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COVID-19 vaccination implementation in 52 African countries: trajectory and implications for future pandemic preparedness

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ABSTRACT

Introduction To end the COVID-19 pandemic, the WHO set a goal in 2021 to fully vaccinate 70% of the global population by mid-2022. We projected the COVID-19 vaccination trajectory in 52 African countries and compared the projected to the 'actual' or 'observed' coverage as of December 2022. We also estimated the required vaccination speed needed to have attained the WHO 70% coverage target by December 2022.

Methods We obtained publicly available, country-reported daily COVID-19 vaccination data, covering the initial 9 months following the deployment of vaccines. We used a deterministic compartmental Susceptible-Exposed-Infectious-Recovered-type model and fit the model to the number of COVID-19 cases and vaccination coverage in each African country using a Markov chain Monte Carlo approach within a Bayesian framework.

Findings Only nine of the 52 African countries (Tunisia, Cabo Verde, Lesotho, Mozambique, Rwanda, Seychelles, Morocco, Botswana and Mauritius) were on track to achieve full COVID-19 vaccination coverage rates ranging from 72% to 97% by the end of December 2022, based on their progress after 9 months of vaccine deployment. Of the 52 countries, 26 (50%) achieved 'actual' or 'observed' vaccination coverage rates within ±10 percentage points of their projected vaccination coverage. Among the countries projected to achieve <30% by December 2022, nine of them (Chad, Niger, Nigeria, South Sudan, Tanzania, Somalia, Zambia, Sierra Leone and Côte d'Ivoire) achieved a higher observed coverage than the projected coverage, ranging from 12.3 percentage points in South Sudan to 35.7 percentage points above the projected coverage in Tanzania. Among the 52 countries, 83% (43 out of 52) needed to at least double their vaccination trajectory after 9 months of deployment to reach the 70% target by December 2022.

Conclusion Our findings can guide countries in planning strategies for future global health emergencies and learning from each other, especially those that exceeded expectations and made significant progress towards the WHO's 2022 COVID-19 vaccination target despite projected poor coverage rates.

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ Studies have reported that most African countries did not meet the WHO target of vaccinating at least 70% of their populations with COVID-19 vaccines by mid-2022 to attain the population-level immunity needed to end the acute phase of the pandemic.

WHAT THIS STUDY ADDS

⇒ Our findings showed that some countries projected to have poor trajectory to meet the WHO target overcame their contextual challenges which improved their COVID-19 vaccination rates, but they did not eventually achieve the WHO target.

⇒ We also provide useful insights for future pandemic preparedness as we now know which countries on the African continent are likely to lag behind in delivering life-saving interventions during future global health emergencies.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ Our findings may inform continent-wide strategies and shared learnings as countries that did not achieve the targets can learn from those that achieved the WHO mid-2022 target.

⇒ Evidence from our study can guide African governments and policymakers in planning and implementation of continued COVID-19 vaccination programmes in their countries.

INTRODUCTION

As of 4 October 2023, COVID-19 had been reported in over 770 million people and resulted in about 7 million deaths in over 210 countries and territories globally.[1] While the symptoms of COVID-19 may resolve in many people, debilitating long-term sequelae of the virus, which impact the quality of life and productivity of individuals, are well documented.[2 3] Some individuals have developed

ongoing fatigue, respiratory and heart complications and neurological symptoms lasting several weeks or months beyond the initial illness—the 'long-COVID' phenomenon.[4] The COVID-19 pandemic is far more than a health crisis. At its peak, the economic and social disruption it caused plunged the world into its worst recession since World War II.[5 6] The pandemic also amplified entrenched equity gaps and set back developmental progress. In 2020, an estimated 34 million people were pushed into extreme poverty, with 56% disproportionately occurring in Africa.[7] Although the acute phase of COVID-19 pandemic has been declared officially over by the WHO, the risk of new variants remains.[8] A key question the world now faces is how countries can progressively recover from the social and economic impact caused by the COVID-19 pandemic while learning and implementing lessons learnt to prevent similar impacts from future threats.

Widespread use of vaccines played an important tool in ending the acute phase of the pandemic, and this was made possible due to the development of highly effective and safe COVID-19 vaccines at an unprecedented speed. In early 2021, the WHO set a target for all countries to fully vaccinate 10% of their populations by the end of September 2021. While almost 90% of high-income countries (HICs) met this target, less than 30% of the 54 countries in Africa achieved the target.[9] Driven by the health and economic imperatives of ending the pandemic quickly, the WHO set another target to fully vaccinate 40% of people in all countries by the end of 2021, and 70% by mid-2022.[10] By the end of 2021, only seven countries on the African continent (Seychelles, Mauritius, Morocco, Tunisia, Cabo Verde, Botswana and Rwanda) met the 40% target. These countries represent only 13% of African countries compared with almost 90% of HICs that met the target.[11]

