

Coronavirus

## The COVID-19 vaccines are highly effective. Here's what the numbers really mean.

No vaccine's real-world results quite measure up to its performance in a clinical trial. All the more reason to make that appointment, these researchers say.



The COVID-19 vaccines work far better than scientists dared hope a year ago. A look behind the numbers. Getty Images



by [Tom Avril](#)

Published

Apr 12, 2021

You may have heard recently that the vaccines prevent all COVID-19 deaths. Or that they prevent all cases of the disease in young people. And that in adults, they prevent 90% of infections — that is, blocking disease as well as those under-the-radar cases with no symptoms.

Well, not exactly.

## CORONAVIRUS COVERAGE

### **LIVE UPDATES FULL COVERAGEVIRUS TRACKER**

Although those three factoids have been in the headlines recently, the reality is a bit more nuanced. For a variety of reasons, the real-world potency of the vaccines is probably not quite as broad as those sound bites suggest.

More on that below, but first a reminder: The COVID-19 vaccines were [tested in tens of thousands of people, just like other vaccines](#). They are safe and work extremely well, far better than scientists dared hope a year ago.

If the true level of protection falls a bit short of [the eye-popping numbers from the clinical trials last fall](#) (which happens with most vaccines when deployed in the general population), that's all the more reason to get injected. An even greater share of the public must be vaccinated to bring the pandemic under control. Especially when you consider that [people with weakened immune systems may be less protected by the vaccines](#), and must rely on healthier folks to take responsibility and get shots.

Those recent headlines on vaccine effectiveness represented attempts to distill the results of complex scientific studies — no easy task. To flesh out the story behind those numbers, we spoke to biostatistician Susan S.

Ellenberg, a professor at the University of Pennsylvania's Perelman School of Medicine, and health economist Zoë M. McLaren, an associate professor at the University of Maryland-Baltimore County.

## What 'effective' means

To measure how well the vaccines worked in the clinical trials, researchers calculated how many cases of disease were prevented. But they did not measure that number directly, in the sense of deliberately exposing vaccinated volunteers to the coronavirus to see whether they would get sick.

Instead, they [divided thousands of participants randomly into two groups](#) — one getting a vaccine, the other getting a placebo. All of them then went about their daily lives, unsure whether they had been given a “dummy” injection or the real thing. Months later, statisticians compared how many had contracted COVID-19 in each group.

The numbers were different in the various trials, but to keep it simple, let's use an example with round figures. Say that 100 out of 20,000 placebo recipients in a trial became ill, but just five out of 20,000 vaccine recipients did so.

Researchers would conclude that if the people in the vaccine group had *not* gotten the vaccine, then they, too, would have fallen ill at a rate of 100 out of 20,000. That is, an additional 95 people would have gotten sick. The vaccine is said to have an *efficacy* of 95% — meaning that it is estimated to have prevented 95 out of 100 cases. (The trial results for both of the RNA vaccines, one made by Moderna, the other by Pfizer and BioNTech SE, were in that ballpark.)

The efficacy calculations are based on the assumption that the vaccinated people and the placebo recipients have been exposed to the virus at the same rate — a reasonable expectation, given that these are large groups chosen with comparable representation of age, gender, and ethnicity. And because no participants knew whether they received the actual vaccine, people in the two groups were assumed to be behaving in similar ways, on average — wearing masks and taking other precautions at the same rates.

But once a vaccine is authorized for general use, that random element is lost, said McLaren, the UMBC health economist. The people getting vaccinated are those who want it, provided they are able to navigate the sign-up process.

Scientists still can estimate how many cases of disease are prevented, but not with the same degree of precision. In that real-world type of study, the term for how a vaccine performs is not efficacy, but *effectiveness*.

### Acknowledging bias

That's the type of study that prompted the headlines claiming that [two of the vaccines prevented 90% of infections](#).

