, fever[338] *≥Grade 3 AE:* **6.6%** reported grade 3 or higher reactogenicity with **0.7%** being local reactions and **5.9%** systemic events[338]	Similar safety and tolerability compared to second dose[334] *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)**[345]	Lower reactogenicity after third dose compared to first dose[90]	No available data	Ongoing trial[333]	The third shot is considered to be safe[95]. *Common side effects:* Pain at the injection site. *Adverse events:* Unrelated to the vaccination	Ongoing clinical trials[xxxvii]	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[336]

Protection against COVID-19	***Confirmed Infection:*** Youngest age group (16-29): **17.2 (95% CI, 15.4-19.2) lower rate** in booster group[347] 30-39 age group: **9.0 (95% CI, 8.4-9.7) lower rate** in booster group[347] 40-49 age group: **9.7 (95% CI, 9.2-10.3) lower rate** in booster group[347] 50-59 age group: **12.2 (95% CI, 11.4-13.0) lower rate** in booster group[347] Oldest age group (≥60): **12.3 (95% CI, 10.4-12.3) lower rate** in booster group [348] **12.3 (95% CI, 11.8-12.8) lower rate** in booster group[347]	No available information	No available information	No available information	No available information	No available information	Ongoing clinical trials[xxxvii]	No available information

	Severe Illness: 40-59 age group: **21.7 (95% CI, 10.6-44.2) lower rate** in booster group[347] Older population (≥60): **19.5 (95% CI, 12.9-29.5) lower rate** in booster group[348] **17.9 (95% CI, 15.1-21.2) lower rate** in booster group[347] ***Mortality:*** ≥60 years old: **14.7 (95% CI, 10.0-21.4) lower rate** in booster group[347] ≥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[349]								
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%**[350] ***Incidence Rate:*** Infection in individuals <60: **0.22 (95% CI, 0.22-0.23) incidence rate** in booster compared to non-booster[351] Infection in individuals ≥60: **0.16 (95% CI, 0.15-0.17)**						For more detailed information regarding immunogenicity of third dose refer to study[lxix]		

[lxix] 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*

	incidence rate in booster compared to non-booster[351] Severe illness in individuals <60: **0.33 (95% CI, 0.21-0.52) incidence rate** in booster compared to non-booster[351] Severe illness in individuals ≥60: **0.12 (95% CI, 0.10-0.14) incidence rate** in booster compared to non-booster[351]							
HETEROLOGOUS BOOSTER DOSES								
Vaccine Schedule	*Heterologous 1:* **mRNA1273/BNT162b2** *Heterologous 2:* **Ad26.CoV.2.S/BNT162b2** *Heterologous 3:* **ChAdOx1/BNT162b2** ***Received BNT162b2 as booster dose	*Heterologous 1:* **BNT162b2/mRNA1273** *Heterologous 2:* **Ad26.CoV.2.S/mRNA1273** *Heterologous 3:* **ChAdOx1/mRNA1273** ***Received mRNA1273 as booster dose	*Heterologous 1:* **BNT162b2/ChAdOx1*** ***Received ChAdOx1 as booster dose	*Heterologous 1:* **BNT162b2/Ad26.CoV.2.S** *Heterologous 2:* **mRNA1273/Ad26.CoV.2.S** *Heterologous 3:* **ChAdOx1/Ad26.CoV.2.S.** ***Received Ad26.CoV.2 as booster dose	*Heterologous:* **SinoPharm/BNT162b2**	*Heterologous 1:* **CoronaVac/ChAdOx1** *Heterologous 2 :* **CoronaVac/BNT162b2** *Heterologous 3 :* **CoronaVac/SinoPharm** ***Received CoronaVac as initial regimen	No available data	*Heterologous 1:* **BNT162b2/NVX-CoV2373** *Heterologous 2:* **ChAdOx1/NVX-CoV2373** ***Received NVX-CoV2373 as booster dose

Time-to-booster dose	At least **3 months** after receiving two dose regimen	At least **3 months** after receiving two dose regimen	**6 months** after initial two-dose regimen	**4 months** after initial two-dose BNT162b2 regimen[352] 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	No available data	**6 months** after initial two-dose regimen
Effectiveness	*Heterologous 1:* **94%** (95% CI, 91-96) effectiveness against infection[340] *Heterologous 2 – Effectiveness in ≥50:* **87.4%** (95% CI, 84.9-89.4) against symptomatic COVID-19[341] **93.1%** (95% CI, 91.7-94.3) against symptomatic COVID-19 compared to unvaccinated[341]	*Heterologous 1:* **92%** (95% CI, 88-95) effectiveness against infection[340] *Heterologous 3:* **91%** (95% CI, 63-98) effectiveness against infection[340]						

Effectiveness against Variants	*Heterologous 3:* **82%** (95% CI, 68-90) effectiveness against infection[340]		***Omicron (B.1.1.529):*** *Heterologous 1:* **71.4%** (95% CI, 41.8-86.0) against symptomatic infection[66]					***Heterologous 1:*** *Anti-spike IgG:* In individuals <70: **14961 ELU/mL** (95% CI, 12065-18551) In individuals ≥70: **9130 EUL/mL** (95% CI, 6783-12289)[354] *Cellular Response:* In individuals <70: **69** (95% CI, 45-156) In individuals ≥70: **45** (95% CI, 22-92)[354]
Immunogenicity	*Binding Antibody Responses:* **2-fold or greater rise** in bAb noted in **98-100%** of BNT162b2 recipients[353] *Neutralizing Antibody Responses:* **341.3-677.9 IU50/mL** 15 days after booster with BNT162b2[353] Participants who received mRNA-based booster vaccination had four-fold increase	*Binding Antibody Responses:* **2-fold or greater rise** in bAb noted in **96-100%** of mRNA1273 recipients[353] *Neutralizing Antibody Responses:* **676.1-901.8 IU50/mL** 15 days after booster with mRNA1273[353] Participants who received mRNA-based booster vaccination had four-fold increase	***Heterologous 1:*** *Anti-spike IgG:* In individuals <70: **12440 ELU/mL** (95% CI, 10420-14852) In individuals ≥70: **14961 ELU/mL** (95% CI, 12065-18551)[354] *Cellular Response :* In individuals <70 : **105** (95% CI, 67-164) In individuals ≥70: **84** (95% CI, 45-156)[354]	***Heterologous 1:*** **14.8 to 32.4-fold** increase in neutralization titers against wild-type virus[352] *Binding Antibody Responses (bAb):* **2-fold or greater rise** in bAb noted in **98-100%** of Ad26.COV2.S. recipients[353] *Neutralizing Antibody Responses:* **31.2-382.2 IU50/mL** 15 days	No available data	***Heterologous 1:*** Heterologous vaccination had a **9-fold greater GMT** (7,947 U/mL) than fully patients fully vaccinated with AZD1222 and the highest antibody response, IgA, and neutralizing antibodies than other groups[355] *Anti-RBD Antibody:* **9865 U/mL** 14-days after booster[356]	No available data	

	compared to Ad26.COV2.S.[353] ***Heterologous 3:*** *Anti-spike IgG:* In individuals <70: **22479 ELU/mL** (95% CI, 18276-27648) Individuals ≥70: **19091 EUL/mL** (95% CI, 15554-23432)[354] *Cellular Response:* In individuals <70 : **119 (95% CI, 83-169)** sport forming cells per 10^6 peripheral blood mononuclear cells In individuals ≥70: **113 (95% CI, 64-200)** sport forming cells per 10^6 peripheral blood mononuclear cells[354]	compared to Ad26.COV2.S. [353] ***Heterologous 1:*** *Anti-spike IgG:* In individuals <70: **44547 ELU/mL** (95% CI, 38424-51645) In individuals ≥70: **25118 ELU/mL** (95% CI, 17698-35650)[354] *Cellular Response :* In individulas <70 : **143 (95% CI, 82-250)** In individuals ≥70: **88 (95% CI, 46-168)** ***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)[354]		after booster with Ad26.COV2.S. [353] *Anti-spike IgG:* In individuals >70: **17312 ELU/mL** (95% CI, 13678-21911) In individuals ≥70: **16855 ELU/mL** (95% CI, 13360-21264)[354] *Cellular Response:* In individuals <70: **114** (95% CI, 55-236) In individuals ≥70: **109** (95% CI, 64-187)[354] ***Heterologous 3 :*** *Anti-spike IgG:* In individuals <70: **5582 ELU/mL** (95% CI, 4415-7057) In individuals ≥70: **5464 ELU/mL** (95% CI, 4266-6998) *Cellular Response:* In individuals <70:		***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**[357] *Anti-spike RBD:* Single booster dose of BNT162b2 induced higher anti-spike RBD IgG antibody levels, compared to single booster dose of CoronaVac[87] **20,787 U/mL** 14 days after booster[356] ***Heterologous 3:*** *Anti-spike RBD:*		***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)[354] *Cellular Response:* In individuals <70: **137** (95% CI, 88-213) In individuals ≥70: **55** (95% CI, 35-89)[354]

		Cellular Response: In individuals <70: **228** (95% CI, 177-294) In individuals ≥70: **101** (95% CI, 54-187)[354]		**141** (95% CI, 100-200) In individuals ≥70: **82** (95% CI, 54-124)		**1073 U/mL** 14 days after booster[356]		
Immunogenicity against variants	*Binding Antibody Responses:* Baseline bAb levels for **Delta** were **34-45% lower** compared to Wa-1 strain[353] Following boost, bAB levels for **Delta** were **15-36% lowe**r compared to Wa-1 strain[353] ***Heterologous 1:*** *Neutralizing Ab:* **22.7-fold decrease** in neutralization after 0.5 months after booster compared to **Delta**[346]	*Binding Antibody Responses:* Baseline bAb levels for **Delta were 34-45% lower** compared to Wa-1 strain[353] Following boost, bAB levels for **Delta** were **15-36% lower** compared to Wa-1 strain[353] *Neutralizing Antibody Responses:* **Delta and Beta** variants were only available in those boosted with mRNA-1273[353] ***Heterologous 1:***	*Pseudovirus neutralizing antibody NT_{50}:* **260 GMT** (95% CI, 217-313) against **Delta**[354]	***Heterologous 1:*** **10.9 to 21.2-fold** increase in pseudo virus neutralization assay (one volunteer did not have any against B.1.351) [352] *Binding Antibody Responses:* Baseline bAb levels for **Delta** were **34-45% lower** compared to Wa-1 strain[353] Following boost, bAB levels for **Delta** were **15-36% lower** compared to Wa-1 strain[353]	No available data	***Heterologous 1:*** Neutralizing activity against the wild type and variant strains showed higher neutralizing activity in the following order: **wild type > B.1.617.2 > B.1.1.7 > B.1.351**[355]	No available data	***Heterologous 1:*** *Pseudotype neutralizing antibody NT_{50}:* **165 GMT** (95% CI, 131-209) against **Delta**[354] ***Heterologous 2:*** *Pseudotype neutralizing antibody NT_{50}:* **124 GMT** (95% CI, 99-156) against **Delta**[354]

	Heterologous 3: *Pseudotype virus neutralizing antibody NT_{50}:* **315 GMT** (95% CI, 1314–1998) against **Delta**[354]	*Pseudotype virus neutralizing antibody NT_{50}:* **508.7 GMT** (95% CI, 408.6-633.4) against **Delta**[354] ***Heterologous 3:*** *Pseudotype virus neutralizing antibody NT_{50}:* **559.7 GMT** (95% CI, 441.3-709.9) against **Delta**[354]		*Pseudotype virus neutralizing antibody NT_{50}:* **418 GMT** (95% CI, 330-530) against **Delta**[354] ***Heterologous 3:*** *Pseudotype virus antibody NT_{50}:* **125 GMT** (95% CI, 99-159) against **Delta**[354]				
Reactogenicity	*Adverse Events:* **72-92%** participants reported local pain or tenderness[353] Malaise, myalgias, and headaches were commonly reported[353] **14.4%** of the participants reported unsolicited adverse events[353]	*Adverse Events:* **75-86%** participants reported local pain or tenderness[353] Malaise, myalgias, and headaches were commonly reported[353] **15.6%** of participants reported unsolicited adverse events[353]	No available data	*Adverse Events:* **71-84%** participants reported local pain or tenderness[353] Malaise, myalgias, and headaches were commonly reported[353] **12%** of participants reported unsolicited adverse events[353]	No available data	Similar results to homologous booster administration	No available data	No available data

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[lxx]		

[lxx] 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

ANNEXES

	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)	Sinopharm/BBIBP-CorV, China	Sinovac CoronaVac, China	COVAXIN/ BBV152 (Bharat Biotech, India)	Novavax/ NVX-CoV2373
FURTHER INFORMATION								
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)[lxxi]; EMA (21.12.20); WHO EUL (31.12.20); and list of countries (including Switzerland – approved on 20.12.20)	FDA (18.12.20); EMA (06.01.21); WHO EUL (30.04.21); and list of 51 countries (including Switzerland – approved 12.01.21)	FDA (awaiting on approval); EMA (29.01.21); WHO EUL (15.02.21); and list of 121 countries (Switzerland awaiting on approval)	FDA (27.02.21); EMA (11.03.21), WHO EUL (12.03.21), and list of 59 countries (including Switzerland – approved 22.03.21)	WHO EUL (07.05.21); and list of 55 countries (e.g., Argentina, Bahrain, Brazil, China, Indonesia, United Arab Emirates, Zimbabwe)	WHO EUL (01.06.21), and list of 33 countries (e.g., Albania, Chile, Egypt, Hong Kong, Malaysia, Tunisia, Turkey, Ukraine)	WHO EUL (03.11.21) and list of 9 countries (Guyana, Inidia, Iran, Mauritius, Mexico, Nepal, Paraguay, Philippines & Zimbabwe)	Waiting on approval (Not-yet-approved by countries or WHO for emergency use)
IMMUNOGENICITY								

[lxxi] 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

Immunogenicity	*7-14 days after second dose:* *18-55 years*: GMT ranged from **1.7 to 4.6** times the GMT of the convalescent serum[358]. *65-85 years*: GMT ranged from **1.1 to 2.2** times the GMT of the convalescent serum[358].	*14 days after second dose:* *18-55 years*: $PRNT_{80}$ GMT **654.3 (95% CI, 460.1-930.5)**[359]. *56-70 years:* $PRNT_{80}$ GMT **878 (95% CI, 516-1494**)[360]. *≥71 years*: $PRNT_{80}$ GMT **317 (95% CI, 181-557**)[360].	*28 days after second dose median antibody titres:* *18–55 years*: **20,713 AU/mL [IQR 13,898 - 33,550**][361] *56–69 years*: 1**6,170 AU/mL [IQR 10,233 - 40,353]**[361]. *≥70 years*: **17,561 AU/mL [IQR 9,705 - 37,796]**[361].	*29 days after vaccination:* *18-55 years:* GMC **586 (95% CI, 445-771**); GMT **224 (95% CI, 168-298**)[362]. *≥65 years*: GMC **312 (95% CI, 246-396);** GMT **212 (95% CI, 163-266**)[362]. *57 days after vaccination:* *18-55 years*: **754 (95% CI, 592-961**); GMT **288 (95% CI, 221-376**)[362].	*14 days after second dose:* *18-55 years:* GMT ***211.2* (95% CI, 158.9-280.6**)[363]. *≥60 years: GMT **131.5** (95% CI, 108.2-159.7**)[363].	*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) *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)[364]. *2 weeks after second dose:* 164.4 BAU/ mL[365] *4 weeks after second dose:* 94.8 BAU/ mL[365] *8-12 weeks after second dose:* 34.7 BAU/ mL[365]	*Single dose (≥4 weeks:* **43.8%** seropositive for anti-spike antibody > 15 AU/mL[366] GMT **16.8 (95% CI, 15.80-17.88)** for SARS-CoV-2 spike antibody titre[366] *Two doses (≥4 weeks)*: **80.0%** seropositive for anti-spike antibody > 15 AU/mL[366] GMT **48.3 (95% CI, 47.46-48.92)** for SARS-CoV-2 spike antibody titre[366]	

Immunogenicity against the Mu variant	6.8-fold decrease in neutralizing titres when compared to convalescent sera[367]	Neutralizing titre similar to that of BNT162b2 sera[367]	Neutralizing titre similar to that of BNT162b2 sera[367]	No available data	No available data	No available data	No available data	No available data
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[346] **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[368] **41-fold decrease** in neutralization level against Omicron[369]	**20-fold decrease** in neutralization 6 months after vaccination compared to Delta[346] **1/10 seropositive** against Omicron[332]	Mean neutralizing titres drop to below the detectable threshold in all but one participant[346] **0/20 seropositive** against Omicron[332]					

	9/20 seropositive against Omicron [332]							
				EFFICACY				
Single dose[lxxii]	**52%** (95% CI, 29.5 to 68.4; starting at 12 days) or 82.2% (75.1 to 87.3; starting at ≥14 days)[370]. **91%** (95% CI, 85-94)[371]. ≥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][372] ≥65 years : **56%** (95% CI 19-76) at 28-34 days and **62%** (95% CI	**95.2%** (95% CI, 91.2.8 to 97.4; starting at >14 days)[121].	**72.8%** (starting at 22 days up to 60 days)[373]. **88%** (95% CI, 75-94)[371].[lxxiv] ≥80 years : **80.4%** (95% CI, 36.4-94.5) vaccine efficacy for symptomatic disease 14 days after one dose [United Kingdom, 18 Dec 2020 – 26 Feb 2021[372] ≥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,	Single dose vaccine	Unknown	**35.1%** (95% CI, -6.6 to -60.5) [conducted in a setting with high P.1 transmission][374].	No available data	**83.4%** (95% CI, 73.6-89.5) starting at ≥14 days[42]

[lxxii] Against SARS-COV-2 infection

[lxxiv] Conducted between 8 December 2020 and 8 February 2021. Study sample = ≤1 million participants.