The equity gaps in access to COVID-19 vaccines, which were characterised by vaccine nationalism, overpurchasing of vaccine doses[12] and prioritisation of booster programmes by HICs while poorer nations lacked vaccine supplies, seem to be closing. The 96 million doses of COVID-19 vaccines shipped to Africa in January 2022 were more than double those received in the preceding 6 months.[13] Nevertheless, much work needed to be done as African countries struggled to turn vaccines into vaccinations. As of mid-February 2022, more than half of the African countries had used less than 50% of their vaccine stock.[11 13] Donation of vaccines with short shelf life, weak public health infrastructure and competing priorities from other endemic diseases all played a part in slowing vaccination progress.[14] In addition, operational challenges such as lack of sustainable funding, and limited human resources needed to deliver the vaccines also contributed to the problem. The slow COVID-19 vaccination rates reported on the African continent may present a threat to global recovery from the endemic phase of the pandemic.[15]

In a paper published in 2021, we previously showed that to achieve a COVID-19 vaccination coverage of at least 60% by mid-2022—a target set by African heads of governments, the West African subregion must increase the speed of COVID-19 vaccinations by four times the rate as of 3 months after vaccine deployment.[16] Few studies[15 17] have reported COVID-19 vaccine coverage across all African countries. To our knowledge, no published study has reported the vaccination trajectory in the context of the speed needed to achieve the WHO target, or compared modelled or projected COVID-19 vaccination coverage rates with 'actual' or 'observed' coverage rates. Such data will be important for planning continent-wide strategies during future pandemics and for countries to learn from each other, especially those that surpassed their projected poor coverage rates and made significant progress towards achieving the WHO 2022 COVID-19 vaccination target. Against this backdrop, we projected the COVID-19 vaccination trajectory in 52 African countries after 9 months of vaccine deployment. We modelled the timelines for achieving the WHO target in each country and compared the modelled coverage to the observed coverage as of December 2022 to determine which countries made progress in reaching the target. Additionally, based on the trajectory after 9 months of vaccine deployment, we estimated the required vaccination speed to attain at least 70% coverage by December 2022.

METHODS

Overview

We included all African countries that deployed COVID-19 vaccines within the preceding 9 months to ensure there were sufficient data to build our model and generate robust outcomes. Complete data were available for 52 out of the 54 countries in Africa. The excluded countries were Algeria and Eritrea. According to the United Nations estimates, the total population of people on the African continent was approximately 1.4 billion in 2020, accounting for about 18% of the total world population.[18] According to the Africa Centres for Disease Control and Prevention, as of December 2022, more than 1 billion doses of COVID-19 vaccines have been shipped to African countries, with COVID-19 Vaccines Global Access (COVAX) deliveries accounting for almost two-thirds.[19] Other sources of vaccines were from the African Union's African Vaccine Acquisition Trust, direct donations from foreign partners such as China, Russia, USA and European countries.

Data sources

We used publicly available country-level daily vaccination data from Our World in Data[20] covering the first 9 months of vaccine deployment in Africa. Other data sources that we used to model vaccination trajectories and the speed needed to achieve the WHO COVID-19 vaccination

