

Evaluating the Effectiveness of COVID-19 Vaccines Over Time

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ABSTRACT

Approximately 800 million COVID-19 cases and 7 million COVID-19 deaths have been reported to the World Health Organization thus far. Vaccination is a major tool to combat the COVID-19 pandemic, but its effectiveness wanes over time and tends to be lower against new SARS-CoV-2 variants. The knowledge about the waning effects of vaccination can guide boosting strategies. In a series of papers published in *The New England Journal of Medicine* and *JAMA*, we reported several large cohort studies using COVID-19 case surveillance and vaccination data from the states of North Carolina and Nebraska. We developed a novel statistical framework to evaluate the time-varying effects of the five generations of COVID-19 vaccines produced in the United States on infections with different SARS-CoV-2 variants and on severe outcomes (hospitalization and death). Our findings have been used by the World Health Organization and the U.S. Centers for Disease Control and Prevention and Food and Drug Administration and reported by *The New York Times*, *The Washington Post*, *ABC News*, and *NBC News*.

Keywords: B-spline; Cox model; Time-varying coefficients; Vaccination policy; Waning vaccine efficacy