Cost-effective boosting allocations in the post-Omicron era of COVID-19 management

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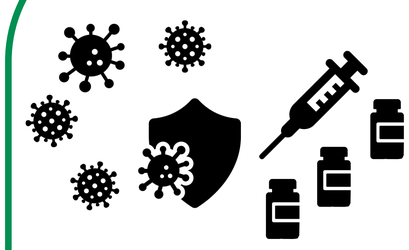
Vaccination + Infection = Hybrid Immunity

As we transition from pandemic to endemic circulation of COVID-19 around the world, populations have varying levels of hybrid immunity resulting from previous vaccination and infection histories. In this work we assess the impact and cost-effectiveness of targeted COVID-19 vaccination strategies for various countries.

Our modelling simulates complex immune landscapes by considering a variety of factors that impact a country's infections, deaths and vaccine cost-effectiveness:

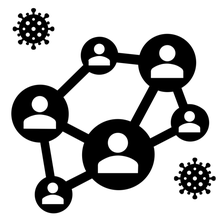
- Age demographic (older or younger)
- Vaccination coverage (high or low)
- Attack rate of previous COVID-19 waves (high or low transmission)
- Timing of immune escape of a new variant (early or late emergence)
- Current/future boosting vaccination strategy

Model Pipeline



Immunological model
Outputs: Infection parameters, neutralisation antibody parameters for any variant/vaccine combination

Clinical studies

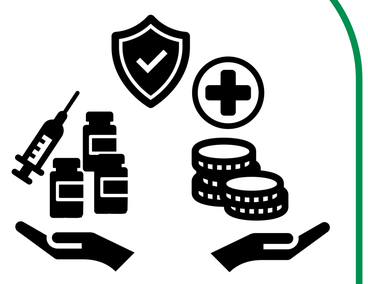


Population transmission
Outputs: infection histories

Age distribution, vaccination coverage and schedule, contact matrices, transmission potential

Clinical pathways
Outputs: clinical outcomes

Clinical progression probabilities and length of stay distributions by variant and age



Cost-effectiveness analysis
Outputs: Vaccine cost-effectiveness for exemplar country contexts

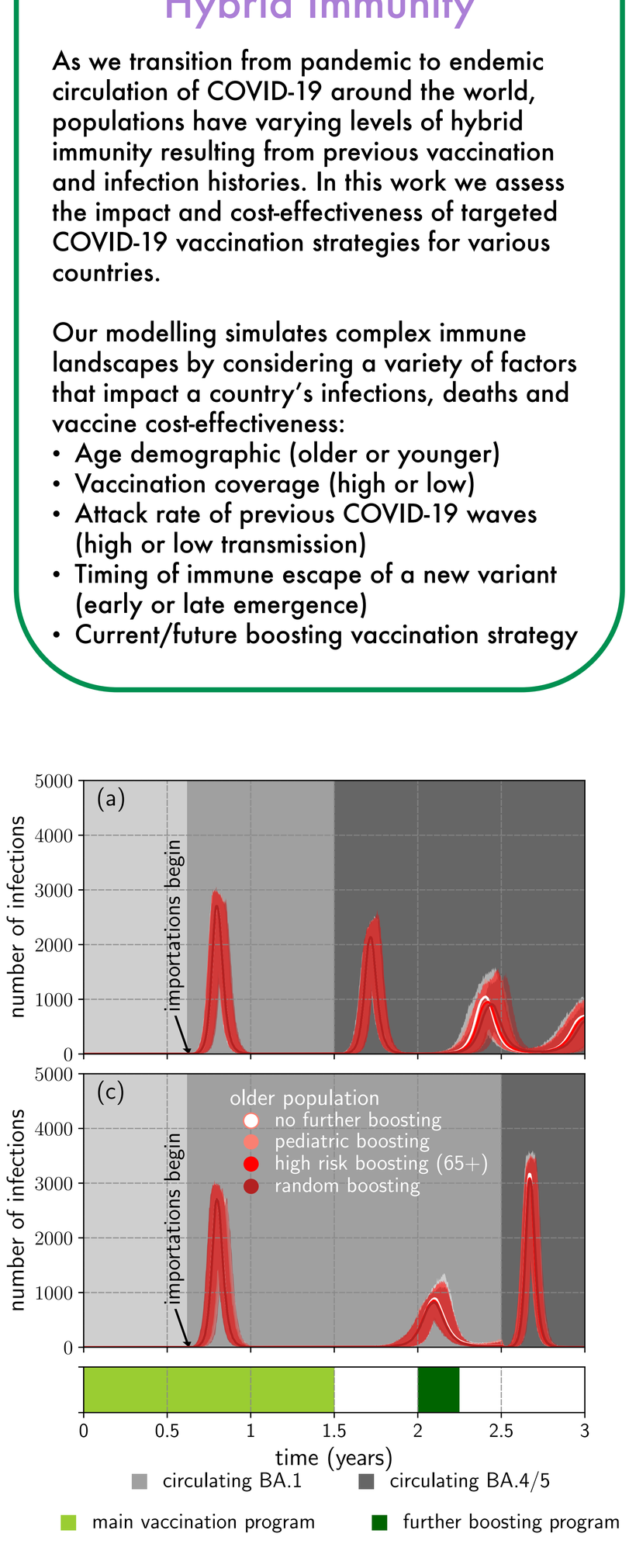
Disability weights and life tables, disease management cost, vaccine cost, exemplar countries

inputs and parameters

Scenario 1: Older population, high transmission, high vaccination coverage

We compare the impact of a variety boosting strategies on infections/deaths and vaccine cost-effectiveness given early or late emergence of an immune escape variant

Immune escape	Boosting strategy	Median deaths
Early	No further boosting	40.0 (28.0, 53.0)
	Pediatric (ages 5-15)	40.0 (29.0, 53.0)
	High-risk (65+)	34.0 (23.0, 46.0)
	Random	39.0 (27.0, 52.0)
Late	No further boosting	49.0 (36.0, 62.0)
	Pediatric (ages 5-15)	49.0 (36.0, 62.0)
	High-risk (65+)	34.0 (23.0, 47.0)
	Random	44.0 (32.0, 59.0)



Infections and deaths:

- We see little difference in infection dynamics between vaccination strategies
- Late emergence of an immune escape variant shifts epidemic peaks to the right
- We do see a difference in severe outcomes between strategies
- High-risk boosting averts the most severe disease

Vaccine cost-effectiveness

- Boosting is more cost-effective when it occurs prior to immune escape
- High-risk boosting is likely to be cost-effective or cost-saving
- Pediatric boosting does not appear to be cost-effective
- The cost-effectiveness of high-risk boosting is driven primarily by vaccine program (delivery and dose) costs, followed by disease management costs in general ward

Elder-targeted strategies are most likely to be cost-effective and could even be cost-saving

The flexibility of our modelling pipeline allowed us to assess the impact and cost-effectiveness of booster strategies across a variety of populations. Across all scenarios we found:

- Pediatric programs (primary of boosting) were not cost-effective
- Absolute harms averted by vaccination are influenced by: age and risk profile of population, prior hybrid immunity, and timing of emergence of an immune escape variant in relation to booster delivery
- Half-yearly 'high risk' booster programs are more expensive, but may be cost effective in older, high income populations

This work was presented to the Advisory Committee on Immunization and Vaccines-related Implementation Research (IVIRAC) and was subsequently cited as part of the WHO updated COVID-19 vaccination guidance for March 2023.

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We acknowledge the traditional owners of the land on which we work, the Wurundjeri people of the Kulin Nation