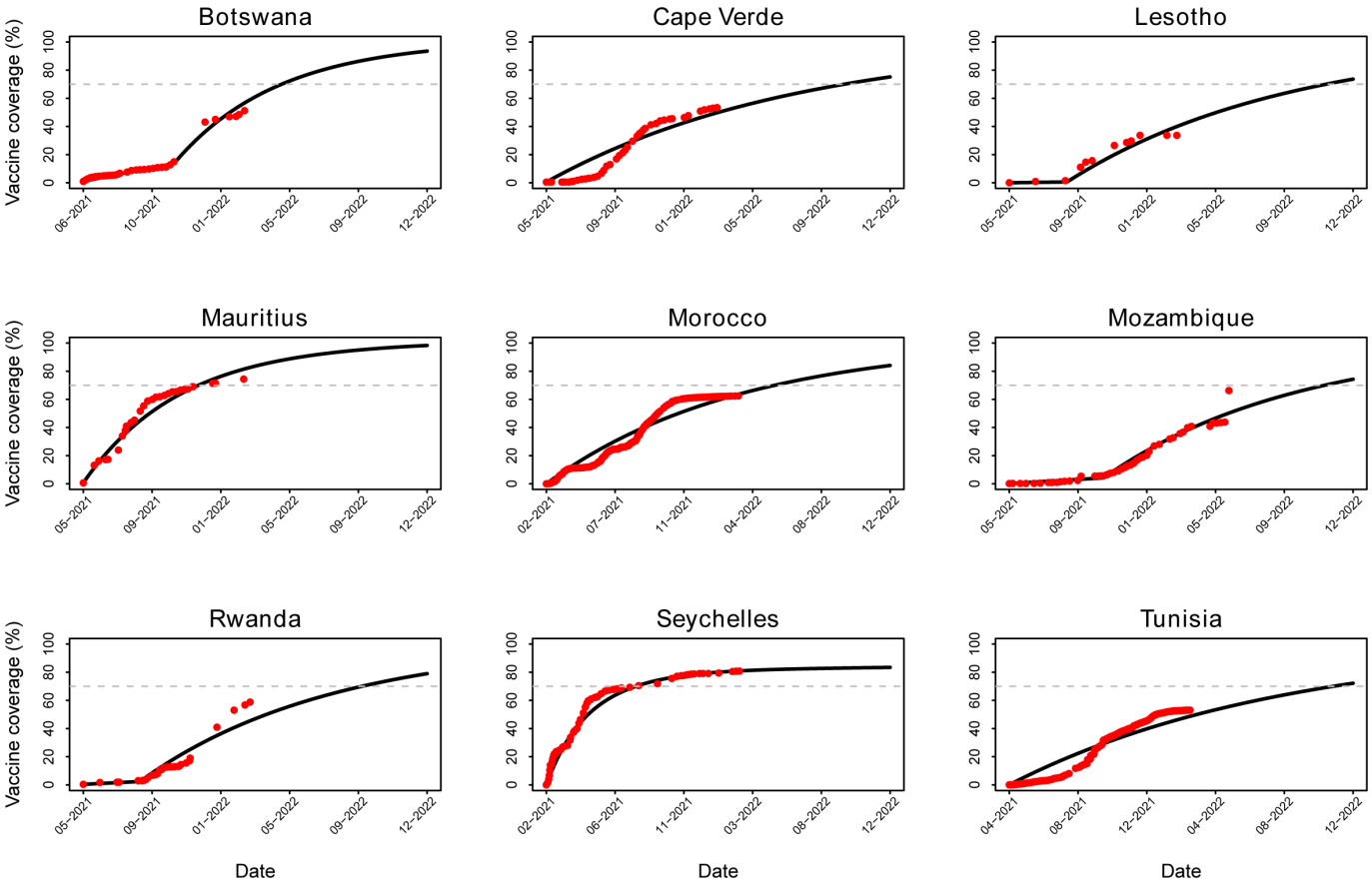

Figure 1 COVID-19 vaccination coverage trajectory after at least 9 months of vaccine deployment, that is, as of February 2022 for the highest performing African countries or countries. The black lines (modelled trajectory), red dots (actual or observed vaccination coverage) and grey dashed lines indicate the WHO 70% coverage target.

targets are summarised in online supplemental table S1, S2 and S3.

Outcome measures and statistical analysis

The primary outcome of our analysis is the proportion of the population in each country who have completed the recommended COVID-19 vaccination primary series (ie, fully vaccinated), either through two doses of vaccines like Oxford AstraZeneca's or Pfizer's, or a single-dose vaccine like Johnson & Johnson's. To determine which countries made progress as projected, we subtracted the modelled/expected coverage as of December 2022 from the observed coverage as of December 2022 and reported the difference in percentage points above or below the expected coverage target. Secondary outcome measures include: (a) the date on which each country was expected to achieve the 70% vaccine coverage target based on the existing vaccination trajectory after 9 months, and (b) the pace at which countries need to vaccinate to achieve the 70% full vaccination target by December 2022. We ranked and presented all outcome measures graphically for all countries, while also providing separate analyses for individual country vaccination scenarios. All analysis was done in R (R Development Core Team, 2023).

Modelling the trajectory and speed of COVID-19 vaccination

The model parameters and values used in the analysis with their references are shown in online supplemental table S2. We used a deterministic compartmental Susceptible-Exposed-Infectious-Recovered-type model and extended it to incorporate vaccination and demographic parameters for each country. The total population of each country was divided into susceptible $(S(t))$, vaccinated $(V(t))$, exposed $(E(t))$, infectious $(I(t))$ and recovered $(R(t))$. Individuals enter the susceptible population through births at a rate Λ. Susceptible individuals are infected at a rate β, which is the effective contact rate between susceptible and COVID-19 infectious individuals. Susceptible individuals are vaccinated at a rate ω and move to the vaccinated state. We assume that the vaccines are not 100% effective and therefore their effectiveness was modelled by $\varepsilon = 1 - \theta$. After a period of $1/\rho$ days, exposed individuals become infectious. Infectious individuals either recover at a rate κ or die from the infection at a rate δ.

