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Modelling the Cost-Effectiveness of COVID-19 Vaccination Strategies in Kenya

Policy Brief

Key Messages

- We modelled the epidemiological impact and cost-effectiveness of a range of COVID-19 vaccine deployment scenarios in Kenya using a societal perspective
- The deployment of COVID-19 vaccines in the Kenyan population is likely to avert substantial cases, hospitalizations, and deaths from COVID-19
- Achieving a low population coverage (30%) which preferentially targets the elderly who are at high risk of severe disease and deaths is more cost-effective compared to no vaccination and strategies that target higher population coverage
- Deployment strategies that achieve rapid (6 months) coverage of the target groups are more effective compared to slow (18 months) vaccine deployment strategies
- Kenya and other similar settings will achieve better health impacts and value for money from their COVID-19 vaccination programmes with improved targeting of the elderly and other groups at high risk of severe disease and death
- Given a constrained fiscal space, as Kenya considers transitioning to COVID-19 endemicity, a vaccination strategy that is targeted to the elderly and those with comorbidities is likely more feasible, affordable, and cost-effective, compared to a universal vaccination strategy

Introduction

The Kenyan government is implementing a phased COVID-19 vaccination strategy whose roll out prioritizes high risk groups and targets to vaccinate at least 100% of adults by December 2022. The prioritized population groups include health and other essential workers, individuals at high risk of severe disease (those above 58 years, and those above 18 years with co-morbidities), and individuals at high risk of infection (individuals in congregate settings, and those working in hospitality and transport sectors) (figure 1). Vaccine roll-out commenced in early March 2021. As of early April 2022 30% of Kenya's adult population above the age of 18 years are fully vaccinated. We modelled the epidemiological impact and cost-effectiveness of a range of COVID-19 vaccination strategies in Kenya.

