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IMPACT OF EARLIER BOOSTERS AND PEDIATRIC VACCINES ON COVID-19

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ABSTRACT

The objective is to evaluate the impact of the earlier availability of COVID-19 vaccinations to children and boosters to adults in the face of the Delta and Omicron variants. We employed an agent-based stochastic network simulation model with a modified SEIR compartment model populated with demographic and census data for North Carolina. We found that earlier availability of childhood vaccines and earlier availability of adult boosters could have reduced the peak hospitalizations of the Delta wave by 10% and the Omicron wave by 42%, and could have reduced cumulative deaths by 9% by July 2022. When studied separately, we found that earlier childhood vaccinations reduce cumulative deaths by 2,611 more than earlier adult boosters. Therefore, the results of our simulation model suggest that the timing of childhood vaccination and booster efforts could have resulted in a reduced disease burden and that prioritizing childhood vaccinations would most effectively reduce disease spread.

1 INTRODUCTION

On November 1, 2021, the CDC/FDA approved the use of Pfizer COVID-19 vaccinations for children ages 5-11 (CDC 2021a), and on November 19, 2021, the CDC/FDA approved the use of Pfizer and Moderna booster vaccines for adults 20+ (CDC 2021b). These pharmaceutical interventions (PIs) for COVID-19 were made available after the Delta variant epidemic surge and roughly four weeks before the spread of the Omicron variant in the United States. As a result, the pandemic environment became increasingly complex in the second half of 2021. This complexity includes age group-specific PIs with county specific-uptake, dynamic adherence to non-pharmaceutical interventions (NPIs), multiple variants of differing severity causing multiple epidemic waves, immunity escape due to Omicron, and waning immunity for all recovered classes. In this environment, it is not clear how the timing of PI rollout may impact disease spread, and with the great effort required to get PIs to market, it is essential to understand the tradeoffs associated with prioritizing PI rollout on disease spread. Through counterfactual scenarios, we aim to answer the two research questions: (i) what is the effect of the earlier distribution of PIs by age group under the pandemic environment of summer and fall of 2021, and (ii) which PI (childhood vaccination or adult booster) would more effectively reduce disease burden if rolled out sooner?

2 METHODS

We employ a stochastic agent-based network model with an extended Susceptible-Exposed-Infected-Recovered (SEIR) framework to define the progression of SARS-CoV-2. Our simulation model is populated with census demographic data at the census tract level for the population of North Carolina (U.S. Census 2017). The agents' attributes captured are age, and race/ethnicity, household size, and diabetes prevalence. Agents interact in groups via a time-varying interaction network composed of their household, peer group (school or workplace), and community. We use a generalized force of infection model to generate the time until the next infection. We generate multiple stochastic realizations to represent the uncertainty of disease.

We examine four scenarios varying the timing of childhood vaccine and adult booster availability and subsequent distribution. These start times are 8/1/21 (shifted) and 11/1/21 (real), and 8/19/2021 (shifted) and 11/19/21 (real) for childhood vaccination and boosters, respectively. Additionally, we address modeling challenges of waning immunity, variant competition, county level vaccine distribution, simulation seeding. The model is calibrated to state-level hospitalizations and deaths.

3 RESULTS

Figure 4A-D shows the average number of cumulative deaths over the simulation time horizon, for four scenarios. Observed values are shown in the red lines, while the green shaded areas show the 10th and 90th percentiles of the simulation results. Comparing Figures 4A to 4C and 4B to 4D, we observed that distributing childhood vaccines earlier leads to 2,615 and 2,170 fewer cumulative deaths at the end of the time horizon, respectively. Comparing Figures 4A to 4B and 4C to 4D, earlier availability of boosters reduces cumulative deaths by 6 and 451 at the end of the time horizon, respectively. Comparing 4A to 4D, distributing both childhood vaccines and booster earlier reduces the number of cumulative deaths by 2,164 at the end of the time horizon

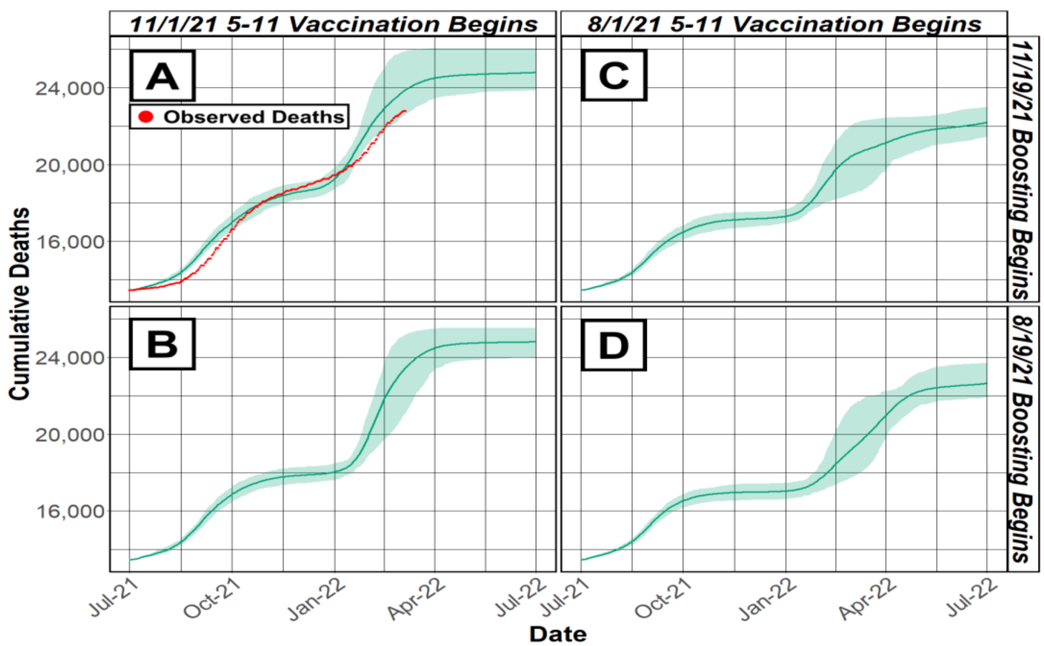

Figure 4: Impact of Booster and Childhood Vaccination Timing on Cumulative Deaths

While the distribution of the childhood vaccination is non-trivial to speed up due to FDA regulatory procedures and clinical trials, these works suggest a prioritization of childhood vaccination above booster rollout in the allocation of PI rollout policy. Children have a larger impact on statewide disease spread due to their limited cumulative immunity prior to PI availability.

REFERENCES

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