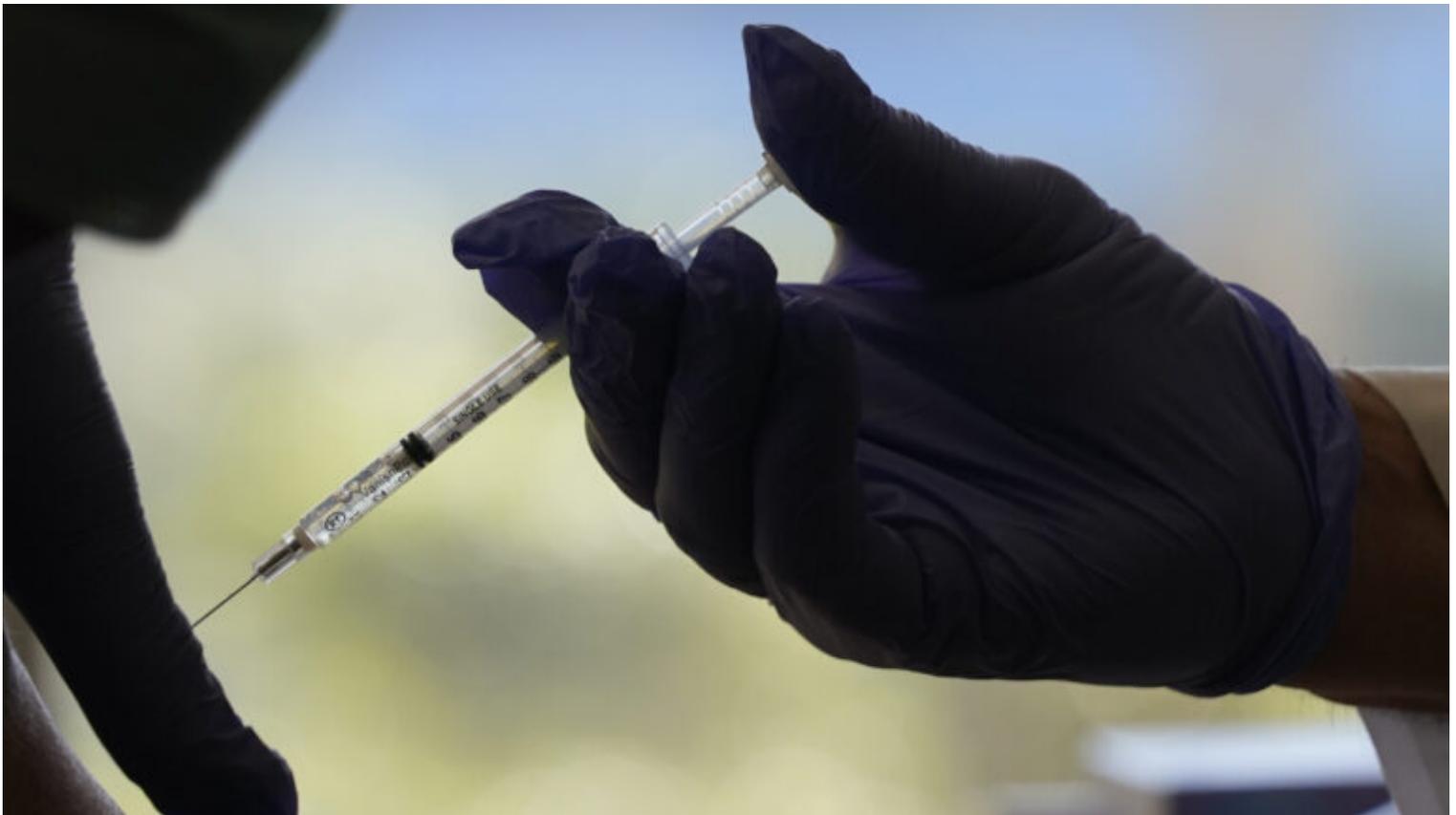


# STAT

## Comparing the Covid-19 vaccines developed by Pfizer, Moderna, and Johnson & Johnson



By [Helen Branswell](#) Feb. 2, 2021



CVS registered pharmacist Ken Ramey prepares to give a Covid-19 vaccine at the Isles of Vero Beach assisted and independent senior living community in Vero Beach, Fla. *Wilfredo Lee/AP*

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In an ideal world, a pandemic vaccine could be delivered in a single shot, so supplies could be stretched to cover a lot of people. It would trigger no side effect more significant than a sore arm. And it would be easy to ship and store.