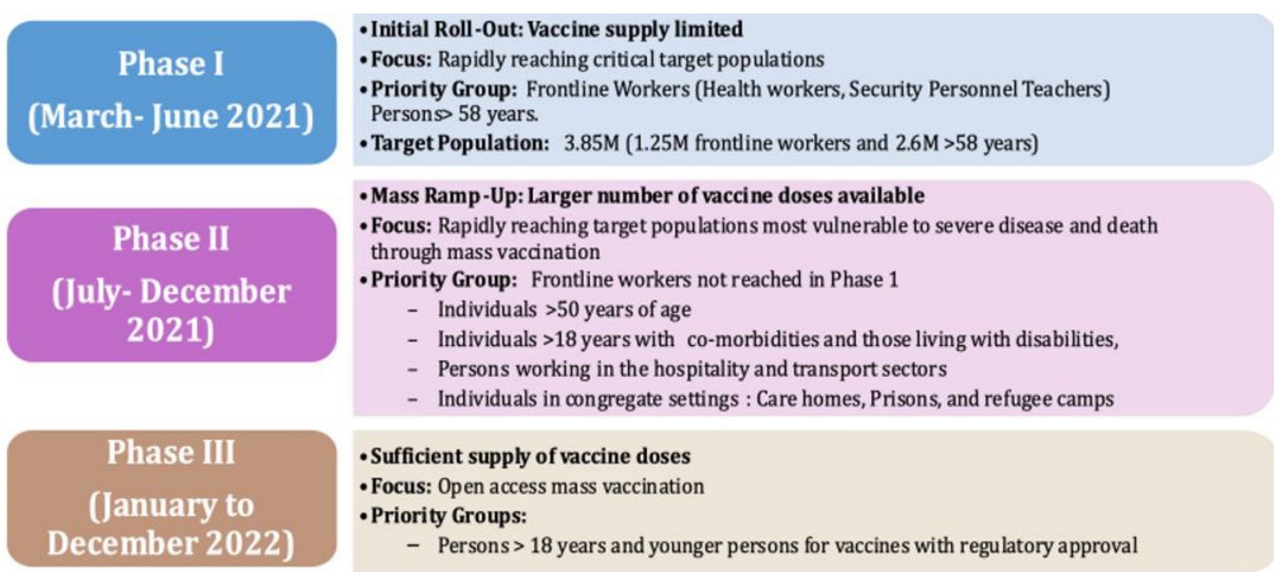

Figure 1: Kenya COVID-19 vaccine deployment strategy

Methods

We carried out a cost-effectiveness analysis using a societal perspective and a 1.5-year (18 months) time horizon. We included vaccination costs, COVID-19 treatment costs, and productivity loses due to illness and death from COVID-19. We used costs obtained from primary cost analysis and modelled the epidemiological impact of the COVID-19 vaccine on cases, hospitalizations, and death from a SARS-CoV-2 age-structured dynamic transmission model that we have used previously to model SARS-CoV-2 transmission dynamics in Kenya. We fitted the model to predict the course of the pandemic from 1st September 2021 to 30 June 2023. The model assumed the rapid spread of a new variant of SARS-CoV-2 in November 2021 that avoids protection from infection due to prior naturally acquired immunity and/or vaccination and spreads more rapidly. Vaccination is introduced on 1st September 2021. We computed incremental cost-effectiveness ratios (ICERs) as incremental cost per disability adjusted life years averted (DALY), and compared them with Kenya's recommended cost-effectiveness threshold(US$919.11). We assessed the robustness of our analysis using one way and probabilistic sensitivity analysis. We compared different vaccination coverage strategies under a slow and a rapid vaccination deployment scenario (table 1). In the model, priority is given to the elderly (above 50 years) in each of the vaccination scenarios. Given that this population represents 11% of the Kenyan population, coverage is achieved for this population under the 30% coverage scenario, with the higher coverage scenarios (50% and 70%) extending coverage among younger populations. We assume a maximum fully vaccinated coverage for any age group of 80%. In practice, the primary target age group of 50 years of age and above is vaccinated up to a maximum of 80%, then followed by the vaccination of other age groups uniformly.

Table 1: Modelled COVID-19 vaccine deployment scenarios and coverage strategies

	Vaccine Deployment Scenarios	
Vaccine Coverage Strategies	**Slow vaccine deployment over 18 months**	**Rapid vaccine deployment over 6 months**
	No vaccination (0%) where we assume that no vaccines are administered in the country	
	Minimal coverage: 30% of the population older than 18 years will be vaccinated, with prioritization of those aged 50 years and above	
	Optimistic coverage scenario: 50% of the population older than 18 years will be vaccinated, with prioritization of those aged 50 years and above	
	Very optimistic coverage scenario: 70% of the population older than 18 years will be vaccinated while prioritizing those aged 50 years and above	

Results

Clinical Impacts of Vaccination Strategies

Table 2 and figure 2 outlines the epidemiological impact of the COVID-19 vaccines under the modelled scenarios.

- In the base case analysis (slow deployment scenario), introduction of vaccination to the adult population at a coverage of 30%, prioritizing the elderly would result in a decrease of infections by 10%, averting on average 32 per 100,000 infections and a decrease in deaths by 54%, saving an average of 8,132 lives compared to a no vaccination scenario
- Increase of vaccine coverage to 50% results in a further 1% reduction in cases and a further 12% reduction in deaths
- Increase of vaccine coverage to 70% leads to a further 1% reduction in cases and a further 5% reduction in deaths compared to the 50% vaccination coverage
- Therefore, while increasing vaccine coverage increases health impacts, it is associated with decreasing marginal benefits
- The rapid vaccine deployment scenarios achieve higher health impacts compared to the slow deployment scenarios

Table 2: Projected clinical outcomes, costs, and the cost-effectiveness of different vaccination strategies in Kenya from a societal perspective