Researchers tracked 3,950 health-care personnel, first responders and other essential workers in eight U.S. locations for 13 weeks. By the end of that period, 75% had gotten at least one dose of the two-dose RNA vaccines.

Among those who got both doses, the rate of infection was 90% lower than for those who got none — a promising sign by any measure. But was that edge entirely due to the vaccine, or did human behavior play a role?

McLaren noted that in [a recent Gallup poll](#), vaccinated people were more likely than unvaccinated people to say they were taking precautions such as avoiding crowds and travel. So in the study of essential workers, it is possible the vaccines' apparent performance was boosted by the cautious behavior of those who got vaccinated, she said. If they experienced less exposure to the virus, there were fewer chances for their vaccine-primed immune systems to be put to the test.

"Comparing people who agreed to get vaccinated with people who delayed or refused to get vaccinated, that's not an apples-to-apples comparison," she said.

Or perhaps biases nudged the results in the other direction, said Penn's Ellenberg, who used to work for the U.S. Food and Drug Administration. Maybe some vaccinated people felt free to let down their guard a bit, and were exposed to the virus even more than those who were not injected.

Another possible confounding factor, Ellenberg said: The study began during the wintertime surge. But by the time most participants were vaccinated, there was less COVID-19 going around — again, possibly making the vaccines seem a bit more effective than they were.

"If the time when they were vaccinated coincided with the time when there were fewer infections, and the time when they were not vaccinated coincided with a time when there were more infections, there's a bias there," she said.

## Preventing death

Even more important than blocking infection is preventing hospitalization and death, and the trials were very promising in that regard. No one who was vaccinated died of COVID-19.

Those results have [prompted optimistic social media posts from a few](#) physicians and health officials, who suggested that the vaccines might prevent all COVID-19 deaths. Likewise, [Pfizer reported recently that after six months](#), its vaccine had been "100% efficacious" in preventing severe disease.

Not so fast, say McLaren and Ellenberg. Although it's true that no vaccinated people in the trials died of COVID-19, the placebo group also was largely unscathed: Just a few died of the disease. It was too small a sample to make firm predictions about what would happen in a larger population.

And while zero vaccinated people in Pfizer's trial came down with severe disease, just 32 did so in the placebo group. Again, a small sample size.

Pfizer's 100% figure got the headlines, but it was merely a best estimate. The true figure could be as low as 88%, the company said.

Sure enough, a handful of [elderly vaccine recipients in Washington](#) and Michigan have since become infected and died, though investigation is continuing into what role COVID-19 played in their deaths. A few others have been hospitalized, and McLaren and Ellenberg said it is fair to expect more. These cases should in no way undermine public confidence in the vaccines, both said. It is important for people to realize that the vaccines do not confer absolute protection, so that when a few suffer severe illness despite vaccination, it does not create doubts about the whole enterprise. The public needs the facts, and is able to handle nuance, McLaren said.

"There is a way to say these are incredibly effective, without saying there is no risk," she said. "Sugarcoating it is one of the worst things you can do."

## Protecting kids

The same thing goes for another recent addition to the research: a Pfizer study of the vaccine in children aged 12 to 15.

The company [reported that among more than 1,100 children who got the vaccine](#), none so far have contracted the disease. Among those who got a placebo, 18 have become ill with COVID-19.

Promising, for sure. But 100% protection? As with the cases of severe disease and death in older trial participants, this sample is too small to make that type of conclusion, Ellenberg said.

The Penn professor, whose granddaughter is among the trial participants, said the vaccine was very unlikely to prevent all disease in children, as few things in medicine are absolute.

But again, that's no reason to avoid vaccination, she said.

"We don't decide to stop wearing seat belts because you heard about somebody who was in an accident who was wearing a seat belt and got hurt."

And unlike seat belts, vaccines protect not only the recipient but people around them.

So don't get too hung up on the numbers in the headlines, she said. And make that appointment as soon as you're eligible.

Published

April 12, 2021



I write about scientific research with an emphasis on findings that can impact everyday lives.