	23-81) at 35-48 days post-vaccination [United Kingdom, 8 Dec 2020 – 15 Mar 2021][372] [lxxiii]		8 Dec 2020 – 15 Mar 2021][372] [lxxv]					
Two doses[lxxvi]	**95.0%** (95% CI, 90.3-97.6) starting at ≥7 days in population without prior SARS-CoV-2 infection[136] **94.6%** (95% CI, 89.9-97.3) starting at ≥7 days in population with or without prior infection[136]	**94.1%** (95% CI, 89.3-96.8) after median follow-up of less than 63 days[121] **93.2%** (95% CI, 91.0-94.8)[375] Against severe disease: **98.2%** (95% CI, 92.8-99.6)[375] *Prevention against COVID-19 illness:* **93.2%** (95% CI, 91.0-94.8; United States) [375] *Prevention against severe disease:*	**63.1% (**95% CI, 51.8-71.7) starting at ≥14 days for two standard doses[373] **80.7%** (95% CI, 62.1-90.2) starting at ≥14 days for first low dose and standard second dose[373] **66.7%** (95% CI, 57.4-74.0) starting at ≥14 days for pooled analysis efficacy[373] *Against mild-to-moderate symptomatic COVID-19 >14 days after second injection*:	**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-severe-critical COVID-19[377] **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[377]	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 86.3; in HBO2 vaccine).[236]	After 14 days, efficacy against symptomatic cases was **50.7%** (95% CI 35.9 to 0-62.0).[127] 99.17% of NAb titres were above or equal to the Nab positivity cut-off (20 units) against wild-type[378].	*Symptomatic SARS-CoV-2 infection:* **77.8%** (95% CI, 65.2-86.4)[379] *Severe symptomatic SARS-CoV-2 infection:* **93.4** (95% CI, 57.1-99.8)[379] *Symptomatic COVID-19 in ≥60 years old:* **67.8%** (95% CI, 65.2-86.4) against symptomatic COVID-19[379] *Symptomatic COVID-19 in 18-59 years old:* **79.4%** (95% CI, 66.0-88.2) against	**89.7%** (95% CI, 80.2-94.6) starting at ≥7 days[42] **90.4%** (95% CI, 82.9-94.6)[380] **100%** (95% CI, 87-100) against moderate-to-severe COVID-19[380] **100%** (95% CI, 34.6-100) against severe COVID-19[380] **90%** (95% CI, 80-95) (≥7 days after second dose)[381]

[lxxiii] Does not differentiate between BNT162b2 and ChAdOx1 nCoV-19.
[lxxv] Does not differentiate between BNT162b2 and ChAdOx1 nCoV-19.
[lxxvi] Against SARS-CoV-2 infection.

		98.2% (95% CI, 92.8-99.6; United States) [375] *Prevention against asymptomatic infection starting 14 days after second infection:* **63.0%** (95% CI, 56.6-68.5; United States) [375]	**21.9%** (95% CI, -49.9 to 59.8; South Africa) [24 June – 09 November 2020][376]				symptomatic COVID-19[379]	
Against asymptomatic infection	**90%** (starting at 14 days) regardless of symptom status[382]	**63.0%** (95% CI, 56.6-68.5)[375]	Statistically non-significant **reduction of 22.2%** (95% CI -9.9 to 45.0) for asymptomatic cases **61.9%** efficacy[39]	At day 71, vaccine efficacy against asymptomatic infections was **65.5%** (95% CI 39.9 to 81.1)[377].	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 82.2; in HBO2 vaccine)[236].	Unknown	**63.6** (95% CI, 29.0-82.4) efficacy against asymptomatic cases[379]	Unknown
				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[383].	**NAbs remained high** and consistent with titres of the wildtype for the B.1.1.7 variant[384].	**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	**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	**10.4-fold** reduction in neutralization capacity when compared to natural infection sera[378]. **85.83%** of NAb titres were above	$PRNT_{50}$ **0.8** when compared with wild type against Alpha (no significant difference in neutralization capacity)[387]	Two dose efficacy against the B.1.1.7 variant **86.3%** (95% CI, 71.3-93.5)[42] **93.6%** (95% CI, 81.7-97.8)

			infection with B.1.1.7[109].		individuals vs. those naturally infected, suggesting the vaccine has a similar level of protection against infection as natural infections[385].	or equal to the Nab positivity cut-off (20 units) against wild-type[378]. Neutralization decreased by **4.1-fold** when compared to wild-type[386].		against the Alpha variant[380] *Against non-B.1.1.7 variant* **96%** (95% CI, 74-99.5) (≥7 days after second dose)[381] *Against B.1.1.7 variant* **86%** (95% CI, 71-94) (≥7 days after second dose)[381]
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[388] **100%** (95% CI, 53.5-100)[389].	NAbs were **6-fold** lower. Nevertheless, NAbs were still found to be protective[384].	Two doses of the vaccine had no efficacy against the B.1.351 (VE = **21.9%;** 95% CI, -49.9 to 59.8)[376]. *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][376]	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)[377]. Demonstrated **3.6-fold** reduction in neutralization sensitivity[390]. Neutralization titres were	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[378]. **82.5%** of NAb titres were above or equal to the Nab positivity cut-off (20 units) against wild-type[378].	GMT **61.57 (95% CI, 36.34-104.3)** against Beta variant with significant reduction in neutralization titre[392]	**51.0%** (95% CI, -0.6-76.2) efficacy against B.1.351 variant[393]

				decreased by **6.7-fold**[391].				
Gamma (P.1)	*Single dose:* *≥21 days*: **83%** against hospitalization and death[394]. *Two doses*: *≥14 days*: **98%** against hospitalization and death[394].	**3.2-fold** reduction in neutralization capacity when compared to wild-type[395].	*Single dose:* *≥21 days*: **94%** against hospitalization and death[394]. *Two doses:* **64%** (95% CI, -2-87) [n=18][396] Efficacy against Zeta (P.2) [2 doses]: **69%** (95% CI, 55-78)[396]	Demonstrated **3.4-fold** reduction in neutralization sensitivity[390].	No published data	**49.6%** against P.1 (>14 days after 1st dose)[374]. Neutralization decreased by **7.5-fold** when compared to wild-type[386].	No available data	No available data
Delta (B. 1.671.2)	**Reduced NAb activity** relative to B.1.1.7 strain[397].	**2.1-fold** reduction in neutralization capacity when compared to wild-type[395].	*Single dose:* *≥21 days*: **90%** against hospitalization and death[394].	Demonstrated **1.6-fold** reduction in neutralization sensitivity[390]. Neutralization titres were decreased by **5.4-fold**[391].	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	NT_{GM} **24.48** (95% CI,19.2-31.2)[378]. **69.17%** of NAb titres were above or equal to the Nab positivity cut-off (20 units) against wild-type[378].	**65.2** (95% CI, 33.1-83.0) estimated efficacy[130] GMT **68.97** (95% CI, 24.72-192.4) against Delta variant with significant reduction in neutralization titre[392]	No available data

					natural infections[385].			
Omicron (B.1.1.529)	**22.5%** (95% CI, 8.5-40.7) against symptomatic infection[369]							
				PHASE III TRIALS RESULTSlxxvii				
Number of participants (vaccine/ placebo)	43,448 (21,720/ 21,728)[136]	30,420 (15,210/15,210)[121]	17,178 (8597/8581)[373]	39,321 (19,630/19,691)[377]	26,917 (13,459/13458); or 26,914 (13,465/13,458)[236]	9,823 (4,953/4,870)[127]	25,798 (12,899/12899)[130]	14,039 (7,020/7,019)[42]
Total COVID-19 cases (vaccine/ control)	170(8/162)[136]	196 (11/185)[121]	332 (84/248)[373]	464 (116/348)[377]	121(26/95) or 116(21/95)[236]	253(85/168)[127]	130 (24/106)[130]	106(10/96)[42]
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)[121].	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	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).[127]	**77.8%** (95% CI, 65.2-86.4) against symptomatic COVID-19 starting at ≥14 days after second dose[130]	**83.4%** (95% CI, 73.6-89.5) starting at ≥14 days after first dose[42] **89.7%** (95% CI, 80.2-94.6) starting at ≥7

[lxxvii] 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)[136].		was **80.7%** (95% CI 62.1 to 90.2). Pooled analysis efficacy was **66.7%** (95% CI 57.4 to 74.0). For any nucleic acid amplification test-positive swab: efficacy was 54.1% (95% CI 44.7 to 61.9)[373].	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[377]. SII-ChAdOx1 nCoV-19 has a non-inferior immune response compared to AZD1222 and an acceptable safety/ reactogenicity profile[398]	86.3; in HBO2 vaccine)[236].			days after second dose[42]
Efficacy against hospitalization and death	**100%** (after 7 days)[136]	**100%** (≥14 days)[121]	**100%** (after 21 days)[373]	**76.7%** (≥14 days) or **85.4%** (≥28 days)[377]	**100%** (>14 days)[236]	**100%** (>14 days)[127]	**93.4%** (>14 days) against severe COVID-19[130]	**100%** (after 7 days)[42].
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[117,399].	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[126].	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[127].	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 [130]	<u>Phase II:</u> Nine serious adverse events were reported, only one of which was assessed as related to the vaccine: acute colitis[400].

		(0.6%). 3 Bell's Palsy cases occurred in the vaccine group and one Bell's Palsy case occurred in the placebo group[121].	control vaccine (out of 11 636 vaccine recipients): transverse myelitis, haemolytic anaemia and a case of fever higher than 40°C [123].	Guillain-Barré syndrome (1), pericarditis (1), brachial radiculitis (1), hypersensitivity (1), Bell's Palsy (2), & severe generalized weakness, fever & headache (1)[377].			15 deaths, none considered related to the vaccine or placebo[130]	
	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.[20] *Efficacy against severe/ critical SARS-CoV-2 infection* **100%** (95% CI, 33-100)[20]	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							
	BNT162b2/ COMIRNATY (Pfizer-BioNTech, USA)[lxxviii]	**Spikevax/ Moderna COVID-19 Vaccine/ mRNA-1273 (Moderna, USA)[lxxix]**	**Vaxzevria/ ChAdOx1 nCoV-19/ AZD1222/ Covishield (AstraZeneca/Oxford, UK, India)[lxxx]**	**Janssen COVID-19 vaccine/Johnson & Johnson (Janssen, USA)[lxxxi]**	**Sinopharm/BBIBP-CorV, China[lxxxii]**	**Sinovac CoronaVac, China[lxxxiii]**	**COVAXIN / BBV152 (Bharat Biotech, India)**	**Novavax/ NVX-CoV2373**
EUL holder	BioNTech Manufacturing GmbH (Germany)	ModernaTX, Inc. (USA)[1] Moderna Biotech (Spain)[2]	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 (USA)
Production sites (Drug substance)	BioNTech Manufacturing GmbH (Mainz, Germany) BioNTech Manufacturing Marburg (Marburg, Germany)	Lonza Biologics, Inc., (USA)[1] Moderna TX, Inc. (USA)[1] Lonza AG (Switzerland)[2]	Henogen S.A (Belgium) Catalent Maryland, Inc. (USA) Oxford Biomedica (UK) Ltd. (United Kingdom)	Janssen Vaccines & Prevention B.V. (The Netherlands) Janssen Biologics B.V. (The Netherlands) Emergent Manufacturing Operations Baltimore LLC	Beijing Institute of Biological Products Co., Ltd. (China)	Sinovac Life Sciences Co., Ltd. (China)	-	Novavax (Bohumil, Czech Republic)

[lxxviii] 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

[lxxix] 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

[lxxx] 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

[lxxxi] 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

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

[lxxxiii] 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

	Rentschler Biopharma SE (Laupheim, Germany) Wyeth BioPharma Division of Wyeth Pharmaceuticals (USA)		SK Bioscience (Republic of Korea) Halix B.V (Netherlands) WuXi Biologics (China)	(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) Delpharm Saint-Remy (France)	Baxter Pharmaceutical Solutions, LLC. (USA)[1] Catalent Indiana, LLC. (USA)[1] Rovi Pharma Industrial Services, S.A. (Spain)[2]	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)

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

References

1. European Medicines Agency. 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. Published 2021. Updated 4 October. Accessed 5 October, 2021.
2. Hall VJ, Foulkes S, Saei A, et al. Effectiveness of BNT162b2 mRNA Vaccine Against Infection and COVID-19 Vaccine Coverage in Healthcare Workers in England, Multicentre Prospective Cohort Study (the SIREN Study). *SSRN - Preprint.* 2021.https://doi.org/10.2139/ssrn.3790399
3. Pilishvili T, Gierke R, Fleming-Dutra KE, et al. Effectiveness of mRNA Covid-19 Vaccine among U.S. Health Care Personnel. *N Engl J Med.* 2021.https://doi.org/10.1056/NEJMoa2106599
4. Chemaitelly H, Tang P, Hasan MR, et al. Waning of BNT162b2 Vaccine Protection against SARS-CoV-2 Infection in Qatar. *New England Journal of Medicine.* 2021.https://doi.org/10.1056/NEJMoa2114114
5. Martínez-Baz I, Trobajo-Sanmartín C, Miqueleiz A, et al. Product-specific COVID-19 vaccine effectiveness against secondary infection in close contacts, Navarre, Spain, April to August 2021. *Euro surveillance : bulletin Europeen sur les maladies transmissibles = European communicable disease bulletin.* 2021;26(39).https://doi.org/10.2807/1560-7917.ES.2021.26.39.2100894
6. Rahmani K, Shavaleh R, Forouhi M, et al. Effectiveness of COVID-19 Vaccines and Post-vaccination SARS-COV 2 Infection, Hospitalization, and Mortality: a Systematic Review and Meta-analysis of Observational Studies. *medRxiv.* 2021:2021.2011.2003.21265819.https://doi.org/10.1101/2021.11.03.21265819
7. Young-Xu Y, Korves C, Roberts J, et al. Coverage and Estimated Effectiveness of mRNA COVID-19 Vaccines Among US Veterans. *JAMA Netw Open.* 2021;4(10):e2128391.https://doi.org/10.1001/jamanetworkopen.2021.28391
8. Starrfelt J, Buanes EA, Juvet LK, et al. Age and product dependent vaccine effectiveness against SARS-CoV-2 infection and hospitalisation among adults in Norway: a national cohort study, January – September 2021. *medRxiv.* 2021:2021.2011.2012.21266222.https://doi.org/10.1101/2021.11.12.21266222
9. Public Health England. *Public Health England vaccine effectiveness report.* 2021. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/989360/PHE_COVID-19_vaccine_effectiveness_report_March_2021_v2.pdf
10. Chung H, He S, Nasreen S, et al. Effectiveness of BNT162b2 and mRNA-1273 covid-19 vaccines against symptomatic SARS-CoV-2 infection and severe covid-19 outcomes in Ontario, Canada: test negative design study. *BMJ.* 2021;374:n1943.https://doi.org/10.1136/bmj.n1943
11. Lumley SF, Rodger G, Constantinides B, et al. An observational cohort study on the incidence of SARS-CoV-2 infection and B.1.1.7 variant infection in healthcare workers by antibody and vaccination status. *Clinical infectious diseases.* 2021.https://doi.org/10.1093/cid/ciab608
12. Singh C, Naik BN, Pandey S, et al. Effectiveness of COVID-19 Vaccine in Preventing Infection and Disease Severity: A Case Control Study from an Eastern State of India. *Epidemiology and Infection.* 2021:1-20.https://doi.org/10.1017/S0950268821002247

13. Corchado-Garcia J, Puyraimond-Zemmour D, Hughes T, et al. Real-World Effectiveness of Ad26.COV2.S Adenoviral Vector Vaccine for COVID-19. *SSRN - Preprint.* 2021.https://doi.org/10.2139/ssrn.3835737
14. Polinski JM, Weckstein AR, Batech M, et al. Effectiveness of the Single-Dose Ad26.COV2.S COVID Vaccine. *medRxiv.* 2021:2021.2009.2010.21263385.https://doi.org/10.1101/2021.09.10.21263385
15. Self WH, Tenforde MW, Rhoads JP, IVY Network. Vaccines in Preventing COVID-19 Hospitalizations Among Adults Without Immunocompromising Conditions. *Morbidity & Mortality Weekly Report.* 2021.https://doi.org/10.15585/mmwr.mm7038e1
16. Braeye T, Cornelissen L, Catteau L, et al. Vaccine effectiveness against infection and onwards transmission of COVID-19: Analysis of Belgian contact tracing data, January-June 2021. *Vaccine.* 2021;39(39):5456-5460.https://doi.org/10.1016/j.vaccine.2021.08.060
17. Ranzani OT, Leite RdS, Castilho LD, et al. Vaccine effectiveness of Ad26.COV2.S against symptomatic COVID-19 and clinical outcomes in Brazil: a test-negative study design. *medRxiv.* 2021:2021.2010.2015.21265006.https://doi.org/10.1101/2021.10.15.21265006
18. Corchado-Garcia J, Zemmour D, Hughes T, et al. Analysis of the Effectiveness of the Ad26.COV2.S Adenoviral Vector Vaccine for Preventing COVID-19. *JAMA Netw Open.* 2021;4(11):e2132540.https://doi.org/10.1001/jamanetworkopen.2021.32540
19. Lan F-Y, Sidossis A, Iliaki E, et al. Continued Effectiveness of COVID-19 Vaccination among Urban Healthcare Workers during Delta Variant Predominance. *medRxiv.* 2021:2021.2011.2015.21265753.https://doi.org/10.1101/2021.11.15.21265753
20. Johnson & Johnson. 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. Published 2021. Updated 21 September. Accessed 21 September, 2021.
21. Sadoff J, Struyf F, Douoguih M. A plain language summary of how well the single-dose Janssen vaccine works and how safe it is. *Future Virol.* 2021;16(11):725-739.https://doi.org/10.2217/fvl-2021-0199
22. Thomson EC, Rosen LE, Shepherd JG, et al. Circulating SARS-CoV-2 spike N439K variants maintain fitness while evading antibody-mediated immunity. *Cell.* 2021;184(5):1171-1187.e1120.https://doi.org/10.1016/j.cell.2021.01.037
23. Jahromi M, Al Sheikh MH. Partial protection of Sinopharm vaccine against SARS COV2 during recent outbreak in Bahrain. *Microb Pathog.* 2021;158:105086.https://doi.org/10.1016/j.micpath.2021.105086
24. Jara A, Undurraga EA, González C, et al. Effectiveness of an Inactivated SARS-CoV-2 Vaccine in Chile. *New England Journal of Medicine.* 2021.https://doi.org/10.1056/NEJMoa2107715
25. Cerqueira-Silva T, Oliveira VdA, Pescarini J, et al. Influence of age on the effectiveness and duration of protection in Vaxzevria and CoronaVac vaccines. *medRxiv.* 2021:2021.2008.2021.21261501.https://doi.org/10.1101/2021.08.21.21261501
26. Desai D, Khan AR, Soneja M, et al. Effectiveness of an inactivated virus-based SARS-CoV-2 vaccine, BBV152, in India: a test-negative, case-control study. *Lancet Infect Dis.* 2021.https://doi.org/10.1016/s1473-3099(21)00674-5
27. A Study Looking at the Effectiveness and Safety of a COVID-19 Vaccine in South African Adults. In. ClinicalTrials.gov2021.

