

Study compares COVID-19 vaccines' ability to stimulate immune protection against the coronavirus

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A team of scientists at Massachusetts General Hospital (MGH) has conducted one of the first comparisons of how effectively each of the three COVID-19 vaccines authorized or approved in the United States stimulates a protective immune response against the virus. This study,

published in the *Journal of Infectious Diseases*, also includes an analysis of data from several other studies on how well each vaccine guards against breakthrough cases of COVID-19, or infections that occur in people who have received the inoculations.

COVID-19 vaccines work by "teaching" the body's immune system to detect the presence of the coronavirus and respond by producing protective antibodies that neutralize it, known as immunogenicity. The three COVID-19 vaccines available in the U.S. are informally known by the names of their manufacturers: Moderna, Pfizer, and Johnson & Johnson/Janssen. Moderna and Pfizer are administered as two-dose regimens, while Johnson & Johnson requires only one dose. Although there are differences in dose and mechanism of delivery between the three vaccines, each targets the "spike" protein on the SARS-CoV-2 strain of COVID-19 that was originally isolated in Wuhan, China.

"We wanted to know how much anti-spike antibody people make when they receive each vaccine," says the study's senior author, John Iafrate, MD, Ph.D., vice chair of Pathology at MGH. To find out, Iafrate and his colleagues studied [blood samples](#) from 215 [healthy adults](#) from Chelsea, Massachusetts, and the MGH Vaccine and Immunotherapy Center, which is directed by Mark Poznansky, MD, Ph.D. Each adult had received one or two doses of vaccine at least one week earlier. The researchers also analyzed blood samples from a group of adults who were unvaccinated and not infected with COVID-19, and another group of adults who were unvaccinated and recovering from infections.

A laboratory analysis of these blood samples found that two doses of the Moderna and Pfizer vaccines produced roughly similar concentrations of antibodies, which were greater than 100-fold higher than the amount produced by the single-dose Johnson & Johnson vaccine. The study also found that people who had recovered from COVID-19 infections had antibody concentrations similar to those who had received a single dose

of Moderna and Pfizer, which were more than 10 times higher than antibody levels produced by a dose of Johnson & Johnson.

A separate analysis conducted with Gaurav Gaiha, MD, of the Ragon Institute of MGH, MIT and Harvard found that the Johnson & Johnson vaccine was somewhat more effective at stimulating production of a different type of immune cell, known as CD4 T cells. However, those levels were still lower than those induced by the Moderna and Pfizer vaccines.

Next, the team collaborated with Alejandro Balazs, Ph.D., and members of his lab at the Ragon Institute to examine the vaccines' ability to neutralize three variants (or mutated versions) of COVID-19 that have evolved and spread throughout the world, known by the names Beta, Delta and Gamma. They found that Beta is the variant most likely to escape surveillance by the immune system. That suggests to Balazs that the Delta and Gamma variants must possess some other qualities, such as the ability to replicate rapidly, that have helped them spread. All three variants have rendered antibodies raised by the existing vaccines less effective. How effectively the three vaccines neutralize the [Omicron variant](#), which was identified in late November, is currently under investigation.

To gain insight into how well each vaccine protects recipients from being infected with breakthrough cases of COVID-19, the paper's lead author, Vivek Naranbhai, Ph.D., MBChB, analyzed data from studies conducted in California, the District of Columbia, and Oklahoma, as well as Iceland and South Korea. By merging these findings (a statistical method called a meta-analysis), they found that people inoculated with the Moderna vaccine had the lowest risk for breakthrough infections. Compared to adults who received the Moderna vaccine, Pfizer vaccine recipients were 1.53 times more likely to become infected with COVID-19, while those who received the Johnson & Johnson vaccine

were 2.54 times more likely.

"Our data strongly indicate that a single dose of Johnson & Johnson results in a weaker antibody response than the other vaccine regimens," says Iafrate. "These findings certainly support making booster shots available for that population." At this time, the Centers for Disease Control and Prevention recommends boosters for people aged 18 and older who have received any three of the primary vaccine regimens, and for people aged 16 and 17 who received the Pfizer primary [vaccine](#).

More information: Vivek Naranbhai et al, Comparative immunogenicity and effectiveness of mRNA-1273, BNT162b2 and Ad26.COVS COVID-19 vaccines, *The Journal of Infectious Diseases* (2021). [DOI: 10.1093/infdis/jiab593](https://doi.org/10.1093/infdis/jiab593)

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