We now have one such vaccine.

On Feb. 27, the Food and Drug Administration announced it had [issued an emergency use authorization](#) for Johnson & Johnson's one-dose Covid vaccine. Developed by J&J's vaccines division, Janssen Pharmaceuticals, it [was shown to be 66% protective](#) against moderate to severe Covid infection in a multi-country study. Importantly, it was 85% effective in protecting against severe disease. And there were no hospitalizations or deaths among people in the vaccine arm of a large clinical trial.

Overall efficacy varied a bit geographically, especially in South Africa, where a new variant appears to evade to some degree the immunity induced both by infection and by Covid vaccines, which were designed to target earlier strains of the SARS-CoV-2 virus.

Rollout of the vaccine has already started, though the company is not expected to be able to supply substantial numbers of doses until April.

Earlier STAT published a head-to-head comparison of the vaccines developed by [Pfizer and its partner, BioNTech](#), and by [Moderna](#), which have been in use in the country since December. We have updated it here with information about the J&J vaccine.

Please note that in the initial rollout of vaccine, individuals are unlikely to be offered a choice of which vaccine they want. Supplies are too scarce. The vaccine available at the place where you are being vaccinated is the one you'll get.

## Vaccine types

The Pfizer and Moderna vaccines are made using messenger RNA, or [mRNA](#),

a technology that delivers a bit of genetic code to cells — in effect, a recipe to make the surface protein (known as spike) on the SARS-2 virus. The proteins made with the mRNA instructions activate the immune system, teaching it to see the spike protein as foreign and develop antibodies and other immunity weapons with which to fight it.

The J&J vaccine uses a different approach to instruct human cells to make the SARS-2 spike protein, which then triggers an immune response. It is what's known as a viral vectored vaccine. A harmless adenovirus — from a large family of viruses, some of which cause common colds — has been engineered to carry the genetic code for the SARS-2 spike protein. Once the adenovirus enters cells, they use that code to make spike proteins. J&J employed this same approach to make an Ebola vaccine that has been authorized for use by the European Medicines Agency.

## **Target population**

The Pfizer vaccine has been authorized for use for people aged 16 and older. Moderna's has been cleared for use in people 18 and older, though the company is now testing its vaccine in 12- to 17-year-olds. J&J's vaccine has been tested in people 18 and older, and that's who it was authorized for. Until testing in children and younger teens is conducted, this vaccine won't be available for use anyone under 18 years old either.

## **Vaccine efficacy**

The Pfizer and Moderna vaccines have shown astonishing — and essentially equivalent — degrees of efficacy, at least in the early stages after vaccination.

The Pfizer vaccine showed efficacy of 95% at preventing symptomatic Covid infection after two doses. The vaccine appeared to be more or less equally

protective across age groups and racial and ethnic groups.

The Moderna vaccine was 94.1% effective at preventing symptomatic Covid-19 after the second dose. The vaccine's efficacy appeared to be slightly lower in people 65 and older, but during a presentation to the Food and Drug Administration's advisory committee in December, the company explained that the numbers could have been influenced by the fact there were few cases in that age group in the trial. The vaccine appeared to be equally effective across different ethnic and racial groups.

But comparing the efficacy of those vaccines to the efficacy of Johnson & Johnson's is challenging because of differences in the designs of the Phase 3 clinical tests — essentially the trials were testing for different outcomes. Pfizer's and Moderna's trials both tested for any symptomatic Covid infection. Pfizer started counting cases from seven days after receipt of the second dose of vaccine, while Moderna waited until day 14 to start counting cases.