28. A Study Looking at the Effectiveness, Immune Response, and Safety of a COVID-19 Vaccine in Adults in the United Kingdom. In. ClinicalTrials.gov2021.
29. Paris C, Perrin S, Hamonic S, et al. Effectiveness of mRNA-BNT162b2, mRNA-1273, and ChAdOx1 nCoV-19 vaccines against COVID-19 in healthcare workers: an observational study using surveillance data. *Clinical Microbiology and Infection.* 2021.https://doi.org/10.1016/j.cmi.2021.06.043
30. Katz MA, Bron Harlev E, Chazan B, et al. Covid-19 Vaccine Effectiveness in Healthcare Personnel in six Israeli Hospitals (CoVEHPI). *medRxiv.* 2021:2021.2008.2030.21262465.https://doi.org/10.1101/2021.08.30.21262465
31. Puranik A, Lenehan PJ, Silvert E, et al. Comparison of two highly-effective mRNA vaccines for COVID-19 during periods of Alpha and Delta variant prevalence. *medRxiv.* 2021:2021.2008.2006.21261707.https://doi.org/10.1101/2021.08.06.21261707
32. Tartof SY, Slezak JM, Fischer H, et al. Effectiveness of mRNA BNT162b2 COVID-19 vaccine up to 6 months in a large integrated health system in the USA: a retrospective cohort study. *The Lancet.* 2021;398(10309):1407-1416.https://doi.org/10.1016/S0140-6736(21)02183-8
33. Irizarry RA, Robles-Fontan MM, Nieves EG, Cardona-Gerena I, Irizarry RA. Time-Varying Effectiveness of Three Covid-19 Vaccines in Puerto Rico. *medRxiv.* 2021:2021.2010.2017.21265101.https://doi.org/10.1101/2021.10.17.21265101
34. Fabiani M, Ramigni M, Gobbetto V, Mateo-Urdiales A, Pezzotti P, Piovesan C. Effectiveness of the comirnaty (BNT162b2, BioNTech/Pfizer) vaccine in preventing SARS-CoV-2 infection among healthcare workers, Treviso province, Veneto region, Italy, 27 December 2020 to 24 March 2021. *Eurosurveillance.* 2021;26(17):1-7.https://doi.org/10.2807/1560-7917.ES.2021.26.17.2100420
35. Bjork J, Bonander C, Moghaddassi M, et al. Surveillance of COVID-19 vaccine effectiveness - a real-time case-control study in southern Sweden. *medRxiv.* 2021:2021.2012.2009.21267515.https://doi.org/10.1101/2021.12.09.21267515
36. Knobel P, Serra C, Grau S, et al. Coronavirus disease 2019 (COVID-19) mRNA vaccine effectiveness in asymptomatic healthcare workers. *Infection Control & Hospital Epidemiology.* 2021:1-2.https://doi.org/10.1017/ice.2021.287
37. Gomes D, Beyerlein A, Katz K, et al. Is the BNT162b2 COVID-19 vaccine effective in elderly populations? Results from population data from Bavaria, Germany. *PLoS One.* 2021;16(11):e0259370.https://doi.org/10.1371/journal.pone.0259370
38. Tande AJ, Pollock BD, Shah ND, Binnicker M, Berbari EF. mRNA Vaccine Effectiveness Against Asymptomatic SARS-CoV-2 Infection Over a Seven-Month Period. *Infect Control Hosp Epidemiol.* 2021:1-7.https://doi.org/10.1017/ice.2021.399
39. McQuade ETR, Platts-Mills JA. ChAdOx1 nCoV-19 vaccine: asymptomatic efficacy estimates. *The Lancet.* 2021;397(10291):2247-2248.https://doi.org/10.1016/S0140-6736(21)00951-X
40. Bhatnagar T, Chaudhuri S, Ponnaiah M, et al. Effectiveness of BBV152/Covaxin and AZD1222/Covishield Vaccines Against Severe COVID-19 and B.1.617.2/Delta Variant in India, 2021: A Multi-Centric Hospital-Based Case-Control Study. *SSRN.* 2021.https://doi.org/https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3955739
41. Paixão ES, Wong KL, Alves FJO, de Araújo Oliveira V, Cerqueira-Silva T, Júnior JB. Effectiveness of the CoronaVac Vaccine in Prevention of Symptomatic and Progression to Severe COVID-19 in Pregnant Women in Brazil. *SSRN.* 2021. https://ssrn.com/abstract=3962119.
42. Heath PT, Galiza EP, Baxter DN, et al. Safety and Efficacy of NVX-CoV2373 Covid-19 Vaccine. *New England Journal of Medicine.* 2021.https://doi.org/10.1056/NEJMoa2107659

43. Lopez Bernal J, Andrews N, Gower C, et al. Effectiveness of Covid-19 Vaccines against the B.1.617.2 (Delta) Variant. *New England Journal of Medicine.* 2021;385(7):585-594.https://doi.org/10.1056/NEJMoa2108891
44. Nasreen S, Chung H, He S, et al. Effectiveness of COVID-19 vaccines against variants of concern in Ontario, Canada. *medRxiv.* 2021:2021.2006.2028.21259420.https://doi.org/10.1101/2021.06.28.21259420
45. Seppälä E, Veneti L, Starrfelt J, et al. Vaccine effectiveness against infection with the delta (b.1.617.2) variant, norway, april to august 2021. *Eurosurveillance.* 2021;26(35).https://doi.org/10.2807/1560-7917.ES.2021.26.35.2100793
46. Sheikh A, McMenamin J, Taylor B, Robertson C. SARS-CoV-2 Delta VOC in Scotland: demographics, risk of hospital admission, and vaccine effectiveness. *The Lancet.* 2021;397(10293):2461-2462.https://doi.org/10.1016/S0140-6736(21)01358-1
47. Pouwels KB, Pritchard E, Matthews P, et al. Impact of Delta on viral burden and vaccine effectiveness against new SARS-CoV-2 infections in the UK. *medRxiv.* 2021:2021.2008.2018.21262237.https://doi.org/10.1101/2021.08.18.21262237
48. Chemaitelly H, Yassine HM, Benslimane FM, et al. mRNA-1273 COVID-19 vaccine effectiveness against the B.1.1.7 and B.1.351 variants and severe COVID-19 disease in Qatar. *Nature Medicine.* 2021.https://doi.org/10.1038/s41591-021-01446-y
49. Bruxvoort K, Sy LS, Qian L, et al. Effectiveness of mRNA-1273 against Delta, Mu, and other emerging variants. *medRxiv.* 2021:2021.2009.2029.21264199.https://doi.org/10.1101/2021.09.29.21264199
50. Singer SR, Angulo FJ, Swerdlow DL, et al. Effectiveness of BNT162b2 mRNA COVID-19 vaccine against SARS-CoV-2 variant Beta (B.1.351) among persons identified through contact tracing in Israel: A prospective cohort study. *EClinicalMedicine.* 2021;42.https://doi.org/10.1016/j.eclinm.2021.101190
51. Chen Y, Shen H, Huang R, Tong X, Wu C. Serum neutralising activity against SARS-CoV-2 variants elicited by CoronaVac. *The Lancet Infectious Diseases.* 2021;21(8):1071-1072.https://doi.org/10.1016/S1473-3099(21)00287-5
52. Gidari A, Sabbatini S, Bastianelli S, et al. Cross-neutralization of SARS-CoV-2 B.1.1.7 and P.1 variants in vaccinated, convalescent and P.1 infected. *Journal of Infection.* 2021.https://doi.org/10.1016/j.jinf.2021.07.019
53. Ranzani O, Hitchings M, Neto M, et al. Effectiveness of the CoronaVac vaccine in the elderly population during a P.1 variant-associated epidemic of COVID-19 in Brazil: A test-negative case-control study. *medRxiv preprint.* 2021.https://doi.org/10.1101/2021.05.19.21257472
54. World Health Organization. The Sinovac-CoronaVac COVID-19 vaccine: What you need to know. World Health Organization. https://www.who.int/news-room/feature-stories/detail/the-sinovac-covid-19-vaccine-what-you-need-to-know?gclid=Cj0KCQjw4eaJBhDMARIsANhrQADBYtFm2zMvzbfjthveE2gmCJTRl_jPc4HPlIFSwdZpzTix45gmEM0aAml9EALw_wcB. Published 2021. Updated 2 September 2021. Accessed 8 September, 2021.
55. Borges MC, Palacios R, Brango HA, et al. Projeto S: A Stepped-Wedge Randomized Trial to Assess CoronaVac Effectiveness in Serrana, Brazil. *SSRN - Preprint.* 2021.https://doi.org/10.2139/ssrn.3973422
56. Grant R, Charmet T, Schaeffer L, et al. Impact of SARS-CoV-2 Delta variant on incubation, transmission settings and vaccine effectiveness: Results from a nationwide case-control study in France. *Lancet Reg Health Eur.* 2021:100278.https://doi.org/10.1016/j.lanepe.2021.100278
57. State of Israel Ministry of Health. Vaccine efficacy among those first vaccinated. https://www.gov.il/BlobFolder/reports/vaccine-efficacy-safety-follow-up-

committee/he/files_publications_corona_two-dose-vaccination-data.pdf Published 2021. Accessed 25 August, 2021.

58. Andrews N, Tessier E, Stowe J, et al. Vaccine effectiveness and duration of protection of Comirnaty, Vaxzevria and Spikevax against mild and severe COVID-19 in the UK *Public Health England - Preprint.* 2021. https://khub.net/documents/135939561/338928724/Vaccine+effectiveness+and+duration+of+protection+of+covid+vaccines+against+mild+and+severe+COVID-19+in+the+UK.pdf/10dcd99c-0441-0403-dfd8-11ba2c6f5801.
59. Nanduri S, Pilishvili T, Derado G, Schrag SJ. Effectiveness of Pfizer-BioNTech and Moderna Vaccines in Preventing SARS-CoV-2 Infection Among Nursing Home Residents Before and During Widespread Circulation of the SARS-CoV-2 B.1.617.2 (Delta) Variant - National Healthcare Safety Network, March 1–August 1. *Morbidity & Mortality Weekly Report.* 2021;70(34):163-1166.https://doi.org/10.15585/mmwr.mm7034e3
60. Cohn BA, Cirillo PM, Murphy CC, Krigbaum NY, Wallace AW. Breakthrough SARS-CoV-2 infections in 620,000 U.S. Veterans, February 1, 2021 to August 13, 2021. *medRxiv.* 2021:2021.2010.2013.21264966.https://doi.org/10.1101/2021.10.13.21264966
61. Mayo Foundation for Medical Education and Research (MFMER). Do COVID-19 vaccines protect against the variants? Mayo Clinic. Published 2021. Updated 24 August 2021. Accessed 8 September, 2021.
62. Chin ET, Leidner D, Zhang Y, et al. Effectiveness of the mRNA-1273 Vaccine during a SARS-CoV-2 Delta Outbreak in a Prison. *New England Journal of Medicine.* 2021.https://doi.org/10.1056/NEJMc2114089
63. Mlcochova P, Kemp SA, Shanker Dhar M, et al. SARS-CoV-2 B.1.617.2 Delta variant replication, sensitivity to neutralising antibodies and vaccine breakthrough. *bioRxiv.* 2021:2021.2005.2008.443253.https://doi.org/10.1101/2021.05.08.443253
64. Li X-n, Huang Y, Wang W, et al. Efficacy of inactivated SARS-CoV-2 vaccines against the Delta variant infection in Guangzhou: A test-negative case-control real-world study. *Emerging Microbes & Infections.* 2021:1-32.https://doi.org/10.1080/22221751.2021.1969291
65. Uriu K, Kimura I, Shirakawa K, et al. Neutralization of the SARS-CoV-2 Mu Variant by Convalescent and Vaccine Serum. *New England Journal of Medicine.* 2021.https://doi.org/10.1056/NEJMc2114706
66. Rickeard NAJSFKSTT. Effectiveness of COVID-19 vaccines against the Omicron (B.1.1.529) variant of concern. 2021. https://khub.net/documents/135939561/430986542/Effectiveness+of+COVID-19+vaccines+against+Omicron+variant+of+concern.pdf/f423c9f4-91cb-0274-c8c5-70e8fad50074.
67. Volkov O. Predicted Symptomatic Effectiveness of Pfizer-BioNTech BNT162b2 Vaccine Against Omicron Variant of SARS-CoV-2. *medRxiv.* 2021:2021.2012.2009.21267556.https://doi.org/10.1101/2021.12.09.21267556
68. Suah JL, Tok PSK, Ong SM, et al. Pick-ing malaysia's epidemic apart: Effectiveness of a diverse covid-19 vaccine portfolio. *Vaccines.* 2021;9(12).https://doi.org/10.3390/vaccines9121381
69. Clifford S, Waight P, Hackman J, et al. Effectiveness of BNT162b2 and ChAdOx1 against SARS-CoV-2 household transmission - a prospective cohort study in England. *medRxiv.* 2021:2021.2011.2024.21266401.https://doi.org/10.1101/2021.11.24.21266401
70. Stowe J, Andrews N, Gower C, et al. Effectiveness of COVID-19 vaccines against hospital admission with the delta (B.1.617.2) variant. *Public Health Enland Publishing*

- *Preprint.* 2021. https://khub.net/web/phe-national/public-library/-/document_library/v2WsRK3ZlEig/view_file/479607329?_com_liferay_document_library_web_portlet_DLPortlet_INSTANCE_v2WsRK3ZlEig_redirect=https%3A%2F%2Fkhub.net%3A443%2Fweb%2Fphe-national%2Fpublic-library%2F-%2Fdocument_library%2Fv2WsRK3ZlEig%2Fview%2F479607266.

71. Foley KE. J&J shot effective against Delta variant in large South Africa study. Politico. https://www.politico.eu/article/johnson-johnson-coronavirus-vaccine-delta-variant/. Published 2021. Updated 6 August 2021. Accessed 7 September, 2021.
72. de Gier B, Andeweg S, Joosten R, et al. Vaccine effectiveness against SARS-CoV-2 transmission and infections among household and other close contacts of confirmed cases, the Netherlands, February to May 2021. *Eurosurveillance.* 2021;26(31).https://doi.org/10.2807/1560-7917.ES.2021.26.31.2100640
73. Tenforde MW, Self WH, Naioti EA, et al. Sustained Effectiveness of Pfizer-BioNTech and Moderna Vaccines Against COVID-19 Associated Hospitalizations Among Adults — United States, March–July 2021. *Morbidity & Mortality Weekly Report.* 2021;70(34):1156-1162.https://doi.org/10.15585/mmwr.mm7034e2
74. Grannis SJ, Rowley EA, Ong TC, et al. Interim Estimates of COVID-19 Vaccine Effectiveness Against COVID-19–Associated Emergency Department or Urgent Care Clinic Encounters and Hospitalizations Among Adults During SARS-CoV-2 B.1.617.2 (Delta) Variant Predominance — Nine States, June–August 2021. *Morbidity & Mortality Weekly Report.* 2021;70(37):1291–1293. https://www.cdc.gov/mmwr/volumes/70/wr/mm7037e2.htm.
75. Tartof SY, Slezak JM, Fischer H, et al. Six-Month Effectiveness of BNT162B2 mRNA COVID-19 Vaccine in a Large US Integrated Health System: A Retrospective Cohort Study. *SSRN - Preprint.* 2021.https://doi.org/10.2139/ssrn.3909743
76. Rosenberg ES, Dorabawila V, Easton D, et al. Covid-19 Vaccine Effectiveness in New York State. *New England Journal of Medicine.* 2021.https://doi.org/10.1056/NEJMoa2116063
77. Sheikh A, Robertson C, Taylor B. BNT162b2 and ChAdOx1 nCoV-19 Vaccine Effectiveness against Death from the Delta Variant. *New England Journal of Medicine.* 2021.https://doi.org/10.1056/NEJMc2113864
78. Sheikh A, Robertson C, Taylor B. BNT162b2 and ChAdOx1 nCoV-19 Vaccine Effectiveness against Death from the Delta Variant. *New England Journal of Medicine.* 2021;385(23):2195-2197.https://doi.org/10.1056/NEJMc2113864
79. Dickerman BA, Gerlovin H, Madenci AL, et al. Comparative Effectiveness of BNT162b2 and mRNA-1273 Vaccines in U.S. Veterans. *New England Journal of Medicine.* 2021.https://doi.org/10.1056/NEJMoa2115463
80. Thiruvengadam R, Awasthi A, Medigeshi G, et al. Effectiveness of ChAdOx1 nCoV-19 vaccine against SARS-CoV-2 infection during the delta (B.1.617.2) variant surge in India: a test-negative, case-control study and a mechanistic study of post-vaccination immune responses. *Lancet Infect Dis.* 2021.https://doi.org/10.1016/s1473-3099(21)00680-0
81. Johnson & Johnson. Positive New Data for Johnson & Johnson Single-Shot COVID-19 Vaccine on Activity Against Delta Variant and Long-lasting Durability of Response. Johnson & Johnson. https://www.jnj.com/positive-new-data-for-johnson-johnson-single-shot-covid-19-vaccine-on-activity-against-delta-variant-and-long-lasting-durability-of-response. Published 2021. Updated 1 July 2021. Accessed 8 September, 2021.
82. Hu Z, Tao B, Li Z, et al. Effectiveness of inactive COVID-19 vaccines against severe illness in B.1.617.2 (Delta) variant-infected patients in Jiangsu, China. *medRxiv.* 2021:2021.2009.2002.21263010.https://doi.org/10.1101/2021.09.02.21263010