	Health Outcomes		Economic Outcomes		
	*Averted SARS-CoV-2 infections, per 100,000 median (2.5th to 97.5th percentile)	Averted SARS-CoV-2 deaths median (2.5th to 97.5th percentile)	Total costs ($millions), median (2.5th to 97.5th percentile)	Total DALYs averted (thousands), median (2.5th to 97.5th percentile)	ICER, ($ per DALY averted) mean(95%CI)
Slow vaccination scenario (administered within 1.5years)					
No vaccination (baseline)	-	-	787 (740 to 882)	247 (243 to 252)	-
30% coverage	32 (24 to 38)	8,132 (7,914 to 8,373)	614 (589 to 659)	114 (110 to 118)	-1,343 (-1,345 to -1,341) Dominant
50% coverage	4 (3 to 5)	810 (757 to 872)	658 (636 to 699)	101 (97 to 104)	3,291 (3,287 to 3,295)
70% coverage	2(1 to 3)	282 (251 to 317)	763 (742 to 801)	96 (92 to 100)	22,623 (22,602 to 22,645)
Rapid vaccination scenario (administered within 6 months)					
No vaccination (baseline)	-	-	787 (740 to 882)	247 (243 to 252)	-
30% coverage	39 (29 to 48)	9,433 (9,197 to 9,711)	545 (524 to 582)	93 (89 to 96)	-1,607 (-1,609 to -1,604) Dominant
50% coverage	1 (0.5 to 2)	250 (201 to 296)	620 (599 to 655)	88 (85 to 92)	18,257 (18,226 to 18,287)
70% coverage	0.5 (-0.05 to 1)	161 (106 to 208)	731 (713 to 765)	86 (82 to 89)	44,250 (44,126 to 44,374)

*Averted SARS-Cov-2 infections and deaths = This is the incremental averted infections/deaths compared to the vaccination strategy that appears in the row above.
Total averted infections=rounded off to the nearest 100,000; Total Cost=rounded off to the nearest 1,000,000; Total DALY rounded off to the nearest 1,000; Total deaths and ICERs=rounded off to the nearest whole number

Cost-Effectiveness of Vaccination Strategies

Table 2 shows the total costs, DALYs and ICERs of the vaccination scenarios.

- Under the slow vaccination deployment scenario, vaccinating 30% of the adult population is cost-saving (ICER=-$1,345) and hence highly cost-effective at Kenya's cost-effectiveness threshold of $919.11
- Increasing vaccine coverage to 50% and 70% of the adult population was not cost-effective (ICER=$3,291 and $22,623 per DALY averted respectively)
- Under the rapid vaccination scenario, a 30% vaccine coverage strategy will result in a lower ICER ($-1,607) compared to the same coverage level under the slow scenario, and hence is more cost-effective
- The ICERs for 50% and 70% coverage strategies under the non-rapid scenario are $18,257 and $44,250 respectively and hence are not cost-effective
- Sensitivity analysis revealed that vaccine prices had the largest effect on the ICERs, leading to a 32%-103% decrease and a 36%-77% increase in ICERs across the different vaccination scenario

