

Are pandemic lockdowns and vaccinations complements or substitutes?

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Worldwide, one of the initial responses to the COVID-19 virus was locking down parts of the economy to reduce social interactions and the virus's spread. Now, the development and production of vaccines have

largely replaced broad lockdowns. In a new study that considered epidemiology and economics, researchers sought to determine how the arrival of vaccines should affect the duration and intensity of lockdown policies. They concluded that boosting the rate of vaccine use influences intensity and duration of lockdowns, depending on a variety of factors.

The study was conducted by researchers at Carnegie Mellon University (CMU), the International Institute for Applied Systems Analysis, Vienna University of Technology, and the University of Vienna. It is published in the *European Journal of Operational Research*.

"While it is too late for policymakers to apply this model directly to the COVID-19 pandemic, there will likely be future pandemics," says Jonathan Caulkins, professor of operations research and public policy at CMU's Heinz College, who was lead author on the paper. "The devastation wrought by COVID-19—in terms of health and the economy—suggests that we should invest now in creating planning models for the next pandemic."

For the COVID-19 pandemic, vaccines were invented, tested, and approved in record-breaking time. Yet it still took nearly two years to produce and distribute enough to vaccinate everyone who wanted the [vaccine](#). In this study, researchers asked: During the period between when vaccines begin to become available and when there are enough vaccines for everyone, how should policymakers balance them with [lockdown](#) policies? More specifically: Are vaccines and lockdowns substitutes for one another, suggesting that lockdowns should decline as vaccination rates rise? Or are they complementary, with the prospect of imminent vaccination increasing the value of stricter lockdowns since hospitalization and deaths averted may be permanently prevented, not just delayed?

Researchers created a model of the epidemic's spread and resulting

health and [economic costs](#). Analysis began when the first vaccine was approved, with policymakers increasing or decreasing the intensity of lockdowns as vaccinations were disseminated and used.

Increasing the rate of vaccine use influences the intensity and duration of lockdowns, depending on various other factors (e.g., the duration and severity of infection, the death rate from COVID-19 and from other morbidities, the costs of shutting down businesses, the vaccination rate) and the state of the epidemic when the vaccine is approved, the study found.

Under certain circumstances, increased vaccination capacity should substitute for lockdowns, since greater vaccination capacity buys reduced unemployment. Within the study's model, that would be the case for countries that highly value preventing COVID-19 deaths and can vaccinate their population within two years. But when these parameters are lower, increased vaccination capacity could stimulate more lockdowns (complementarity), in which case greater vaccination capacity would be used to "buy" better health outcomes.

In addition, it may be sensible for lockdowns and vaccinations to co-exist, although there is not a static relationship between the two, the authors suggest. Sometimes it is optimal to ease lockdowns steadily as vaccination progresses; sometimes it is optimal to first increase lockdown stringency and reduce it later. Likewise, there are conditions when expanding vaccine production capacity would reduce the total effort involved in locking down, and conditions when the opposite is true. When vaccination evolves slowly, there is a complementary relationship, and when vaccination evolves quickly, vaccines can be viewed as substitutes for lockdowns.

Among the study's limitations, the authors note they did not consider the possibility that people would undermine lockdown restrictions.

Similarly, the study did not consider the costs of vaccination (because they vary considerably from country to country), nor did it factor vaccine hesitancy. In addition, their model examined just one type of virus; it did not consider multiple competing virus variants, loss of vaccine effectiveness because of mutations, or re-infections. Also, the study did not distinguish people by age, sex, occupation, or any category other than disease state, nor did it factor the effects of migration or international trade.

"Nations spend a great deal maintaining militaries during peacetime as a precaution and prevention measure," notes Caulkins. "Based on our findings, it may be equally prudent for nations to spend substantial sums on vaccine research and maintain idle [vaccine](#) production capacity even though pandemics come along only every few decades."

More information: J.P. Caulkins et al, The hammer and the jab: Are COVID-19 lockdowns and vaccinations complements or substitutes?, *European Journal of Operational Research* (2023). [DOI: 10.1016/j.ejor.2023.04.033](#)

Provided by Carnegie Mellon University's Heinz College

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