83. Gardner BJ, Kilpatrick AM. Estimates of reduced vaccine effectiveness against hospitalization, infection, transmission and symptomatic disease of a new SARS-CoV-2 variant, Omicron (B.1.1.529), using neutralizing antibody titers. *medRxiv.* 2021:2021.2012.2010.21267594.https://doi.org/10.1101/2021.12.10.21267594
84. Israel A, Merzon E, Schäffer AA, et al. Elapsed time since BNT162b2 vaccine and risk of SARS-CoV-2 infection in a large cohort. *medRxiv.* 2021:2021.2008.2003.21261496.https://doi.org/10.1101/2021.08.03.21261496
85. Salvagno GL, Henry B, Pighi L, De Nitto S, Lippi G. Total Anti-SARS-CoV-2 Antibodies Measured 6 Months After Pfizer-BioNTech COVID-19 Vaccination in Healthcare Workers. *SSRN- Preprint.* 2021.https://doi.org/10.2139/ssrn.3915349
86. Collier A-rY, Yu J, McMahan K, et al. Differential Kinetics of Immune Responses Elicited by Covid-19 Vaccines. *New England Journal of Medicine.* 2021;385(21):2010-2012.https://doi.org/10.1056/NEJMc2115596
87. Barin B, Kasap U, Selçuk F, Volkan E, Uluckan O. Longitudinal Comparison of SARS-CoV-2 Anti-Spike RBD IgG antibody Responses After CoronaVac, BNT162b2, ChAdOx1 nCoV-19 Vaccines and Evaluation of a Single Booster Dose of BNT162b2 or CoronaVac After a Primary CoronaVac Regimen. *SSRN - Preprint.* 2021. https://ssrn.com/abstract=3929973.
88. Levin EG, Lustig Y, Cohen C, et al. Waning Immune Humoral Response to BNT162b2 Covid-19 Vaccine over 6 Months. *New England Journal of Medicine.* 2021.https://doi.org/10.1056/NEJMoa2114583
89. Doria-Rose N, Suthar MS, Makowski M, et al. Antibody Persistence through 6 Months after the Second Dose of mRNA-1273 Vaccine for Covid-19. *New England Journal of Medicine.* 2021;384(23):2259-2261.https://doi.org/10.1056/NEJMc2103916
90. Flaxman A, Marchevsky N, Jenkin D, et al. Tolerability and Immunogenicity After a Late Second Dose or a Third Dose of ChAdOx1 nCoV-19 (AZD1222). *SSRN - Preprint.* 2021.https://doi.org/10.2139/ssrn.3873839
91. Sadoff J, Le Gars M, Cardenas V, et al. Durability of antibody responses elicited by a single dose of Ad26.COV2.S and substantial increase following late boosting. *medRxiv.* 2021:2021.2008.2025.21262569.https://doi.org/10.1101/2021.08.25.21262569
92. Barouch DH, Stephenson KE, Sadoff J, et al. Durable Humoral and Cellular Immune Responses 8 Months after Ad26.COV2.S Vaccination. *New England Journal of Medicine.* 2021.https://doi.org/http://doi.org/10.1056/NEJMc2108829
93. Badano MN, Sabbione F, Keitelman I, et al. Humoral response to the BBIBP-CorV vaccine over time in healthcare workers with or without exposure to SARS-CoV-2. *medRxiv.* 2021:2021.2010.2002.21264432.https://doi.org/10.1101/2021.10.02.21264432
94. Ju B, Zhou B, Song S, et al. Potent antibody immunity to SARS-CoV-2 variants elicited by a third dose of inactivated vaccine. *bioRxiv.* 2021:2021.2011.2010.468037.https://doi.org/10.1101/2021.11.10.468037
95. Li M, Yang J, Wang L, et al. A booster dose is immunogenic and will be needed for older adults who have completed two doses vaccination with CoronaVac: a randomised, double-blind, placebo-controlled, phase 1/2 clinical trial. *medRxiv.* 2021:2021.2008.2003.21261544.https://doi.org/10.1101/2021.08.03.21261544
96. Wang K, Cao YR, Zhou Y, et al. A third dose of inactivated vaccine augments the potency, breadth, and duration of anamnestic responses against SARS-CoV-2. *medRxiv.* 2021:2021.2009.2002.21261735.https://doi.org/10.1101/2021.09.02.21261735

97. Chemaitelly H, Tang P, Hasan MR, et al. Waning of BNT162b2 vaccine protection against SARS-CoV-2 infection in Qatar. *medRxiv.* 2021:2021.2008.2025.21262584.https://doi.org/10.1101/2021.08.25.21262584
98. Iskander J, Frost JK, Russell S, et al. Effectiveness of Vaccination Against Reported SARS-CoV-2 Infection in United States Coast Guard Personnel Between May and August 2021: A Time-Series Analysis. *medRxiv.* 2021:2021.2011.2019.21266537.https://doi.org/10.1101/2021.11.19.21266537
99. Feikin D, Higdon MM, Abu-Raddad LJ, Andrews N, Araos R, Goldberg Y. Duration of Effectiveness of Vaccines Against SARS-CoV-2 Infection and COVID-19 Disease: Results of a Systematic Review and Meta-Regression. *SSRN.* 2021. https://ssrn.com/abstract=3961378.
100. Poukka E, Baum U, Palmu AA, et al. Cohort study of Covid-19 vaccine effectiveness among healthcare workers in Finland, December 2020 - October 2021. *medRxiv.* 2021:2021.2011.2003.21265791.https://doi.org/10.1101/2021.11.03.21265791
101. Cohn BA, Cirillo PM, Murphy CC, Krigbaum NY, Wallace AW. SARS-CoV-2 vaccine protection and deaths among US veterans during 2021. *Science.* 2021:eabm0620.https://doi.org/10.1126/science.abm0620
102. Hall VJ, Foulkes S, Insalata F, et al. Effectiveness and durability of protection against future SARS-CoV-2 infection conferred by COVID-19 vaccination and previous infection; findings from the UK SIREN prospective cohort study of healthcare workers March 2020 to September 2021. *medRxiv.* 2021:2021.2011.2029.21267006.https://doi.org/10.1101/2021.11.29.21267006
103. Baden LR, ElSahly HM, Essink B, et al. Covid-19 in the Phase 3 Trial of mRNA-1273 During the Delta-variant Surge. *medRxiv.* 2021:2021.2009.2017.21263624.https://doi.org/10.1101/2021.09.17.21263624
104. Prunas O, Warren JL, Crawford FW, et al. Vaccination with BNT162b2 reduces transmission of SARS-CoV-2 to household contacts in Israel. *medRxiv.* 2021:2021.2007.2013.21260393.https://doi.org/10.1101/2021.07.13.21260393
105. Riemersma KK, Grogan BE, Kita-Yarbro A, et al. Shedding of Infectious SARS-CoV-2 Despite Vaccination when the Delta Variant is Prevalent - Wisconsin, July 2021. *medRxiv.* 2021:2021.2007.2031.21261387.https://doi.org/10.1101/2021.07.31.21261387
106. Harris RJ, Hall JA, Zaidi A, Andrews NJ, Dunbar JK, Dabrera G. Effect of vaccination on household transmission of sars-cov-2 in england. *New England Journal of Medicine.* 2021;385(8):759-760.https://doi.org/10.1056/NEJMc2107717
107. Shah ASV, Gribben C, Bishop J, et al. Effect of vaccination on transmission of COVID-19: an observational study in healthcare workers and their households. *medRxiv.* 2021:2021.2003.2011.21253275.https://doi.org/10.1101/2021.03.11.21253275
108. de Gier B, Andeweg S, Backer JA, et al. Vaccine effectiveness against SARS-CoV-2 transmission to household contacts during dominance of Delta variant (B.1.617.2), the Netherlands, August to September 2021. *Euro Surveill.* 2021;26(44).https://doi.org/10.2807/1560-7917.Es.2021.26.44.2100977
109. Emary KRW, Golubchik T, Aley PK, et al. Efficacy of ChAdOx1 nCoV-19 (AZD1222) vaccine against SARS-CoV-2 variant of concern 202012/01 (B.1.1.7): an exploratory analysis of a randomised controlled trial. *Lancet.* 2021;397(10282):1351-1362.https://doi.org/10.1016/s0140-6736(21)00628-0
110. Kemp SA, Cheng MTK, Hamilton W, et al. Transmission of B.1.617.2 Delta Variant between vaccinated healthcare workers in Delhi, India. *medRxiv.* 2021:2021.2011.2019.21266406.https://doi.org/10.1101/2021.11.19.21266406

111. Bosch W, Cowart JB, Bhakta S, et al. COVID-19 Vaccine-Breakthrough Infections Requiring Hospitalization in Mayo Clinic Florida through August 2021. *Clin Infect Dis.* 2021.https://doi.org/10.1093/cid/ciab932
112. Mizrahi B, Lotan R, Kalkstein N, et al. Correlation of SARS-CoV-2-breakthrough infections to time-from-vaccine. *Nat Commun.* 2021;12(1):6379.https://doi.org/10.1038/s41467-021-26672-3
113. Preiser; CKCKMMCTGMADSTSMSW. Breakthrough Infections with SARS-CoV-2 Omicron Variant Despite Booster Dose of mRNA Vaccine. *SSRN.* 2021.https://doi.org/https://dx.doi.org/10.2139/ssrn.3981711
114. Dash GC, Subhadra S, Turuk J, et al. Breakthrough SARS-CoV-2 infections among BBV-152 (COVAXIN®) and AZD1222 (COVISHIELDTM) recipients: Report from the eastern state of India. *Journal of Medical Virology.* 2021.https://doi.org/10.1002/jmv.27382
115. Chau NVV, Ngoc NM, Nguyet LA, et al. An observational study of breakthrough SARS-CoV-2 Delta variant infections among vaccinated healthcare workers in Vietnam. *EClinicalMedicine.* 2021;41:101143.https://doi.org/10.1016/j.eclinm.2021.101143
116. Maurya D, Kaur A, Faraz F, Tandon S, Rana A, Grover S. Assessment of breakthrough infections among post-vaccinated healthcare workers in a Tertiary Dental Hospital in New Delhi, India. *medRxiv.* 2021:2021.2011.2015.21266333.https://doi.org/10.1101/2021.11.15.21266333
117. Oliver SE, Gargano JW, Marin M, et al. The Advisory Committee on Immunization Practices' Interim Recommendation for Use of Pfizer-BioNTech COVID-19 Vaccine - United States, December 2020. *MMWR Morbidity and mortality weekly report.* 2020;69(50):1922-1924.https://doi.org/10.15585/mmwr.mm6950e2
118. Im JH, Kim E, Lee E, et al. Adverse Events with the Pfizer-BioNTech COVID-19 Vaccine among Korean Healthcare Workers. *Yonsei Med J.* 2021;62(12):1162-1168.https://doi.org/10.3349/ymj.2021.62.12.1162
119. Caminati M, Guarnieri G, Batani V, et al. Covid-19 vaccination in patients with severe asthma on biologic treatment: Safety, tolerability, and impact on disease control. *Vaccines.* 2021;9(8).https://doi.org/10.3390/vaccines9080853
120. Haroun F, Alharbi M, Hong A. Case series on the safety of mRNA COVID19 vaccines in cancer patients undergoing treatment. *Journal of Clinical Oncology.* 2021;39(15 SUPPL).https://doi.org/10.1200/JCO.2021.39.15_suppl.e14562
121. Baden LR, El Sahly HM, Essink B, et al. Efficacy and Safety of the mRNA-1273 SARS-CoV-2 Vaccine. *New England Journal of Medicine.* 2020;384(5):403-416.https://doi.org/10.1056/NEJMoa2035389
122. Wei N, Fishman M, Wattenberg D, Gordon M, Lebwohl M. "COVID arm": A reaction to the Moderna vaccine. *JAAD Case Rep.* 2021;10:92-95.https://doi.org/10.1016/j.jdcr.2021.02.014
123. Voysey M, Costa Clemens SA, Madhi SA, et al. Safety and efficacy of the ChAdOx1 nCoV-19 vaccine (AZD1222) against SARS-CoV-2: an interim analysis of four randomised controlled trials in Brazil, South Africa, and the UK. *The Lancet.* 2021;397(10269):99-111.https://doi.org/10.1016/S0140-6736(20)32661-1
124. Ghiasi N, Valizadeh R, Arabsorkhi M, et al. Efficacy and side effects of Sputnik V, Sinopharm and AstraZeneca vaccines to stop COVID-19; a review and discussion. 2021.https://doi.org/http://immunopathol.com/PDF/ipp-7-e31.pdf
125. Shay DK, Gee J, Su JR, et al. Safety Monitoring of the Janssen (Johnson & Johnson) COVID-19 Vaccine - United States, March–April 2021. *Morbidity and Mortality Weekly Report.* 2021;70(18):680–684.https://doi.org/http://dx.doi.org/10.15585/mmwr.mm7018e2external

126. Saeed BQ, Al-Shahrabi R, Alhaj SS, Alkokhardi ZM, Adrees AO. Side Effects and Perceptions Following Sinopharm COVID-19 Vaccination. *Int J Infect Dis.* 2021.https://doi.org/10.1016/j.ijid.2021.08.013
127. Palacios R, Batista AP, Santos Nascimento Albuquerque C, et al. Efficacy and Safety of a COVID-19 Inactivated Vaccine in Healthcare Professionals in Brazil: The PROFISCOV Study. *SSRN - Preprint.* 2021.https://doi.org/http://dx.doi.org/10.2139/ssrn.3822780
128. Durmaz K, Temiz SA, Zuhal K, Dursun R, Abdelmaksoud A. Allergic and Cutaneous reactions following Inactivated SARS-CoV-2 vaccine (CoronaVac®) in Healthcare workers. *Clin Exp Dermatol.* 2021.https://doi.org/10.1111/ced.14896
129. Benjamanukul S, Traiyan S, Yorsaeng R, et al. Safety and immunogenicity of inactivated COVID-19 vaccine in health care workers. *J Med Virol.* 2021.https://doi.org/10.1002/jmv.27458
130. Ella R, Reddy S, Blackwelder W, et al. Efficacy, safety, and lot to lot immunogenicity of an inactivated SARS-CoV-2 vaccine (BBV152): a, double-blind, randomised, controlled phase 3 trial. *medRxiv.* 2021:2021.2006.2030.21259439.https://doi.org/10.1101/2021.06.30.21259439
131. Kim HW, Jenista ER, Wendell DC, et al. Patients With Acute Myocarditis Following mRNA COVID-19 Vaccination. *JAMA Cardiology.* 2021.https://doi.org/10.1001/jamacardio.2021.2828
132. Bozkurt B, Kamat I, Hotez PJ. Myocarditis With COVID-19 mRNA Vaccines. *Circulation.* 2021;144(6):471-484.https://doi.org/doi:10.1161/CIRCULATIONAHA.121.056135
133. Kafil T, Lamacie MM, Chenier S, et al. mRNA COVID-19 Vaccination and Development of CMR-confirmed Myopericarditis. *medRxiv.* 2021:2021.2009.2013.21262182.https://doi.org/10.1101/2021.09.13.21262182
134. Cirillo N. Reported orofacial adverse effects of COVID-19 vaccines: The knowns and the unknowns. *Journal of Oral Pathology & Medicine.* 2021;50(4):424-427.https://doi.org/10.1111/jop.13165
135. Shimabukuro T. Allergic reactions including anaphylaxis after receipt of the first dose of Pfizer-BioNTech COVID-19 vaccine - United States, December 14-23, 2020. *Am J Transplant.* 2021;21(3):1332-1337.https://doi.org/10.1111/ajt.16516
136. Polack FP, Thomas SJ, Kitchin N, et al. Safety and Efficacy of the BNT162b2 mRNA Covid-19 Vaccine. *New England Journal of Medicine.* 2020;383(27):2603-2615.https://doi.org/10.1056/NEJMoa2034577
137. Cohen OG, Clark AK, Milbar H, Tarlow M. Pityriasis rosea after administration of Pfizer-BioNTech COVID-19 vaccine. *Hum Vaccin Immunother.* 2021:1-2.https://doi.org/10.1080/21645515.2021.1963173
138. Temiz SA, Abdelmaksoud A, Dursun R, Durmaz K, Sadoughifar R, Hasan A. Pityriasis rosea following SARS-CoV-2 vaccination: A case series. *Journal of Cosmetic Dermatology.* 2021.https://doi.org/10.1111/jocd.14372
139. Vassallo C, Boveri E, Brazzelli V, et al. Cutaneous lymphocytic vasculitis after administration of COVID-19 mRNA vaccine. *Dermatol Ther.* 2021:e15076.https://doi.org/10.1111/dth.15076
140. Santovito LS, Pinna G. A case of reactivation of varicella-zoster virus after BNT162b2 vaccine second dose? *Inflamm Res.* 2021:1-3.https://doi.org/10.1007/s00011-021-01491-w
141. Fathy RA, McMahon DE, Lee C, et al. Varicella Zoster and Herpes Simplex Virus Reactivation Post-COVID-19 Vaccination: A Review of 40 Cases in an International Dermatology Registry. *J Eur Acad Dermatol Venereol.* 2021.https://doi.org/10.1111/jdv.17646