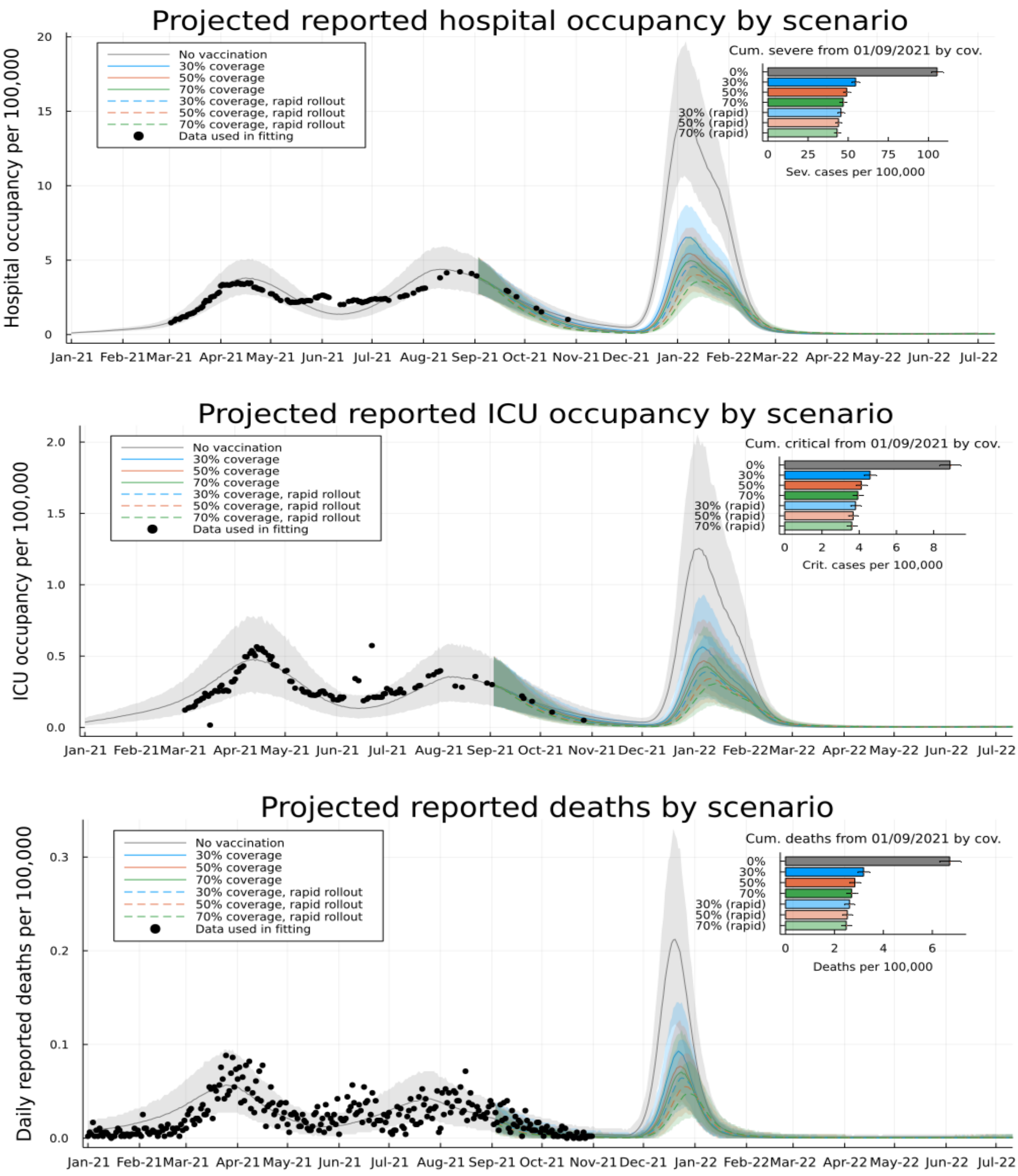

Figure 2: Model-based projections and vaccine scenarios: Model-based prediction intervals for daily occupancy of general wards in health facilities in Kenya (top), daily occupancy of intensive care units in Kenya (middle), and daily reported incidence of death with COVID in Kenya (bottom). All scatter points represented data used in inference of the infection outcome model. Grey curves are the posterior mean model prediction (background shading 95% CIs) with no vaccinations. Colored curves represent a target of 30% (blue), 50% (red) and 70% (green) of over 18 year old population in Kenya over 18 months (solid) or 6 months (dashed). Insets: Projections of cumulative number of severe (top), critical (middle) and deadly (bottom) cases after 1st September 2021 under each vaccine target scenario

Conclusions

- In settings with overall low risk of severe disease and death, and high natural immunity due to previous exposure as is the case in Kenya and Africa more broadly, COVID-19 vaccination is likely to offer the best value for money when targeted to the elderly and those with risk increasing comorbidities rather than to the whole population
- In the context of a pandemic, efforts to rapidly deploy the vaccine not only avert more cases, hospitalization, and deaths, but are also more cost-effective
- Kenya and other similar settings will achieve better health impacts and value for money from their COVID-19 vaccination programmes with improved targeting of vulnerable groups
- Given a constrained fiscal space, as Kenya considers transitioning to COVID-19 endemicity, a vaccination strategy that is targeted to the elderly and those with comorbidities is likely more feasible, affordable, and cost-effective

About This Study

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