J&J, by contrast, sought to determine whether one dose of its vaccine protected against moderate to severe Covid illness — defined as a combination of a positive test and at least one symptom such as shortness of breath, beginning from 14 or 28 days after the single shot. (The company collected data for both.)

Because of the difference in the trials, making direct comparisons is a bit like comparing apples and oranges. Additionally, Pfizer and Moderna's vaccines were tested before the emergence of troubling new variants in Britain, South Africa, and Brazil. It's not entirely clear how well they will work against these mutated viruses.

The J&J vaccine was still being tested when the variants were making the

rounds. Much of the data generated in the South African arm of the J&J trial involved people who were infected with the variant first seen in South Africa, called B.1.351.

The J&J one-dose vaccine was shown to be 66% protective against moderate to severe Covid infections overall from 28 days after injection, though there was variability based on geographic locations. The vaccine was 72% protective in the United States, 66% protective in South America, and 57% protective in South Africa.

But the vaccine was shown to be 85% protective against severe disease, with no differences across the eight countries or three regions in the study, nor across age groups among trial participants. And there were no hospitalizations or deaths in the vaccine arm of the trial after the 28-day period in which immunity developed.

It's not yet known if any of these vaccines prevent asymptomatic infection with the SARS-CoV-2 virus. Nor is it known if vaccinated people can transmit the virus if they do become infected but don't show symptoms.

## **Number of doses/amounts of vaccine per dose**

Both the Moderna and the Pfizer vaccines require two shots: a priming dose, followed by a booster shot. The interval between Moderna doses is 28 days; for the Pfizer vaccine, it's 21 days.

Each dose of Pfizer's contains 30 micrograms of vaccine. Moderna went with a much larger dose of vaccine, 100 micrograms. It means the company is using a little more than three times as much vaccine per person as Pfizer is. And yet, they aren't getting better results. The government's vaccine development program, formerly called Operation Warp Speed, has asked Moderna to test if

it could lower the dosage of its vaccine without eroding the vaccine's protection.

The J&J vaccine is, as mentioned, a single-dose vaccine. The company is also testing a two-dose regimen, with the two shots given eight weeks apart. The results from that 30,000-person trial aren't expected until sometime in May. The single dose contains more antigen than the individual doses in the two-dose regimen.

J&J is also testing what happens to antibody responses when a person who received the single dose regimen receives a small booster shot quite a bit later, Johan Van Hoof, managing director of Janssen Vaccines [revealed recently](#). Van Hoof didn't say how long the interval is between the single shot and the small booster, nor did he say when J&J expects results from that study.

## Side-effect profile

In the vernacular of vaccinology, shots that trigger a range of transient side effects in a lot of recipients are known as reactogenic.

All of these vaccines — in fact, most if not all the Covid-19 vaccines that have reported data so far — fall into the reactogenic category. The Advisory Committee on Immunization Practices, an expert panel that helps the Centers for Disease Control and Prevention set vaccination policies, advised hospitals early in the rollout that they might want to stagger vaccinations among employees in case some feel too unwell to work the day after being vaccinated.

The most common side effects are injection site pain, fatigue, headache, muscle pain, and joint pain. Some people in the clinical trials have reported fever. With the Pfizer and Moderna vaccines, side effects are more common

after the second dose. Younger adults, who have more robust immune systems, reported more side effects than older adults.

To be clear: These side effects are a sign of an immune system kicking into gear. They do not signal that the vaccine is unsafe. To date there are no serious, long-term side effects associated with receipt of these vaccines, which will be closely monitored as their use expands.

There have been reports of severe allergic reactions to the mRNA vaccines. Both the Pfizer and Moderna vaccines appear, on rare occasions, to [trigger anaphylaxis](#), a severe and potentially life-threatening reaction. People who develop anaphylaxis must be treated with epinephrine — the drug in EpiPens — and may need to be hospitalized to ensure their airways remain open. The CDC says people should be monitored for 15 minutes after getting a Covid-19 shot, and 30 minutes if they have a history of severe allergies.