142. Papasavvas I, de Courten C, Herbort CP, Jr. Varicella-zoster virus reactivation causing herpes zoster ophthalmicus (HZO) after SARS-CoV-2 vaccination - report of three cases. *J Ophthalmic Inflamm Infect.* 2021;11(1):28.https://doi.org/10.1186/s12348-021-00260-4
143. Soub HA, Ibrahim W, Maslamani MA, A. Ali G, Ummer W, Abu-Dayeh A. Kikuchi-Fujimoto disease following SARS CoV2 vaccination: Case report. *IDCases.* 2021;25.https://doi.org/10.1016/j.idcr.2021.e01253
144. Chamarti K, Dar K, Reddy A, Gundlapalli A, Mourning D, Bajaj K. Thrombotic Thrombocytopenic Purpura Presentation in an Elderly Gentleman Following COVID Vaccine Circumstances. *Cureus.* 2021;13(7):e16619.https://doi.org/10.7759/cureus.16619
145. Collins EC, Carr MJ, Kim JS, et al. Immune thrombocytopenia in 2 healthy young women after the Pfizer-BioNTech BNT16B2b2 messenger RNA coronavirus disease 2019 vaccination. *J Am Coll Emerg Physicians Open.* 2021;2(5):e12531.https://doi.org/10.1002/emp2.12531
146. Horino T. IgA nephropathy flare-up following SARS-CoV-2 vaccination. *QJM : monthly journal of the Association of Physicians.* 2021.https://doi.org/10.1093/qjmed/hcab223
147. Hughes DL, Brunn JA, Jacobs J, Todd PK, Askari FK, Fontana RJ. Guillain-Barré syndrome after COVID-19 mRNA vaccination in a liver transplant recipient with favorable treatment response. *Liver Transpl.* 2021.https://doi.org/10.1002/lt.26279
148. Osowicki J, Morgan H, Harris A, Crawford NW, Buttery JP, Kiers L. Guillain-Barré Syndrome in an Australian state using both mRNA and adenovirus-vector SARS-CoV-2 vaccines. *Ann Neurol.* 2021.https://doi.org/10.1002/ana.26218
149. Perna D, Jones J, Schadt CR. Acute generalized pustular psoriasis exacerbated by the COVID-19 vaccine. *JAAD Case Rep.* 2021.https://doi.org/10.1016/j.jdcr.2021.08.035
150. Iwata H, Kamiya K, Kado S, et al. Case of immunoglobulin A vasculitis following coronavirus disease 2019 vaccination. *J Dermatol.* 2021.https://doi.org/10.1111/1346-8138.16167
151. Mücke VT, Knop V, Mücke MM, Ochsendorf F, Zeuzem S. First description of immune complex vasculitis after COVID-19 vaccination with BNT162b2: a case report. *BMC Infect Dis.* 2021;21(1):958.https://doi.org/10.1186/s12879-021-06655-x
152. Elias C, Cardoso P, Gonçalves D, Vaz I, Cardoso L. Rhabdomyolysis Following Administration of Comirnaty(®). *Eur J Case Rep Intern Med.* 2021;8(8):002796.https://doi.org/10.12890/2021_002796
153. Franquemont S, Galvez J. Subacute Thyroiditis After mRNA Vaccine for Covid-19. *J Endocr Soc.* 2021;5(Suppl 1):A956-A957.https://doi.org/10.1210/jendso/bvab048.1954
154. Sato K, Mano T, Niimi Y, Toda T, Iwata A, Iwatsubo T. Facial nerve palsy following the administration of COVID-19 mRNA vaccines: analysis of a self-reporting database. *Int J Infect Dis.* 2021;111:310-312.https://doi.org/10.1016/j.ijid.2021.08.071
155. Buján Bonino C, Moreiras Arias N, López-Pardo Rico M, et al. Atypical erythema multiforme related to BNT162b2 (Pfizer-BioNTech) COVID-19 vaccine. *Int J Dermatol.* 2021.https://doi.org/10.1111/ijd.15894
156. Yoshifuji A, Ishioka K, Masuzawa Y, et al. COVID-19 vaccine induced interstitial lung disease. *J Infect Chemother.* 2021.https://doi.org/10.1016/j.jiac.2021.09.010
157. Valenzuela DA, Groth S, Taubenslag KJ, Gangaputra S. Acute macular neuroretinopathy following Pfizer-BioNTech COVID-19 vaccination. *Am J Ophthalmol Case Rep.* 2021;24:101200.https://doi.org/10.1016/j.ajoc.2021.101200

158. Coffman JR, Randolph AC, Somerson JS. Parsonage-Turner Syndrome After SARS-CoV-2 BNT162b2 Vaccine: A Case Report. *JBJS Case Connect.* 2021;11(3).https://doi.org/10.2106/jbjs.Cc.21.00370
159. Rubinstein TJ. Thyroid Eye Disease Following COVID-19 Vaccine in a Patient With a History Graves' Disease: A Case Report. *Ophthalmic Plast Reconstr Surg.* 2021.https://doi.org/10.1097/iop.0000000000002059
160. Yamamoto K, Mashiba T, Takano K, et al. A case of exacerbation of subclinical hyperthyroidism after first administration of bnt162b2 mrna covid-19 vaccine. *Vaccines.* 2021;9(10).https://doi.org/10.3390/vaccines9101108
161. Nassar M, Chung H, Dhayaparan Y, et al. COVID-19 vaccine induced rhabdomyolysis: Case report with literature review. *Diabetes Metab Syndr.* 2021;15(4):102170-102170.https://doi.org/10.1016/j.dsx.2021.06.007
162. Hong S, Fata M, Rahim M, Hanly B, Omidvari K. A RARE CASE OF INTERNAL JUGULAR VEIN THROMBOSIS AFTER MRNA COVID-19 VACCINE. *Chest.* 2021;160(4):A457-A458.https://doi.org/10.1016/j.chest.2021.07.449
163. Alkhalifah MI, Alsobki HE, Alwael HM, Al Fawaz AM, Al-Mezaine HS. Herpes Simplex Virus Keratitis Reactivation after SARS-CoV-2 BNT162b2 mRNA Vaccination: A Report of Two Cases. *Ocular Immunology and Inflammation.* 2021.https://doi.org/10.1080/09273948.2021.1986548
164. Abou-Foul AK, Ross E, Abou-Foul M, George AP. Cervical lymphadenopathy following coronavirus disease 2019 vaccine: clinical characteristics and implications for head and neck cancer services. *J Laryngol Otol.* 2021;135(11):1025-1030.https://doi.org/10.1017/s0022215121002462
165. Klomjit N, Alexander MP, Fervenza FC, et al. COVID-19 vaccination and glomerulonephritis. *Kidney Int Rep.* 2021.https://doi.org/10.1016/j.ekir.2021.09.008
166. Rodríguez-Martín M, Corriols-Noval P, López-Simón E, Morales-Angulo C. Ramsay Hunt syndrome following mRNA SARS-COV-2 vaccine. *Enferm Infecc Microbiol Clin (Engl Ed).* 2021.https://doi.org/10.1016/j.eimce.2021.06.003
167. Baffa ME, Maglie R, Giovannozzi N, et al. Sweet syndrome following sars-cov2 vaccination. *Vaccines.* 2021;9(11).https://doi.org/10.3390/vaccines9111212
168. Kaulen LD, Doubrovinskaia S, Mooshage C, et al. Neurological autoimmune diseases following vaccinations against SARS-CoV-2: a case series. *European Journal of Neurology.* 2021.https://doi.org/10.1111/ene.15147
169. Duke H, Posch L, Green L. Axillary adenopathy following COVID-19 vaccination: A single institution case series. *Clin Imaging.* 2021;80:111-116.https://doi.org/10.1016/j.clinimag.2021.05.023
170. Nistri R, Barbuti E, Rinaldi V, et al. Case Report: Multiple Sclerosis Relapses After Vaccination Against SARS-CoV2: A Series of Clinical Cases. *Frontiers in Neurology.* 2021;12.https://doi.org/10.3389/fneur.2021.765954
171. Ahmad SA, Salih BK, Hama Hussein KF, Mikael TM, Kakamad FH, Salih AM. Aseptic meningoencephalitis after COVID-19 vaccination: A case report. *Ann Med Surg (Lond).* 2021;71:103028.https://doi.org/10.1016/j.amsu.2021.103028
172. Takeyama R, Fukuda K, Kouzaki Y, et al. Intracerebral hemorrhage due to vasculitis following COVID-19 vaccination: a case report. *Acta Neurochir (Wien).* 2021:1-5.https://doi.org/10.1007/s00701-021-05038-0
173. Temiz SA, Abdelmaksoud A, Wollina U, et al. Cutaneous and Allergic reactions due to COVID-19 vaccinations: A review. *Journal of Cosmetic Dermatology.* 2021.https://doi.org/10.1111/jocd.14613
174. Atak MF, Farabi B, Kalelioglu MB, Rao BK. Pigmented purpuric dermatosis after BNT162B2 mRNA COVID-19 vaccine administration. *J Cosmet Dermatol.* 2021.https://doi.org/10.1111/jocd.14607

175. Kaplan B, Farzan S, Coscia G, et al. Allergic reactions to COVID-19 vaccines and addressing vaccine hesitancy: Northwell Health experience. *Ann Allergy Asthma Immunol.* 2021.https://doi.org/10.1016/j.anai.2021.10.019
176. Consoli S, Dono F, Evangelista G, et al. Status migrainosus: a potential adverse reaction to Comirnaty (BNT162b2, BioNtech/Pfizer) COVID-19 vaccine-a case report. *Neurol Sci.* 2021:1-4.https://doi.org/10.1007/s10072-021-05741-x
177. Nioi M, d'Aloja E, Fossarello M, Napoli PE. Dual Corneal-Graft Rejection after mRNA Vaccine (BNT162b2) for COVID-19 during the First Six Months of Follow-Up: Case Report, State of the Art and Ethical Concerns. *Vaccines (Basel).* 2021;9(11).https://doi.org/10.3390/vaccines9111274
178. Hai J, Shawa H, Kim-Lim P, et al. Systemic drug-related intertriginous and flexural exanthema induced by the Pfizer-BioNTech COVID-19 vaccine: A report of 2 cases. *JAAD Case Rep.* 2021;18:57-60.https://doi.org/10.1016/j.jdcr.2021.10.016
179. Doughty H, Barton D. Severe Non-anaphylactic Allergic Reaction to the Pfizer-BioNTech COVID-19 vaccine. *JAAD Case Rep.* 2021.https://doi.org/10.1016/j.jdcr.2021.11.015
180. Rabinovitch T, Ben-Arie-Weintrob Y, Hareuveni-Blum T, et al. Uveitis after the bnt162b2 mrna vaccination against sars-cov-2 infection. *Retina.* 2021;41(12):2462-2471.https://doi.org/10.1097/IAE.0000000000003277
181. Iwasawa O, Kamiya K, Okada H, Komine M, Ohtsuki M. A case of erythroderma with elevated serum immunoglobulin E and thymus and activation-regulated chemokine levels following coronavirus disease 2019 vaccination. *Journal of Dermatology.* 2021.https://doi.org/10.1111/1346-8138.16257
182. Rechavi Y, Shashar M, Lellouche J, Yana M, Yakubovich D, Sharon N. Occurrence of BNT162b2 vaccine adverse reactions is associated with enhanced SARS-CoV-2 IgG antibody response. *Vaccines.* 2021;9(9).https://doi.org/10.3390/vaccines9090977
183. Iftikhar H, Noor SMU, Masood M, Bashir K. Bell's Palsy After 24 Hours of mRNA-1273 SARS-CoV-2 Vaccine. *Cureus.* 2021;13(6):e15935-e15935.https://doi.org/10.7759/cureus.15935
184. Thimmanagari K, Veeraballi S, Roach D, Al Omour B, Slim J. Ipsilateral Zoster Ophthalmicus Post COVID-19 Vaccine in Healthy Young Adults. *Cureus.* 2021;13(7):e16725.https://doi.org/10.7759/cureus.16725
185. Drerup KA, Gläser R. SARS-CoV-2—update on skin manifestations, predictive markers and cutaneous reactions after vaccination. *Hautarzt.* 2021.https://doi.org/10.1007/s00105-021-04881-7
186. Khan E, Shrestha AK, Colantonio MA, Liberio RN, Sriwastava S. Acute transverse myelitis following SARS-CoV-2 vaccination: a case report and review of literature. *Journal of Neurology.* 2021.https://doi.org/10.1007/s00415-021-10785-2
187. Christensen SK, Ballegaard M, Boesen MS. Guillian Barré syndromeafter mRNA-1273 vaccination against COVID-19. *Ugeskr Laeger.* 2021;183(35). Published 2021/09/04.
188. Matarneh AS, Al-Battah AH, Farooqui K, Ghamoodi M, Alhatou M. COVID-19 vaccine causing Guillain-Barre syndrome, a rare potential side effect. *Clin Case Rep.* 2021;9(9):e04756.https://doi.org/10.1002/ccr3.4756
189. Agaronov A, Makdesi C, Hall CS. Acute generalized exanthematous pustulosis induced by Moderna COVID-19 messenger RNA vaccine. *JAAD Case Rep.* 2021;16:96-97.https://doi.org/10.1016/j.jdcr.2021.08.013
190. Ajmera KM. Fatal case of rhabdomyolysis post-covid-19 vaccine. *Infection and Drug Resistance.* 2021;14:3929-3935.https://doi.org/10.2147/IDR.S331362
191. Mack M, Nichols L, Guerrero DM. Rhabdomyolysis Secondary to COVID-19 Vaccination. *Cureus.* 2021;13(5):e15004.https://doi.org/10.7759/cureus.15004

192. Ganga K, Solyar AY, Ganga R. Massive Cervical Lymphadenopathy Post-COVID-19 Vaccination. *Ear Nose Throat J.* 2021:1455613211048984.https://doi.org/10.1177/01455613211048984
193. Tagini F, Carrel L, Fallet B, Gachoud D, Ribi C, Monti M. Behçet's-like adverse event or inaugural Behçet's disease after SARS-CoV-2 mRNA-1273 vaccination? *Rheumatology (Oxford, England).* 2021.https://doi.org/10.1093/rheumatology/keab751
194. Rademacher JG, Tampe B, Korsten P. First Report of Two Cases of Löfgren's Syndrome after SARS-CoV-2 Vaccination-Coincidence or Causality? *Vaccines (Basel).* 2021;9(11).https://doi.org/10.3390/vaccines9111313
195. Saibene AM, Allevi F, Ayad T, et al. Appropriateness for SARS-CoV-2 vaccination for otolaryngologist and head and neck surgeons in case of pregnancy, breastfeeding, or childbearing potential: Yo-IFOS and CEORL-HNS joint clinical consensus statement. *Eur Arch Otorhinolaryngol.* 2021;278(10):4091-4099.https://doi.org/10.1007/s00405-021-06794-6
196. Koutlas IG, Camara R, Argyris PP, Davis MDP, Miller DD. Development of pemphigus vulgaris after the second dose of the mRNA-1273 SARS-Cov-2 vaccine. *Oral Diseases.* 2021;n/a(n/a).https://doi.org/https://doi.org/10.1111/odi.14089
197. Balidis M, Mikropoulos D, Gatzioufas Z, de Politis PB, Sidiropoulos G, Vassiliadis V. Acute corneal graft rejection after anti-severe acute respiratory syndrome-coronavirus-2 vaccination: A report of four cases. *European Journal of Ophthalmology.* 2021.https://doi.org/10.1177/11206721211064033
198. Català A, Muñoz-Santos C, Galván-Casas C, et al. Cutaneous reactions after SARS-COV-2 vaccination: A cross-sectional Spanish nationwide study of 405 cases. *The British journal of dermatology.* 2021.https://doi.org/10.1111/bjd.20639
199. Guzmán-Pérez L, Puerta-Peña M, Falkenhain-López D, et al. Small-vessel vasculitis following Oxford-AstraZeneca vaccination against SARS-CoV-2. *Journal of the European Academy of Dermatology and Venereology.* 2021.https://doi.org/10.1111/jdv.17547
200. Perera R, Fletcher J. Thromboembolism and the Oxford-AstraZeneca vaccine. *BMJ.* 2021;373:n1159.https://doi.org/10.1136/bmj.n1159
201. Schulz JB, Berlit P, Diener HC, et al. COVID-19 vaccine-associated cerebral venous thrombosis in Germany. *Annals of neurology.* 2021.https://doi.org/10.1002/ana.26172
202. Al Rawahi B, BaTaher H, Jaffer Z, Al-Balushi A, Al-Mazrouqi A, Al-Balushi N. Vaccine-induced immune thrombotic thrombocytopenia following AstraZeneca (ChAdOx1 nCOV19) vaccine-A case report. *Res Pract Thromb Haemost.* 2021;5(6):e12578.https://doi.org/10.1002/rth2.12578
203. Asmat H, Fayeye F, Alshakaty H, Patel J. A rare case of COVID-19 vaccine-induced thrombotic thrombocytopaenia (VITT) involving the veno-splanchnic and pulmonary arterial circulation, from a UK district general hospital. *BMJ Case Rep.* 2021;14(9).https://doi.org/10.1136/bcr-2021-244223
204. Alalwan AA, Abou Trabeh A, Premchandran D, Razeem M. COVID-19 Vaccine-Induced Thrombotic Thrombocytopenia: A Case Series. *Cureus.* 2021;13(9):e17862.https://doi.org/10.7759/cureus.17862
205. Wolthers SA, Stenberg J, Nielsen HB, Stensballe J, Pedersen HP. Intracerebral haemorrhage twelve days after vaccination with ChAdOx1 nCoV-19. *Ugeskr Laeger.* 2021;183(35). Published 2021/09/04.
206. Fang WC, Chiu LW, Hu SC. Psoriasis exacerbation after first dose of AstraZeneca coronavirus disease 2019 vaccine. *J Dermatol.* 2021.https://doi.org/10.1111/1346-8138.16137

