

Vaccine stockpiling by nations could lead to increase in COVID-19 cases, novel variant emergence

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The allocation of COVID-19 vaccine between countries has thus far tended toward vaccine nationalism, wherein countries stockpile vaccines to prioritize access for their citizenry over equitable vaccine sharing. The extent of vaccine nationalism, however, may strongly impact global

trajectories of COVID-19 case numbers and increase the potential emergence of novel variants, according to a Princeton University and McGill University study published Aug. 17 in the journal *Science*.

"Certain countries such as Peru and South Africa that have had severe COVID-19 outbreaks have received few vaccines, while many doses have gone to countries experiencing comparatively milder pandemic impacts, either in terms of mortality or economic dislocation," said co-first author Caroline Wagner, an assistant professor of bioengineering at McGill University who previously served as a postdoctoral research associate in Princeton's High Meadows Environmental Institute (HMEI).

"As expected, we have seen large decreases in case numbers in many regions with high vaccine access, yet infections are resurging in areas with low availability," said co-first author Chadi Saad-Roy, a Princeton graduate student in ecology and [evolutionary biology](#) and the Lewis-Sigler Institute for Integrative Genomics.

"Our goal was to explore the effects of different vaccine-sharing schemes on the global persistence of COVID-19 infections—as well as the possibility for the evolution of novel variants—using mathematical models," Saad-Roy said.

The researchers projected forward the incidence of COVID-19 cases under a range of vaccine dosing regimes, vaccination rates, and assumptions related to immune responses. They did so in two model regions: One with high access to vaccines—a high-access region (HAR)—and a low-access region (LAR). The models also allowed for the regions to be coupled either through case importation, or the evolution of a novel variant in one of the regions.

"In this way, we could assess the dependence of our epidemiological projections on different immunological parameters, regional

characteristics such as population size and local transmission rate, and our assumptions related to vaccine allocation," Wagner said.

Overall, the study found that increased vaccine-sharing resulted in reduced case numbers in LARs. "Because it appears that vaccines are highly effective at reducing the clinical severity of infections, the public health implications of these reductions are very significant," said co-author Michael Mina, an assistant professor at the Harvard T. H. Chan School of Public Health.

Senior author C. Jessica E. Metcalf, a Princeton associate professor of ecology and evolutionary biology and public affairs and associated faculty in HMEI, added, "High case numbers in unvaccinated populations will likely be associated with higher numbers of hospitalizations and larger clinical burdens compared to highly vaccinated populations."

The authors also drew on a framework developed in their prior work to begin trying to quantify the potential for [viral evolution](#) under different vaccine sharing schemes. In their model, repeat infections in individuals with partial immunity—either from an earlier infection or a vaccine—may result in the evolution of novel variants.

"Overall, the models predict that sustained elevated case numbers in LARs with limited vaccine availability will result in a high potential for viral evolution," said senior author Bryan Grenfell, Princeton's Kathryn Briger and Sarah Fenton Professor of Ecology and Evolutionary Biology and Public Affairs and an associated faculty member in HMEI.

"As with [our earlier work](#), the current study strongly underlines how important rapid, equitable global vaccine distribution is," Grenfell said. "In a plausible scenario where secondary infections in individuals who have previously been infected strongly contribute to viral evolution,

unequal vaccine allocation appears particularly problematic."

As the pandemic progresses, viral evolution may play an increasingly large role in sustaining transmission, said senior author Simon Levin, Princeton's James S. McDonnell Distinguished University Professor in Ecology and Evolutionary Biology and an associated faculty member in HMEI. "In particular, antigenically novel variants have the potential to threaten immunization efforts globally through several mechanisms," he said, "including higher transmissibility, reduced vaccine efficacy, or immune escape."

Saad-Roy added, "In this way, global vaccine coverage will reduce the clinical burden from novel variants, while also decreasing the likelihood that these variants emerge."

There are additional considerations for [vaccine](#) equity beyond epidemiological and evolutionary ones, said co-author Ezekiel Emanuel, the Diane v.S. Levy and Robert M. Levy University Professor and co-director of the Healthcare Transformation Institute at the University of Pennsylvania.

"Ethics also argues against countries stockpiling vaccines or allocating doses for boosters," Emanuel said. "This study strongly supports that ethical position showing that stockpiling will undermine global health."

Co-author Jeremy Farrar, director of the Wellcome Trust, UK, said that the timing of when vaccines are shared also is likely to be critical: "In particular, sharing in parallel is what makes the greatest impact, not in sequence."

More information: Caroline E. Wagner et al, Vaccine nationalism and the dynamics and control of SARS-CoV-2, *Science* (2021). [DOI: 10.1126/science.abj7364](https://doi.org/10.1126/science.abj7364)

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