J&J recently revealed that a single case of anaphylaxis has been reported in someone who received its vaccine.

It will take time to come up with a firm estimate of how frequently this side effect occurs. The most recent data from the CDC suggest that anaphylaxis occurs at a rate of about 2.5 cases per one million doses given of the Moderna vaccine, and 4.7 cases per million doses of the Pfizer. Many of the people who have developed anaphylaxis have a history of severe allergies and some have had previous episodes of anaphylaxis.

## **Safety for those who are pregnant or lactating**

None of the vaccines has been tested in these two groups, although Pfizer recently began a Phase 2/3 trial to test the safety and efficacy of its vaccine during pregnancy. Van Hoof said J&J will begin a similar trial in late March or

early April.

Moderna has completed animal studies the FDA demanded of manufacturers; these studies look for evidence that the vaccine might harm the pregnancy or the developing fetus. The company said it saw no such signals.

The CDC [recommends](#) until those studies are conducted, the choice of whether to get vaccinated should rest with the person who is pregnant or lactating. This is a more permissive stance than has been taken in some countries, which have said people who are pregnant should not be vaccinated with these vaccines.

## **Storage requirements**

The mRNA vaccines require an elaborate cold chain, the term used to describe the conditions under which vaccines must be stored during distribution and when they are in the doctors' offices, pharmacies, or public health clinics where they'll be administered.

The J&J shot does not, which means this vaccine can be given easily anywhere — in doctors' offices, pharmacies, mass vaccination sites, public health clinics — once supplies are adequate. It can be stored for at least three months at the temperature of a regular refrigerator.

Of the mRNA vaccines, Pfizer's was originally the more difficult to use. It had to be shipped and stored in ultra-cold freezers — ones that could keep the vials at -94 degrees Fahrenheit. But recently, the FDA announced that the vaccine can be shipped and stored — for a two-week period only — at temperatures of normal pharmacy freezers, between -13 and 5 degrees Fahrenheit. That should make the final stage of the vaccine's journey from production plant to syringe ready to plunge into an arm somewhat easier.

Moderna's must be shipped at -4 degrees Fahrenheit, which is within the temperature of a regular refrigerator freezer.

After thawing, a vial of the Pfizer vaccine must be used within five days; Moderna's is stable at fridge temperature for 30 days and at room temperature for 12 hours. J&J's vaccine can be stored at room temperature — not to exceed 77 degrees Fahrenheit — for 12 hours when the vial hasn't yet been punctured. After the first dose is withdrawn, the vial can be stored in a fridge for six hours or at room temperature for two hours.

## **Minimum purchase order**

The cold-chain requirement is not the only challenging aspect of the Pfizer vaccine. The minimum amount of vaccine a location can order is 1,170 doses. A large teaching hospital might need several of those. But there are plenty of places across the country that would not have needed 1,000 doses to vaccinate the people eligible for vaccination in the early stages of the rollout, when only selected groups of people were eligible to get vaccine. As states move into vaccinating larger segments of the population, this large minimum order size become less of a disadvantage.

The Moderna vaccine's minimum order is 140 doses, a much more manageable number.

STAT has asked J&J several times what its minimum order will be; the company has not yet disclosed that information.

The Pfizer vaccine is shipped in six-dose vials. Moderna's vaccine comes in 14-dose vials. J&J's vaccine is packaged in five-dose vials.

## **Durability of protection**

Figuring out how long the protection provided by any of these vaccines will last will take time. It's going to involve periodic blood draws from some volunteers to see what their antibody levels look like, though a decline in antibody levels doesn't necessarily equate to loss of protection.

But a large part of this work will involve watching for reports that people who were immunized are starting to contract Covid in larger numbers, a development that would probably lead to recommendations to give people booster shots at some yet-to-be-determined interval.

*This story has been updated with information about the FDA's authorization of the J&J vaccine. An earlier version of this story mischaracterized the way in which viral vectored vaccines work.*

## About the Author



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