207. Corrêa DG, Cañete LAQ, dos Santos GAC, de Oliveira RV, Brandão CO, da Cruz LCH. Neurological symptoms and neuroimaging alterations related with COVID-19 vaccine: Cause or coincidence? *Clinical Imaging.* 2021;80:348-352.https://doi.org/10.1016/j.clinimag.2021.08.021
208. Oh HK, Kim EK, Hwang I, et al. COVID-19 vaccine safety monitoring in the Republic of Korea: February 26, 2021 to April 30, 2021. *Osong Public Health Res Perspect.* 2021;12(4):264-268.https://doi.org/10.24171/j.phrp.2021.0157
209. Mohta A, Arora A, Srinivasa R, Mehta RD. Recurrent herpes zoster after COVID-19 vaccination in patients with chronic urticaria being treated with cyclosporine—A report of 3 cases. *Journal of Cosmetic Dermatology.* 2021.https://doi.org/10.1111/jocd.14437
210. Wantavornprasert K, Noppakun N, Klaewsongkram J, Rerknimitr P. Generalized Bullous Fixed Drug Eruption after ChAdOx1 nCoV-19 Vaccination. *Clin Exp Dermatol.* 2021.https://doi.org/10.1111/ced.14926
211. Oo WM, Giri P, de Souza A. AstraZeneca COVID-19 vaccine and Guillain- Barré Syndrome in Tasmania: A causal link? *J Neuroimmunol.* 2021;360:577719.https://doi.org/10.1016/j.jneuroim.2021.577719
212. Pedrazini MC, da Silva MH. "Pityriasis Rosea-like cutaneous eruption as a possible dermatological manifestation after Oxford-AstraZeneca vaccine: case report and brief literature review.". *Dermatol Ther.* 2021:e15129.https://doi.org/10.1111/dth.15129
213. Leerunyakul K, Pakornphadungsit K, Suchonwanit P. Case Report: Pityriasis Rosea-Like Eruption Following COVID-19 Vaccination. *Front Med (Lausanne).* 2021;8:752443.https://doi.org/10.3389/fmed.2021.752443
214. Wu RW, Lin TK. Oxford-AstraZeneca COVID-19 vaccine-induced acute localized exanthematous pustulosis. *J Dermatol.* 2021.https://doi.org/10.1111/1346-8138.16138
215. Elbæk MV, Vinding GR, Jemec GBE. Darier's Disease Flare following COVID-19 Vaccine. *Case Rep Dermatol.* 2021;13(2):432-436.https://doi.org/10.1159/000517256
216. Tan A, Stepien KM, Narayana STK. Carnitine palmitoyltransferase II deficiency and post-COVID vaccination rhabdomyolysis. *Qjm.* 2021.https://doi.org/10.1093/qjmed/hcab077
217. Sriphrapradang C, Shantavasinkul PC. Graves' disease following SARS-CoV-2 vaccination. *Endocrine.* 2021.https://doi.org/10.1007/s12020-021-02902-y
218. Nasuelli NA, De Marchi F, Cecchin M, et al. A case of acute demyelinating polyradiculoneuropathy with bilateral facial palsy after ChAdOx1 nCoV-19 vaccine. *Neurol Sci.* 2021;42(11):4747-4749.https://doi.org/10.1007/s10072-021-05467-w
219. Mehta H, Handa S, Malhotra P, et al. Erythema nodosum, zoster duplex and pityriasis rosea as possible cutaneous adverse effects of Oxford-AstraZeneca COVID-19 vaccine: report of three cases from India. *J Eur Acad Dermatol Venereol.* 2021.https://doi.org/10.1111/jdv.17678
220. Chan JEZ, Irimpen A. Severe but self-limiting polyarthralgia with functional impairment following chadox1 ncov-19 vaccination in an elderly recipient. *Vaccines.* 2021;9(11).https://doi.org/10.3390/vaccines9111220
221. Panou E, Nikolaou V, Marinos L, et al. Recurrence of cutaneous T-cell lymphoma post viral vector COVID-19 vaccination. *J Eur Acad Dermatol Venereol.* 2021.https://doi.org/10.1111/jdv.17736
222. Jeong J, Choi HS. Sudden sensorineural hearing loss after COVID-19 vaccination. *International Journal of Infectious Diseases.* 2021;113:341-343.https://doi.org/10.1016/j.ijid.2021.10.025

223. Loo LK, Salim O, Liang D, et al. Acute-onset polyradiculoneuropathy after SARS-CoV2 vaccine in the West and North Midlands, United Kingdom. *Muscle Nerve.* 2021.https://doi.org/10.1002/mus.27461
224. Fritzen M, Funchal GDG, Luiz MO, Durigon GS. Leukocytoclastic vasculitis after exposure to COVID-19 vaccine. *An Bras Dermatol.* 2021.https://doi.org/10.1016/j.abd.2021.09.003
225. Miqdadi A, Herrag M. Acute Eosinophilic Pneumonia Associated With the Anti-COVID-19 Vaccine AZD1222. *Cureus.* 2021;13(10):e18959.https://doi.org/10.7759/cureus.18959
226. Žagar T, Hlača N, Brajac I, Prpić-Massari L, Peternel S, Kaštelan M. Bullous Sweet syndrome following SARS-CoV-2 Oxford AstraZeneca vaccine. *British Journal of Dermatology.* 2021.https://doi.org/10.1111/bjd.20876
227. Kim SI, Seok HY, Yi J, Cho JH. Leg paralysis after AstraZeneca COVID-19 vaccination diagnosed as neuralgic amyotrophy of the lumbosacral plexus: a case report. *J Int Med Res.* 2021;49(11):3000605211056783.https://doi.org/10.1177/03000605211056783
228. Pisani D, Leopardi G, Viola P, et al. Sudden sensorineural hearing loss after covid-19 vaccine; A possible adverse reaction? *Otolaryngology Case Reports.* 2021;21:100384.https://doi.org/https://doi.org/10.1016/j.xocr.2021.100384
229. Kim JC, Lee SY, Kang SY, Kim HO, Park CW, Chung BY. Erythema annulare centrifugum induced by COVID-19 vaccination. *Clin Exp Dermatol.* 2021.https://doi.org/10.1111/ced.15002
230. Salih F, Schönborn L, Kohler S, et al. Vaccine-Induced Thrombocytopenia with Severe Headache. *New England Journal of Medicine.* 2021;385(22):2103-2105.https://doi.org/10.1056/NEJMc2112974
231. U.S. Food & Drug Administration. Coronavirus (COVID-19) Update: July 13, 2021. U.S Food & Drug Administration. Published 2021. Updated 13 July 2021. Accessed 18 August, 2021.
232. Kemper M, Berssenbrügge C, Lenz G, Mesters RM. Vaccine-induced pseudothrombocytopenia after Ad26.COV2.S vaccination. *Annals of Hematology.* 2021.https://doi.org/10.1007/s00277-021-04611-y
233. Akuna M, Qureshi M, Miller N. VITT reaction associated with Johnson & Johnson vaccine. *Chest.* 2021;160(4):A811.https://doi.org/10.1016/j.chest.2021.07.764
234. García-Estrada C, Gómez-Figueroa E, Alban L, Arias-Cárdenas A. Optic neuritis after COVID-19 vaccine application. *Clinical and Experimental Neuroimmunology.* 2021.https://doi.org/10.1111/cen3.12682
235. Flores Rebollar A. Tiroiditis subaguda después de la vacuna anti-SARS-CoV-2 (Ad5-nCoV). *Enfermedades Infecciosas y Microbiología Clínica.* 2021.https://doi.org/https://doi.org/10.1016/j.eimc.2021.10.015
236. Al Kaabi N, Zhang Y, Xia S, et al. Effect of 2 Inactivated SARS-CoV-2 Vaccines on Symptomatic COVID-19 Infection in Adults: A Randomized Clinical Trial. *JAMA.* 2021;326(1):35-45.https://doi.org/10.1001/jama.2021.8565
237. Huang L, Yao Z, Zhang J. Two cases of pityriasis rosea after the injection of coronavirus disease 2019 vaccine. *J Eur Acad Dermatol Venereol.* 2021.https://doi.org/10.1111/jdv.17648
238. Pan L, Zhang Y, Cui Y, Wu X. Bilateral uveitis after inoculation with COVID-19 vaccine: A case report. *Int J Infect Dis.* 2021.https://doi.org/10.1016/j.ijid.2021.09.075
239. Tutar NK, EyigÜRbÜZ T, Yildirim Z, Kale N. A variant of guillain-barre syndrome after sars-cov-2 vaccination: Amsan. *Ideggyogyaszati Szemle.* 2021;74(7-8):286-288.https://doi.org/10.18071/ISZ.74.0286

240. Saygılı ES, Karakilic E. Subacute thyroiditis after inactive SARS-CoV-2 vaccine. *BMJ Case Rep.* 2021;14(10).https://doi.org/10.1136/bcr-2021-244711
241. Zhang LW, Wang WJ, Li CH, Chen T. Erythema multiforme after SARS-CoV-2 vaccine. *J Eur Acad Dermatol Venereol.* 2021.https://doi.org/10.1111/jdv.17689
242. Noikongdee P, Police P, Phojanasenee T, et al. Prevalence of anti-platelet factor 4/polyanionic antibodies after COVID-19 vaccination with ChAdOx1 nCoV-19 and CoronaVac in Thais. *Res Pract Thromb Haemost.* 2021;5(7):e12600.https://doi.org/10.1002/rth2.12600
243. Chaijaras S, Seree-Aphinan C, Rutnin S, Ngamjanyaporn P, Rattanakaemakorn P. Serum sickness-like reaction following an administration of the first dose of inactivated COVID19 vaccine: a case report. *JAAD Case Rep.* 2021.https://doi.org/10.1016/j.jdcr.2021.11.004
244. Anamnart C, Tisavipat N, Owattanapanich W, et al. Newly diagnosed neuromyelitis optica spectrum disorders following vaccination: Case report and systematic review. *Multiple Sclerosis and Related Disorders.* 2021.https://doi.org/10.1016/j.msard.2021.103414
245. Bostan E, Yel B, Akdogan N, Gokoz O. New-Onset Bullous Pemphigoid After Inactivated Covid-19 Vaccine: Synergistic Effect of the Covid-19 Vaccine and Vildagliptin? *Dermatol Ther.* 2021:e15241.https://doi.org/10.1111/dth.15241
246. Soltanpoor P, Norouzi G. Subacute thyroiditis following COVID-19 vaccination. *Clinical Case Reports.* 2021;9(10).https://doi.org/10.1002/ccr3.4812
247. Shimazawa R, Ikeda M. Potential adverse events in Japanese women who received tozinameran (BNT162b2, Pfizer-BioNTech). *Journal of Pharmaceutical Policy and Practice.* 2021;14(1):46.https://doi.org/10.1186/s40545-021-00326-7
248. Saito K, Shimizu T, Suzuki-Inoue K, Ishida T, Wada Y. Aseptic meningitis after vaccination of the BNT162b2 mRNA COVID-19 vaccine. *Neurol Sci.* 2021:1-3.https://doi.org/10.1007/s10072-021-05543-1
249. Bril F, Fettig DM. Reply to: "Comment on "Autoimmune hepatitis developing after coronavirus disease 2019 (COVID-19) vaccine: Causality or casualty?"". *Journal of Hepatology.* 2021.https://doi.org/10.1016/j.jhep.2021.06.008
250. Palla P, Vergadis C, Sakellariou S, Androutsakos T. Letter to the editor: Autoimmune hepatitis after COVID-19 vaccination. A rare adverse effect? *Hepatology.* 2021.https://doi.org/10.1002/hep.32156
251. Maniscalco GT, Manzo V, Di Battista ME, et al. Severe Multiple Sclerosis Relapse After COVID-19 Vaccination: A Case Report. *Front Neurol.* 2021;12:721502.https://doi.org/10.3389/fneur.2021.721502
252. Takenaka T, Matsuzaki M, Fujiwara S, Hayashida M, Suyama H, Kawamoto M. Myeloperoxidase Anti-neutrophil Cytoplasmic Antibody Positive Optic Perineuritis after mRNA Coronavirus Disease-19 Vaccine: A Case Report. *Qjm.* 2021.https://doi.org/10.1093/qjmed/hcab227
253. Endo B, Bahamon S, Martínez-Pulgarín DF. Central retinal vein occlusion after mRNA SARS-CoV-2 vaccination: A case report. *Indian J Ophthalmol.* 2021;69(10):2865-2866.https://doi.org/10.4103/ijo.IJO_1477_21
254. Vinzamuri S, Pradeep TG, Kotian R. Bilateral paracentral acute middle maculopathy and acute macular neuroretinopathy following COVID-19 vaccination. *Indian J Ophthalmol.* 2021;69(10):2862-2864.https://doi.org/10.4103/ijo.IJO_1333_21
255. Elboraey MO, Essa E. Stevens-Johnson syndrome post second dose of Pfizer COVID-19 vaccine: a case report. *Oral Surg Oral Med Oral Pathol Oral Radiol.* 2021;132(4):e139-e142.https://doi.org/10.1016/j.oooo.2021.06.019

256. Bakir M, Almeshal H, Alturki R, Obaid S, Almazroo A. Toxic Epidermal Necrolysis Post COVID-19 Vaccination - First Reported Case. *Cureus.* 2021;13(8):e17215.https://doi.org/10.7759/cureus.17215
257. Onn PY, Chang CL. Lichenoid cutaneous skin eruption and associated systemic inflammatory response following Pfizer-BioNTech mRNA COVID-19 vaccine administration. *Respirol Case Rep.* 2021;9(11):e0860.https://doi.org/10.1002/rcr2.860
258. Yesilkaya UH, Sen M, Tasdemir BG. A novel adverse effect of the BNT162b2 mRNA vaccine: First episode of acute mania with psychotic features. *Brain Behav Immun Health.* 2021;18:100363.https://doi.org/10.1016/j.bbih.2021.100363
259. Flannery P, Yang I, Keyvani M, Sakoulas G. Acute Psychosis Due to Anti-N-Methyl D-Aspartate Receptor Encephalitis Following COVID-19 Vaccination: A Case Report. *Frontiers in Neurology.* 2021;12.https://doi.org/10.3389/fneur.2021.764197
260. Rossi A, Magri F, Michelini S, et al. Recurrence of alopecia areata after covid-19 vaccination: A report of three cases in Italy. *Journal of Cosmetic Dermatology.* 2021.https://doi.org/10.1111/jocd.14581
261. Walter A, Kraemer M. A neurologist's rhombencephalitis after comirnaty vaccination. A change of perspective. *Neurological Research and Practice.* 2021;3(1).https://doi.org/10.1186/s42466-021-00156-7
262. Kahn B, Apostolidis SA, Bhatt V, et al. Multisystem Inflammation and Organ Dysfunction After BNT162b2 Messenger RNA Coronavirus Disease 2019 Vaccination. *Crit Care Explor.* 2021;3(11):e0578.https://doi.org/10.1097/cce.0000000000000578
263. Cecchi N, Giannotta JA, Barcellini W, Fattizzo B. A case of severe aplastic anaemia after SARS-CoV-2 vaccination. *British Journal of Haematology.* 2021.https://doi.org/10.1111/bjh.17947
264. Dell'Antonia M, Anedda S, Usai F, Atzori L, Ferreli C. Bullous pemphigoid triggered by COVID-19 vaccine. Rapid resolution with corticosteroid therapy. *Dermatol Ther.* 2021:e15208.https://doi.org/10.1111/dth.15208
265. Hanna J, Ingram A, Shao T. Minimal Change Disease After First Dose of Pfizer-BioNTech COVID-19 Vaccine: A Case Report and Review of Minimal Change Disease Related to COVID-19 Vaccine. *Canadian Journal of Kidney Health and Disease.* 2021;8.https://doi.org/10.1177/20543581211058271
266. Nishiguchi Y, Matsuyama H, Maeda K, Shindo A, Tomimoto H. Miller Fisher syndrome following BNT162b2 mRNA coronavirus 2019 vaccination. *BMC Neurology.* 2021;21(1).https://doi.org/10.1186/s12883-021-02489-x
267. Khochtali S, Krifa H, Zina S, et al. Multimodal Imaging of Acute Foveolitis following COVID-19 Vaccination. *Ocul Immunol Inflamm.* 2021:1-4.https://doi.org/10.1080/09273948.2021.1993270
268. Shimizu M, Ogaki K, Nakamura R, et al. An 88-year-old woman with acute disseminated encephalomyelitis following messenger ribonucleic acid-based COVID-19 vaccination. *eNeurologicalSci.* 2021;25.https://doi.org/10.1016/j.ensci.2021.100381
269. Atas F, Kaya M, Saatci AO. Acute Multifocal Placoid Pigment Epitheliopathy-like Presentation following the First Dose of BNT162B2 COVID-19 Vaccination. *Ocul Immunol Inflamm.* 2021:1-4.https://doi.org/10.1080/09273948.2021.1995763
270. Kaya A, Kaya SY. A case of trigeminal neuralgia developing after a COVID-19 vaccination. *Journal of NeuroVirology.* 2021.https://doi.org/10.1007/s13365-021-01030-7
271. Pawlowski C, Rincón-Hekking J, Awasthi S, et al. Cerebral Venous Sinus Thrombosis is not Significantly Linked to COVID-19 Vaccines or Non-COVID Vaccines in a Large

Multi-State Health System. *Journal of Stroke and Cerebrovascular Diseases.* 2021;30(10).https://doi.org/10.1016/j.jstrokecerebrovasdis.2021.105923
272. Sung JG, Sobieszczyk PS, Bhatt DL. Acute Myocardial Infarction Within 24 Hours After COVID-19 Vaccination. *Am J Cardiol.* 2021;156:129-131.https://doi.org/10.1016/j.amjcard.2021.06.047
273. Murvelashvili N, Tessnow A. A Case of Hypophysitis Following Immunization With the mRNA-1273 SARS-CoV-2 Vaccine. *Journal of Investigative Medicine High Impact Case Reports.* 2021;9.https://doi.org/10.1177/23247096211043386
274. Herrera M, West K, Holstein H. ERYTHEMA NODOSUM-LIKE RASH AFTER SARS-COV-2 VACCINATION: A CASE REPORT. *Chest.* 2021;160(4):A1380.https://doi.org/10.1016/j.chest.2021.07.1261
275. Saxby K, Kingsborough B, Young D, Capone D. MODERNA VACCINE PULMONARY EMBOLISM: ASSOCIATION VS COINCIDENCE. *CHEST.* 2021;160(4):A54.https://doi.org/10.1016/j.chest.2021.07.086
276. Thappy S, Thalappil SR, Abbarh S, Al-Mashdali A, Akhtar M, Alkadi MM. Minimal change disease following the Moderna COVID-19 vaccine: first case report. *BMC Nephrol.* 2021;22(1):376.https://doi.org/10.1186/s12882-021-02583-9
277. Finsterer J. Before attributing encephalomyelitis to SARS-CoV-2 vaccinations thoroughly exclude differentials. *Annals of Clinical and Translational Neurology.* 2021.https://doi.org/10.1002/acn3.51469
278. Sekar A. Lupus nephritis flare post Moderna mRNA-1273 coronavirus vaccine. *Qjm.* 2021.https://doi.org/10.1093/qjmed/hcab284
279. Abramson M, Mon-Wei Yu S, Campbell KN, Chung M, Salem F. IgA Nephropathy After SARS-CoV-2 Vaccination. *Kidney Medicine.* 2021.https://doi.org/10.1016/j.xkme.2021.05.002
280. Londoño MC, Gratacós-Ginès J, Sáez-Peñataro J. Another case of autoimmune hepatitis after SARS-CoV-2 vaccination – still casualty? *Journal of Hepatology.* 2021;75(5):1248-1249.https://doi.org/10.1016/j.jhep.2021.06.004
281. Bril F. Autoimmune hepatitis developing after coronavirus disease 2019 (COVID-19) vaccine: One or even several swallows do not make a summer. *Journal of Hepatology.* 2021;75(5):1256-1257.https://doi.org/10.1016/j.jhep.2021.08.001
282. Edwards AE, Vathenen R, Henson SM, Finer S, Gunganah K. Acute hyperglycaemic crisis after vaccination against COVID-19: A case series. *Diabet Med.* 2021:e14631.https://doi.org/10.1111/dme.14631
283. Essam R, Ehab R, Al-Razzaz R, Khater MW, Moustafa EA. Alopecia areata after ChAdOx1 nCoV-19 vaccine (Oxford/AstraZeneca): a potential triggering factor? *J Cosmet Dermatol.* 2021.https://doi.org/10.1111/jocd.14459
284. Crane P, Wong C, Mehta N, Barlis P. Takotsubo (stress) cardiomyopathy after ChAdOx1 nCoV-19 vaccination. *BMJ Case Rep.* 2021;14(10).https://doi.org/10.1136/bcr-2021-246580
285. Rinaldi V, Bellucci G, Sforza M, et al. Suspected acute disseminated encephalomyelitis (ADEM) after ChAdOx1 nCoV-19 vaccine: A case report. *Journal of the neurological sciences official journal of the World Federation of Neurology.* 2021;429:119796.
286. Wolf ME, Luz B, Niehaus L, Bhogal P, Bäzner H, Henkes H. Thrombocytopenia and Intracranial Venous Sinus Thrombosis after "COVID-19 Vaccine AstraZeneca" Exposure. *Journal of Clinical Medicine.* 2021;10(8):1599. https://www.mdpi.com/2077-0383/10/8/1599.
287. Bayas A, Menacher M, Christ M, Behrens L, Rank A, Naumann M. Bilateral superior ophthalmic vein thrombosis, ischaemic stroke, and immune thrombocytopenia after

ChAdOx1 nCoV-19 vaccination. *The Lancet.* 2021;397(10285):e11.https://doi.org/10.1016/S0140-6736(21)00872-2
288. Girbardt C, Busch C, Al-Sheikh M, et al. Retinal Vascular Events after mRNA and Adenoviral-Vectored COVID-19 Vaccines-A Case Series. *Vaccines (Basel).* 2021;9(11).https://doi.org/10.3390/vaccines9111349
289. Jeon YH, Lim DH, Choi SW, Choi SJ. A flare of Still's disease following COVID-19 vaccination in a 34-year-old patient. *Rheumatol Int.* 2021:1-6.https://doi.org/10.1007/s00296-021-05052-6
290. Kwon H, Kim T. Autoimmune encephalitis following ChAdOx1-S SARS-CoV-2 vaccination. *Neurological Sciences.* 2021.https://doi.org/10.1007/s10072-021-05790-2
291. Pereira A, Haslett RS. Acute Abducens Nerve Palsy Following the Second Dose of the AstraZeneca COVID-19 Vaccine. *J Pediatr Ophthalmol Strabismus.* 2021;58(6):e49-e50.https://doi.org/10.3928/01913913-20210920-01
292. Jain E, Pandav K, Regmi P, Michel G, Altshuler I. Facial Diplegia: A Rare, Atypical Variant of Guillain-Barré Syndrome and Ad26.COV2.S Vaccine. *Cureus.* 2021;13(7):e16612.https://doi.org/10.7759/cureus.16612
293. Patel SN, Yonekawa Y. Acute macular neuroretinopathy following SARS-CoV-2 vaccination. *Retinal cases & brief reports.* 2021.https://doi.org/10.1097/ICB.0000000000001195
294. MacNeil JR, Su JR, Broder KR, et al. Updated Recommendations from the Advisory Committee on Immunization Practices for Use of the Janssen (Johnson & Johnson) COVID-19 Vaccine After Reports of Thrombosis with Thrombocytopenia Syndrome Among Vaccine Recipients - United States, April 2021. *MMWR Morbidity and mortality weekly report.* 2021;70(17):651-656.https://doi.org/10.15585/mmwr.mm7017e4
295. Troeltzsch M, Berndt R, Troeltzsch M. Comment on "Oral lichen planus following the administration of vector based COVID-19 vaccine (Ad26.COV2.S)". Authors' reply. *Oral Diseases.*n/a(n/a).https://doi.org/https://doi.org/10.1111/odi.14060
296. Sepahvand M, Yazdi N, Rohani M, Emamikhah M. Cervical longitudinally extensive myelitis after vaccination with inactivated virus-based COVID-19 vaccine. *Radiol Case Rep.* 2022;17(2):303-305.https://doi.org/10.1016/j.radcr.2021.10.053
297. Tunjungputri RN, Tetrasiwi EN, Veronica M, Pandelaki J, Ibrahim F, Nelwan EJ. Vaccine-associated disease enhancement: a case report of post-vaccination COVID-19. *International Journal of Antimicrobial Agents.* 2021;58.https://doi.org/10.1016/j.ijantimicag.2021.106421.86
298. Cao Z, Gui H, Sheng Z, Xin H, Xie Q. Letter to the editor: Exacerbation of autoimmune hepatitis after COVID-19 vaccination. *Hepatology.* 2021.https://doi.org/10.1002/hep.32269
299. Lane S, Shakir S. Reports of myocarditis and pericarditis following mRNA COVID-19 vaccines: A review of spontaneously reported data from the UK, Europe, and the US. *medRxiv.* 2021:2021.2009.2009.21263342.https://doi.org/10.1101/2021.09.09.21263342
300. Witberg G, Barda N, Hoss S, et al. Myocarditis after Covid-19 Vaccination in a Large Health Care Organization. *New England Journal of Medicine.* 2021.https://doi.org/10.1056/NEJMoa2110737
301. Mevorach D, Anis E, Cedar N, et al. Myocarditis after BNT162b2 mRNA Vaccine against Covid-19 in Israel. *New England Journal of Medicine.* 2021.https://doi.org/10.1056/NEJMoa2109730

302. Simone A, Herald J, Chen A, et al. Acute Myocarditis Following COVID-19 mRNA Vaccination in Adults Aged 18 Years or Older. *JAMA Internal Medicine.* 2021.https://doi.org/10.1001/jamainternmed.2021.5511
303. Levin D, Shimon G, Fadlon-Derai M, et al. Myocarditis following COVID-19 vaccination - A case series. *Vaccine.* 2021.https://doi.org/10.1016/j.vaccine.2021.09.004
304. Frenck RW, Klein NP, Kitchin N, et al. Safety, Immunogenicity, and Efficacy of the BNT162b2 Covid-19 Vaccine in Adolescents. *New England Journal of Medicine.* 2021;385(3):239-250.https://doi.org/10.1056/NEJMoa2107456
305. Walter EB, Talaat KR, Sabharwal C, et al. Evaluation of the BNT162b2 Covid-19 Vaccine in Children 5 to 11 Years of Age. *New England Journal of Medicine.* 2021.https://doi.org/10.1056/NEJMoa2116298
306. Study to Evaluate the Safety, Tolerability, and Immunogenicity of an RNA Vaccine Candidate Against COVID-19 in Healthy Children <12 Years of Age. In: https://ClinicalTrials.gov/show/NCT04816643.
307. Ali K, Berman G, Zhou H, et al. Evaluation of mRNA-1273 SARS-CoV-2 Vaccine in Adolescents. *New England Journal of Medicine.* 2021;385(24):2241-2251.https://doi.org/10.1056/NEJMoa2109522
308. A Study to Evaluate Safety and Effectiveness of mRNA-1273 COVID-19 Vaccine in Healthy Children Between 6 Months of Age and Less Than 12 Years of Age. In: https://ClinicalTrials.gov/show/NCT04796896.
309. Ewen Callaway. COVID vaccines and kids: five questions as trials begin. https://www.nature.com/articles/d41586-021-01061-4. Published 2021. Accessed August 11, 2021, 2021.
310. Han B, Song Y, Li C, et al. Safety, tolerability, and immunogenicity of an inactivated SARS-CoV-2 vaccine (CoronaVac) in healthy children and adolescents: a double-blind, randomised, controlled, phase 1/2 clinical trial. *The Lancet Infectious Diseases.* 2021.https://doi.org/10.1016/S1473-3099(21)00319-4
311. Novavax Initiates Pediatric Expansion for Phase 3 Clinical Trial of COVID-19 Vaccine [press release]. May 3, 2021 2021. https://ir.novavax.com/2021-05-03-Novavax-Initiates-Pediatric-Expansion-for-Phase-3-Clinical-Trial-of-COVID-19-Vaccine
312. Glatman-Freedman A, Hershkovitz Y, Kaufman Z, Dichtiar R, Keinan-Boker L, Bromberg M. Effectiveness of BNT162b2 Vaccine in Adolescents during Outbreak of SARS-CoV-2 Delta Variant Infection, Israel, 2021. *Emerging Infectious Diseases.* 2021;27(11):2919-2922.https://doi.org/10.3201/eid2711.211886.
313. Tartof; SY, Slezak; JM, Fischer; H, et al. Six-Month Effectiveness of BNT162B2 mRNA COVID-19 Vaccine in a Large US Integrated Health System: A Retrospective Cohort Study. *SSRN - Preprint.* 2021. https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3909743.
314. Olson S, Newhams MM, Halasa NB, et al. Effectiveness of Pfizer-BioNTech mRNA Vaccination Against COVID-19 Hospitalization Among Persons Aged 12–18 Years. *Morbidity & Mortality Weekly Report.* 2021;70.https://doi.org/10.15585/mmwr.mm7042e1
315. Moderna Announces Positive Top Line Data from Phase 2/3 Study of COVID-19 Vaccine in Children 6 to 11 Years of Age [press release]. 25 October 2021 2021. https://investors.modernatx.com/news-releases/news-release-details/moderna-announces-positive-top-line-data-phase-23-study-covid-19
316. Xia S, Zhang Y, Wang Y, et al. 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. *Lancet Infect Dis.* 2021.https://doi.org/10.1016/s1473-3099(21)00462-x

317. COVAXIN in a Pediatric Cohort. In: https://ClinicalTrials.gov/show/NCT04918797.
318. 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. In. ClinicalTrials.gov2021.
319. Chai Q, Nygaard U, Schmidt RC, Zaremba T, Møller AM, Thorvig CM. Multisystem inflammatory syndrome in a male adolescent after his second Pfizer-BioNTech COVID-19 vaccine. *Acta Paediatr.* 2021.https://doi.org/10.1111/apa.16141
320. Nakazawa E, Uchimura T, Hirai Y, et al. New-onset pediatric nephrotic syndrome following Pfizer-BioNTech SARS-CoV-2 vaccination: a case report and literature review. *CEN Case Reports.* 2021.https://doi.org/10.1007/s13730-021-00656-0
321. Das BB, Moskowitz WB, Taylor MB, Palmer A. Myocarditis and Pericarditis Following mRNA COVID-19 Vaccination: What Do We Know So Far? *Children.* 2021;8(7).https://doi.org/10.3390/children8070607
322. Cruz J, Duret A, Harwood R, et al. Systematic review of cardiac adverse effects in children and young people un-der 18 years of age after SARS-CoV-2 vaccination. *medRxiv.* 2021:2021.2012.2006.21267339.https://doi.org/10.1101/2021.12.06.21267339
323. University of Oxford. Comparing COVID-19 Vaccine Schedule Combinations. https://comcovstudy.org.uk/about-com-cov2. Published 2021. Accessed September 2, 2021.
324. Liu X, Shaw RH, Stuart ASV, et al. Safety and immunogenicity of heterologous versus homologous prime-boost schedules with an adenoviral vectored and mRNA COVID-19 vaccine (Com-COV): a single-blind, randomised, non-inferiority trial. *Lancet.* 2021.https://doi.org/10.1016/S0140-6736(21)01694-9
325. Schmidt T, Klemis V, Schub D, et al. Immunogenicity and reactogenicity of a heterologous COVID-19 prime-boost vaccination compared with homologous vaccine regimens. *medRxiv.* 2021:2021.2006.2013.21258859.https://doi.org/10.1101/2021.06.13.21258859
326. Borobia AM, Carcas AJ, Pérez-Olmeda M, et al. Immunogenicity and reactogenicity of BNT162b2 booster in ChAdOx1-S-primed participants (CombiVacS): a multicentre, open-label, randomised, controlled, phase 2 trial. *The Lancet.* 2021;398(10295):121-130.https://doi.org/10.1016/S0140-6736(21)01420-3
327. Pozzetto B, Legros V, Djebali S, et al. Immunogenicity and efficacy of heterologous ChadOx1/BNT162b2 vaccination. *Nature.* 2021.https://doi.org/10.1038/s41586-021-04120-y
328. Yorsaeng R, Vichaiwattana P, Klinfueng S, et al. Immune response elicited from heterologous SARS-CoV-2 vaccination: Sinovac (CoronaVac) followed by AstraZeneca (Vaxzevria). *medRxiv.* 2021:2021.2009.2001.21262955.https://doi.org/10.1101/2021.09.01.21262955
329. Li J, Hou L, Guo X, et al. Heterologous prime-boost immunization with CoronaVac and Convidecia. *medRxiv.* 2021:2021.2009.2003.21263062.https://doi.org/10.1101/2021.09.03.21263062
330. Kant R, Dwivedi G, Zaman K, et al. Immunogenicity and safety of a heterologous prime-boost COVID-19 vaccine schedule: ChAdOx1 vaccine Covishield followed by BBV152 Covaxin. *Journal of Travel Medicine.* 2021.https://doi.org/10.1093/jtm/taab166
331. Roessler A, Riepler L, Bante D, von Laer D, Kimpel J. SARS-CoV-2 B.1.1.529 variant (Omicron) evades neutralization by sera from vaccinated and convalescent individuals. *medRxiv.* 2021:2021.2012.2008.21267491.https://doi.org/10.1101/2021.12.08.21267491

332. Safety and Efficacy of COVID-19 Prime-boost Vaccine in Bahrain. In: https://ClinicalTrials.gov/show/NCT04993560.
333. Moderna Announces Positive Initial Booster Data Against SARS-CoV-2 Variants of Concern [press release]. Cambridge, Massachusetts, May 5 2021. https://investors.modernatx.com/news-releases/news-release-details/moderna-announces-positive-initial-booster-data-against-sars-cov
334. Flaxman A, Marchevsky NG, Jenkin D, et al. Reactogenicity and immunogenicity after a late second dose or a third dose of ChAdOx1 nCoV-19 in the UK: a substudy of two randomised controlled trials (COV001 and COV002). *Lancet.* 2021.https://doi.org/10.1016/s0140-6736(21)01699-8
335. Novavax Announces COVID-19 Vaccine Booster Data Demonstrating Four-Fold Increase in Neutralizing Antibody Levels Versus Peak Responses After Primary Vaccination [press release]. Novavax August 5, 2021 2021. https://ir.novavax.com/2021-08-05-Novavax-Announces-COVID-19-Vaccine-Booster-Data-Demonstrating-Four-Fold-Increase-in-Neutralizing-Antibody-Levels-Versus-Peak-Responses-After-Primary-Vaccination
336. PFIZER AND BIONTECH ANNOUNCE PHASE 3 TRIAL DATA SHOWING HIGH EFFICACY OF A BOOSTER DOSE OF THEIR COVID-19 VACCINE [press release]. 21 October 2021 2021. https://www.pfizer.com/news/press-release/press-release-detail/pfizer-and-biontech-announce-phase-3-trial-data-showing
337. Efficacy & Safety of BNT162b2 booster - C4591031 2 month interim analysis [press release]. Pfizer and BioNTech, CDC, 19 November 2021. https://www.cdc.gov/vaccines/acip/meetings/downloads/slides-2021-11-19/02-COVID-Perez-508.pdf
338. Patalon T, Gazit S, Pitzer VE, Prunas O, Warren JL, Weinberger DM. Odds of Testing Positive for SARS-CoV-2 following Receipt of 3 vs 2 Doses of the BNT162b2 mRNA Vaccine. *JAMA Internal Medicine.* 2021.https://doi.org/10.1001/jamainternmed.2021.7382
339. Berec L, Smid M, Pribylova L, et al. Real-life protection provided by vaccination, booster doses and previous infection against covid-19 infection, hospitalisation or death over time in the Czech Republic: a whole country retrospective view. *medRxiv.* 2021:2021.2012.2010.21267590.https://doi.org/10.1101/2021.12.10.21267590
340. Andrews N, Stowe J, Kirsebom F, Gower C, Ramsay M, Lopez Bernal J. Effectiveness of BNT162b2 (Comirnaty, Pfizer-BioNTech) COVID-19 booster vaccine against covid-19 related symptoms in England: test negative case-control study. *medRxiv.* 2021:2021.2011.2015.21266341.https://doi.org/10.1101/2021.11.15.21266341
341. PFIZER AND BIONTECH ANNOUNCE SUBMISSION OF INITIAL DATA TO U.S. FDA TO SUPPORT BOOSTER DOSE OF COVID-19 VACCINE [press release]. NEW YORK & MAINZ, Germany2021. https://www.pfizer.com/news/press-release/press-release-detail/pfizer-and-biontech-announce-submission-initial-data-us-fda
342. Gilboa M, Mandelboim M, Indenbaum V, et al. Early Immunogenicity and safety of the third dose of BNT162b2 mRNA Covid-19 vaccine among adults older than 60 years; real world experience. *J Infect Dis.* 2021.https://doi.org/10.1093/infdis/jiab584
343. Eliakim-Raz N, Leibovici-Weisman Y, Stemmer A, et al. Antibody Titers Before and After a Third Dose of the SARS-CoV-2 BNT162b2 Vaccine in Adults Aged ≥60 Years. *Jama.* 2021.https://doi.org/10.1001/jama.2021.19885
344. Wu K, Choi A, Koch M, et al. Preliminary Analysis of Safety and Immunogenicity of a SARS-CoV-2 Variant Vaccine Booster. *medRxiv.* 2021:2021.2005.2005.21256716.https://doi.org/10.1101/2021.05.05.21256716

345. Dejnirattisai W, Shaw RH, Supasa P, et al. Reduced neutralisation of SARS-COV-2 Omicron-B.1.1.529 variant by post-immunisation serum. *medRxiv.* 2021:2021.2012.2010.21267534.https://doi.org/10.1101/2021.12.10.21267534
346. Bar-On YM, Goldberg Y, Mandel M, et al. Protection against Covid-19 by BNT162b2 Booster across Age Groups. *New England Journal of Medicine.* 2021.https://doi.org/10.1056/NEJMoa2115926
347. Bar-On YM, Goldberg Y, Mandel M, et al. Protection of BNT162b2 Vaccine Booster against Covid-19 in Israel. *New England Journal of Medicine.* 2021.https://doi.org/10.1056/NEJMoa2114255
348. Arbel R, Hammerman A, Sergienko R, et al. BNT162b2 Vaccine Booster and Mortality Due to Covid-19. *New England Journal of Medicine.* 2021.https://doi.org/10.1056/NEJMoa2115624
349. Patalon T, Gazit S, Pitzer VE, Prunas O, Warren JL, Weinberger DM. Short Term Reduction in the Odds of Testing Positive for SARS-CoV-2; a Comparison Between Two Doses and Three doses of the BNT162b2 Vaccine. *medRxiv.* 2021:2021.2008.2029.21262792.https://doi.org/10.1101/2021.08.29.21262792
350. Bomze D, Sprecher E, Gamzu R. Effect of a nationwide booster vaccine rollout in Israel on SARS-CoV-2 infection and severe illness in young adults. *Travel Med Infect Dis.* 2021;44:102195.https://doi.org/10.1016/j.tmaid.2021.102195
351. Iketani S, Liu L, Nair MS, et al. A third COVID-19 vaccine shot markedly boosts neutralizing antibody potency and breadth. *medRxiv.* 2021:2021.2008.2011.21261670.https://doi.org/10.1101/2021.08.11.21261670
352. Atmar RL, Lyke KE, Deming ME, et al. Heterologous SARS-CoV-2 Booster Vaccinations – Preliminary Report. *medRxiv.* 2021:2021.2010.2010.21264827.https://doi.org/10.1101/2021.10.10.21264827
353. Munro APS, Janani L, Cornelius V, et al. Safety and immunogenicity of seven COVID-19 vaccines as a third dose (booster) following two doses of ChAdOx1 nCov-19 or BNT162b2 in the UK (COV-BOOST): a blinded, multicentre, randomised, controlled, phase 2 trial. *Lancet.* 2021.https://doi.org/10.1016/s0140-6736(21)02717-3
354. Yorsaeng R, Suntronwong N, Phowatthanasathian H, et al. Immunogenicity of a third dose viral-vectored COVID-19 vaccine after receiving two-dose inactivated vaccines in healthy adults. *medRxiv.* 2021:2021.2009.2016.21263692.https://doi.org/10.1101/2021.09.16.21263692
355. Kanokudom S, Assawakosri S, Suntronwong N, et al. Safety and immunogenicity of the third booster dose with inactivated, viral vector, and mRNA COVID-19 vaccines in fully immunized healthy adults with inactivated vaccine. *medRxiv.* 2021:2021.2012.2003.21267281.https://doi.org/10.1101/2021.12.03.21267281
356. Keskin AU, Bolukcu S, Ciragil P, Topkaya AE. SARS-CoV-2 specific antibody responses after third CoronaVac or BNT162b2 vaccine following two-dose CoronaVac vaccine regimen. *J Med Virol.* 2021.https://doi.org/10.1002/jmv.27350
357. Walsh EE, Frenck RW, Falsey AR, et al. Safety and Immunogenicity of Two RNA-Based Covid-19 Vaccine Candidates. *New England Journal of Medicine.* 2020;383(25):2439-2450.https://doi.org/10.1056/NEJMoa2027906
358. Jackson LA, Anderson EJ, Rouphael NG, et al. An mRNA vaccine against SARS-CoV-2—preliminary report. *New England Journal of Medicine.* 2020.
359. Anderson EJ, Rouphael NG, Widge AT, et al. Safety and Immunogenicity of SARS-CoV-2 mRNA-1273 Vaccine in Older Adults. *New England Journal of Medicine.* 2020;383(25):2427-2438.https://doi.org/10.1056/NEJMoa2028436
360. Ramasamy MN, Minassian AM, Ewer KJ, et al. Safety and immunogenicity of ChAdOx1 nCoV-19 vaccine administered in a prime-boost regimen in young and old

adults (COV002): a single-blind, randomised, controlled, phase 2/3 trial. *The Lancet.* 2020;396(10267):1979-1993.https://doi.org/10.1016/S0140-6736(20)32466-1
361. Sadoff J, Le Gars M, Shukarev G, et al. Interim results of a phase 1–2a trial of Ad26. COV2. S Covid-19 vaccine. *New England Journal of Medicine.* 2021;384(19):1824-1835.
362. Xia S, Zhang Y, Wang Y, et al. Safety and immunogenicity of an inactivated SARS-CoV-2 vaccine, BBIBP-CorV: a randomised, double-blind, placebo-controlled, phase 1/2 trial. *The Lancet Infectious Diseases.* 2021;21(1):39-51.https://doi.org/10.1016/S1473-3099(20)30831-8
363. Karamese M, Tutuncu EE. The effectiveness of inactivated SARS-CoV-2 vaccine (CoronaVac) on antibody response in participants aged 65 years and older. *Journal of Medical Virology.* 2021.https://doi.org/10.1002/jmv.27289
364. Angkasekwinai N, Sewatanon J, Niyomnaitham S, et al. Safety and Immunogenicity of CoronaVac and ChAdOx1 Against the SARS-CoV-2 Circulating Variants of Concern (Alpha, Delta, Beta) in Thai Healthcare Workers. *medRxiv.* 2021:2021.2010.2003.21264451.https://doi.org/10.1101/2021.10.03.21264451
365. Singh AK, Phatak SR, Singh NK, et al. Antibody Response after First-dose of ChAdOx1-nCOV (Covishield™®) and BBV-152 (Covaxin™®) amongst Health Care Workers in India: Preliminary Results of Cross-sectional Coronavirus Vaccine-induced Antibody Titre (COVAT) study. *medRxiv.* 2021:2021.2004.2007.21255078.https://doi.org/10.1101/2021.04.07.21255078
366. Tada T, Zhou H, Dcosta BM, et al. Neutralization of Mu and C.1.2 SARS-CoV-2 Variants by Vaccine-elicited Antibodies in Individuals With and Without Previous History of Infection. *bioRxiv.* 2021:2021.2010.2019.463727.https://doi.org/10.1101/2021.10.19.463727
367. PFIZER AND BIONTECH PROVIDE UPDATE ON OMICRON VARIANT [press release]. 2021. https://www.pfizer.com/news/press-release/press-release-detail/pfizer-and-biontech-provide-update-omicron-variant
368. Cele S, Jackson L, Khan K, et al. SARS-CoV-2 Omicron has extensive but incomplete escape of Pfizer BNT162b2 elicited neutralization and requires ACE2 for infection. *medRxiv.* 2021:2021.2012.2008.21267417.https://doi.org/10.1101/2021.12.08.21267417
369. Pilishvili T, Fleming-Dutra KE, Farrar JL, et al. Interim Estimates of Vaccine Effectiveness of Pfizer-BioNTech and Moderna COVID-19 Vaccines Among Health Care Personnel — 33 U.S. Sites, January–March 2021. *MMWR Morbidity and mortality weekly report.* 2021;70(20):753–758.https://doi.org/http://dx.doi.org/10.15585/mmwr.mm7020e2external
370. Vasileiou E, Simpson CR, Shi T, et al. Interim findings from first-dose mass COVID-19 vaccination roll-out and COVID-19 hospital admissions in Scotland: a national prospective cohort study. *The Lancet.* 2021;397(10285):1646-1657.https://doi.org/10.1016/S0140-6736(21)00677-2
371. Prendecki M, Willicombe M. Single-dose SARS-CoV-2 vaccination efficacy in the elderly. *The Lancet Infectious Diseases.* 2021;21(11):1474-1475.https://doi.org/10.1016/S1473-3099(21)00354-6
372. Voysey M, Costa Clemens SA, Madhi SA, et al. Single-dose administration and the influence of the timing of the booster dose on immunogenicity and efficacy of ChAdOx1 nCoV-19 (AZD1222) vaccine: a pooled analysis of four randomised trials. *The Lancet.* 2021;397(10277):881-891.https://doi.org/10.1016/S0140-6736(21)00432-3

373. Hitchings MDT, Ranzani OT, Scaramuzzini Torres MS, et al. Effectiveness of CoronaVac in the setting of high SARS-CoV-2 P.1 variant transmission in Brazil: A test-negative case-control study. *medRxiv.* 2021:2021.2004.2007.21255081.https://doi.org/10.1101/2021.04.07.21255081
374. El Sahly HM, Baden LR, Essink B, et al. Efficacy of the mRNA-1273 SARS-CoV-2 Vaccine at Completion of Blinded Phase. *New England Journal of Medicine.* 2021.https://doi.org/10.1056/NEJMoa2113017
375. Madhi SA, Baillie V, Cutland CL, et al. Efficacy of the ChAdOx1 nCoV-19 Covid-19 Vaccine against the B.1.351 Variant. *New England Journal of Medicine.* 2021;384(20):1885-1898.https://doi.org/10.1056/NEJMoa2102214
376. Sadoff J, Gray G, Vandebosch A, et al. Safety and Efficacy of Single-Dose Ad26.COV2.S Vaccine against Covid-19. *N Engl J Med.* 2021;384(23):2187-2201.https://doi.org/10.1056/NEJMoa2101544
377. Vacharathit V, Aiewsakun P, Manopwisedjaroen S, et al. SARS-CoV-2 variants of concern exhibit reduced sensitivity to live-virus neutralization in sera from CoronaVac vaccinees and naturally infected COVID-19 patients. *medRxiv.* 2021:2021.2007.2010.21260232.https://doi.org/10.1101/2021.07.10.21260232
378. Ella R, Reddy S, Blackwelder W, et al. Efficacy, safety, and lot-to-lot immunogenicity of an inactivated SARS-CoV-2 vaccine (BBV152): interim results of a randomised, double-blind, controlled, phase 3 trial. *Lancet.* 2021.https://doi.org/10.1016/s0140-6736(21)02000-6
379. Dunkle LM, Kotloff KL, Gay CL, et al. Efficacy and Safety of NVX-CoV2373 in Adults in the United States and Mexico. *medRxiv.* 2021:2021.2010.2005.21264567.https://doi.org/10.1101/2021.10.05.21264567
380. Sacks HS. The Novavax vaccine had 90% efficacy against COVID-19 ≥7 d after the second dose. *Ann Intern Med.* 2021.https://doi.org/10.7326/acpj202111160-124
381. Thompson MG, Burgess JL, Naleway AL, et al. Interim Estimates of Vaccine Effectiveness of BNT162b2 and mRNA-1273 COVID-19 Vaccines in Preventing SARS-CoV-2 Infection Among Health Care Personnel, First Responders, and Other Essential and Frontline Workers — Eight U.S. Locations, December 2020–March 2021. *MMWR Morbidity and mortality weekly report.* 2021;70(13):495-500.https://doi.org/10.15585/mmwr.mm7013e3external
382. Jalkanen P, Kolehmainen P, Häkkinen HK, et al. COVID-19 mRNA vaccine induced antibody responses against three SARS-CoV-2 variants. *Nat Commun.* 2021;12(1):3991.https://doi.org/10.1038/s41467-021-24285-4
383. Moderna. *Moderna COVID-19 Vaccine Retains Neutralizing Activity Against Emerging Variants First Identified in the U.K. and the Republic of South Africa.* 2021. https://investors.modernatx.com/node/10841/pdf
384. Jeewandara C, Aberathna IS, Pushpakumara PD, et al. Antibody and T cell responses to Sinopharm/BBIBP-CorV in naïve and previously infected individuals in Sri Lanka. *medRxiv.* 2021:2021.2007.2015.21260621.https://doi.org/10.1101/2021.07.15.21260621
385. Fernández J, Bruneau N, Fasce R, et al. Neutralization of alpha, gamma, and D614G SARS-CoV-2 variants by CoronaVac vaccine-induced antibodies. *Journal of Medical Virology.* 2021.https://doi.org/10.1002/jmv.27310
386. Sapkal GN, Yadav PD, Ella R, et al. Inactivated COVID-19 vaccine BBV152/COVAXIN effectively neutralizes recently emerged B.1.1.7 variant of SARS-CoV-2. *Journal of Travel Medicine.* 2021;28(4).https://doi.org/10.1093/jtm/taab051
387. Jalkanen P, Kolehmainen P, Häkkinen HK, et al. COVID-19 mRNA vaccine induced antibody responses against three SARS-CoV-2 variants. *Nature Communications.* 2021;12(1).https://doi.org/10.1038/s41467-021-24285-4

388. Thomas SJ, Moreira ED, Kitchin N, et al. Six Month Safety and Efficacy of the BNT162b2 mRNA COVID-19 Vaccine. *medRxiv.* 2021:2021.2007.2028.21261159.https://doi.org/10.1101/2021.07.28.21261159
389. Jongeneelen M, Kaszas K, Veldman D, et al. Ad26.COV2.S elicited neutralizing activity against Delta and other SARS-CoV-2 variants of concern. *bioRxiv.* 2021:2021.2007.2001.450707.https://doi.org/10.1101/2021.07.01.450707
390. Tada T, Zhou H, Samanovic MI, et al. Comparison of Neutralizing Antibody Titers Elicited by mRNA and Adenoviral Vector Vaccine against SARS-CoV-2 Variants. *bioRxiv.* 2021:2021.2007.2019.452771.https://doi.org/10.1101/2021.07.19.452771
391. Yadav PD, Sapkal GN, Ella R, et al. Neutralization of Beta and Delta variant with sera of COVID-19 recovered cases and vaccinees of inactivated COVID-19 vaccine BBV152/Covaxin. *Journal of travel medicine.* 2021.https://doi.org/10.1093/jtm/taab104
392. Shinde V, Bhikha S, Hoosain Z, et al. Efficacy of NVX-CoV2373 Covid-19 Vaccine against the B.1.351 Variant. *New England Journal of Medicine.* 2021;384(20):1899-1909.https://doi.org/10.1056/NEJMoa2103055
393. Buntz B. AstraZeneca, Pfizer Moderna vaccines fare well against Beta, Gamma and Delta variants in study. Drug Discovery & Development. https://www.drugdiscoverytrends.com/astrazeneca-pfizer-moderna-vaccines-fare-well-against-beta-gamma-and-delta-variants-in-study/. Published 2021. Updated 23 July 2021. Accessed 9 September, 2021.
394. Choi A, Koch M, Wu K, et al. Serum Neutralizing Activity of mRNA-1273 against SARS-CoV-2 Variants. *bioRxiv.* 2021:2021.2006.2028.449914.https://doi.org/10.1101/2021.06.28.449914
395. Clemens SAC, Folegatti PM, Emary KRW, et al. Efficacy of ChAdOx1 nCoV-19 (AZD1222) vaccine against SARS-CoV-2 lineages circulating in Brazil. *Nat Commun.* 2021;12(1):5861.https://doi.org/10.1038/s41467-021-25982-w
396. Wall EC, Wu M, Harvey R, et al. Neutralising antibody activity against SARS-CoV-2 VOCs B.1.617.2 and B.1.351 by BNT162b2 vaccination. *The Lancet.* 2021;397(10292):2331-2333.https://doi.org/10.1016/S0140-6736(21)01290-3
397. Kulkarni PS, Padmapriyadarsini C, Vekemans J, et al. A phase 2/3, participant-blind, observer-blind, randomised, controlled study to assess the safety and immunogenicity of SII-ChAdOx1 nCoV-19 (COVID-19 vaccine) in adults in India. *EClinicalMedicine.* 2021:101218.https://doi.org/10.1016/j.eclinm.2021.101218
398. Chagla Z. The BNT162b2 (BioNTech/Pfizer) vaccine had 95% efficacy against COVID-19 ≥7 days after the 2nd dose. *Annals of Internal Medicine.* 2021;174(2):JC15.https://doi.org/10.7326/ACPJ202102160-015
399. Formica N, Mallory R, Albert G, et al. Evaluation of a SARS-CoV-2 Vaccine NVX-CoV2373 in Younger and Older Adults. *medRxiv.* 2021:2021.2002.2026.21252482.https://doi.org/10.1101/2021.02.26.21252482