The model assumes that those who recover (but not previously vaccinated) can be vaccinated after a period of 1 month. All individuals experience a natural death at rate μ. We assume that births balance natural deaths and therefore not much change occurs in the population

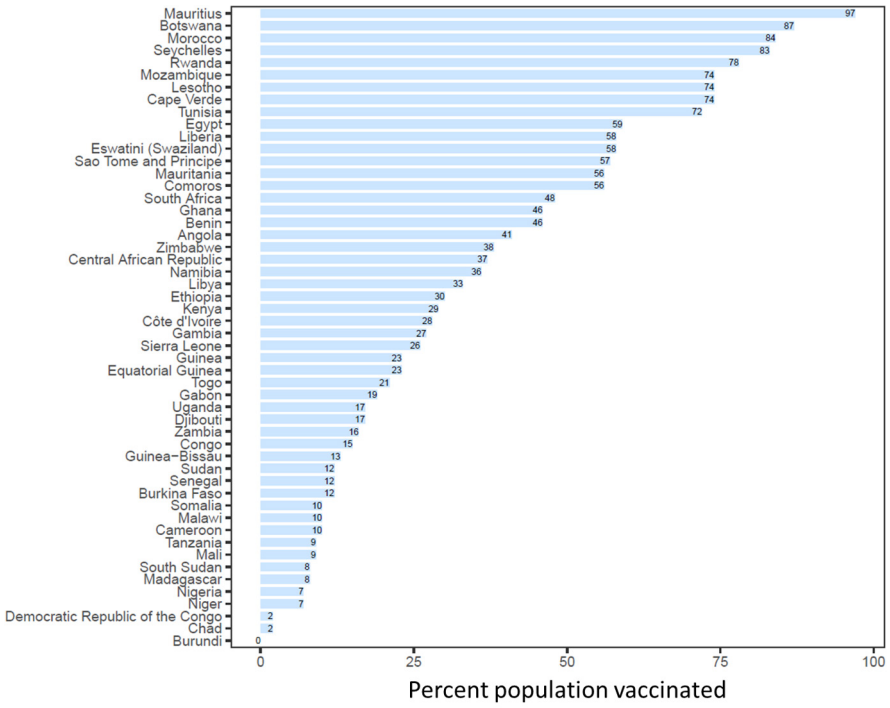

Figure 2 Projected COVID-19 vaccination coverage to be achieved by each country by end of December 2022 if the vaccination trajectory after 9 months of vaccine deployment is maintained in 52 African countries.

size. The flow diagram of the model is shown in online supplemental figure S1 and the model equations are given below:

$$\frac{dS}{dt} = \Lambda - \beta IS/N - (\omega + \mu) S,$$

$$\frac{dV}{dt} = \omega S - \beta\theta IV/N - \mu V,$$

$$\frac{dE}{dt} = (\beta I(S + \theta V))/N - (\rho + \mu) E,$$

$$\frac{dI}{dt} = \rho E - (\kappa + \delta + \mu) I,$$

$$\frac{dR}{dt} = \kappa I - \mu R.$$

We used a Markov chain Monte Carlo (MCMC) within a Bayesian framework (in R FME package)[21] to fit the model to the number of COVID cases and vaccination coverage. The MCMC chain was generated with at least 50 000 runs for the final fitting excluding the burn-in period. Uncertainty of each estimated parameter was evaluated by analysing the MCMC chains and calculating the 2.5 and 97.5 quantiles of the chain around its median to give the 95% credible interval. Total population size,[18] number of people vaccinated[19] and number of people infected and infectious[22] were obtained. In the fitting process, we estimated the effective contact rate, exposed period and infection period for each country. Using the vaccination rates obtained from fitting the modelled vaccine coverage to data, we used the model to project the likely vaccine coverage each country would attain by the end of December 2022, by assuming that the coverage trajectory would not change in that period. For countries that are not able to reach a coverage of 70% by end of December 2022 based on the model, we estimated the duration of time these countries are likely to reach the 70% target. In addition, we calculated the increase in coverage rates (ie, the kinetic or speed), from current rate, needed by each country to reach 70% by the end of December 2022.

Patient and public involvement

Given that this study did not recruit or enrol human participants, patients or participants were neither involved in the study design nor in the recruitment to and conduct of the study. However, the development of the research questions and outcome measures were informed by the need to use the continent-wide performance in COVID-19 vaccination implementation to guide shared learnings among African countries in preparation for future pandemics. In addition to the publication of the findings of this study, the results will also be disseminated to stakeholders including policymakers and decision makers in Africa through presentations at local, regional and international meetings.

RESULTS

COVID-19 vaccination trajectory after at least 9 months of vaccine deployment

Nine months after the start of vaccine deployment in 52 African countries, the proportions of fully vaccinated individuals varied significantly. Countries such as Burundi, Chad, the Democratic Republic of the Congo, Niger, Nigeria, Madagascar, South Sudan, Mali and Tanzania had low vaccination coverage, with only 0.1–4.9% of their populations fully vaccinated. In contrast, Botswana,

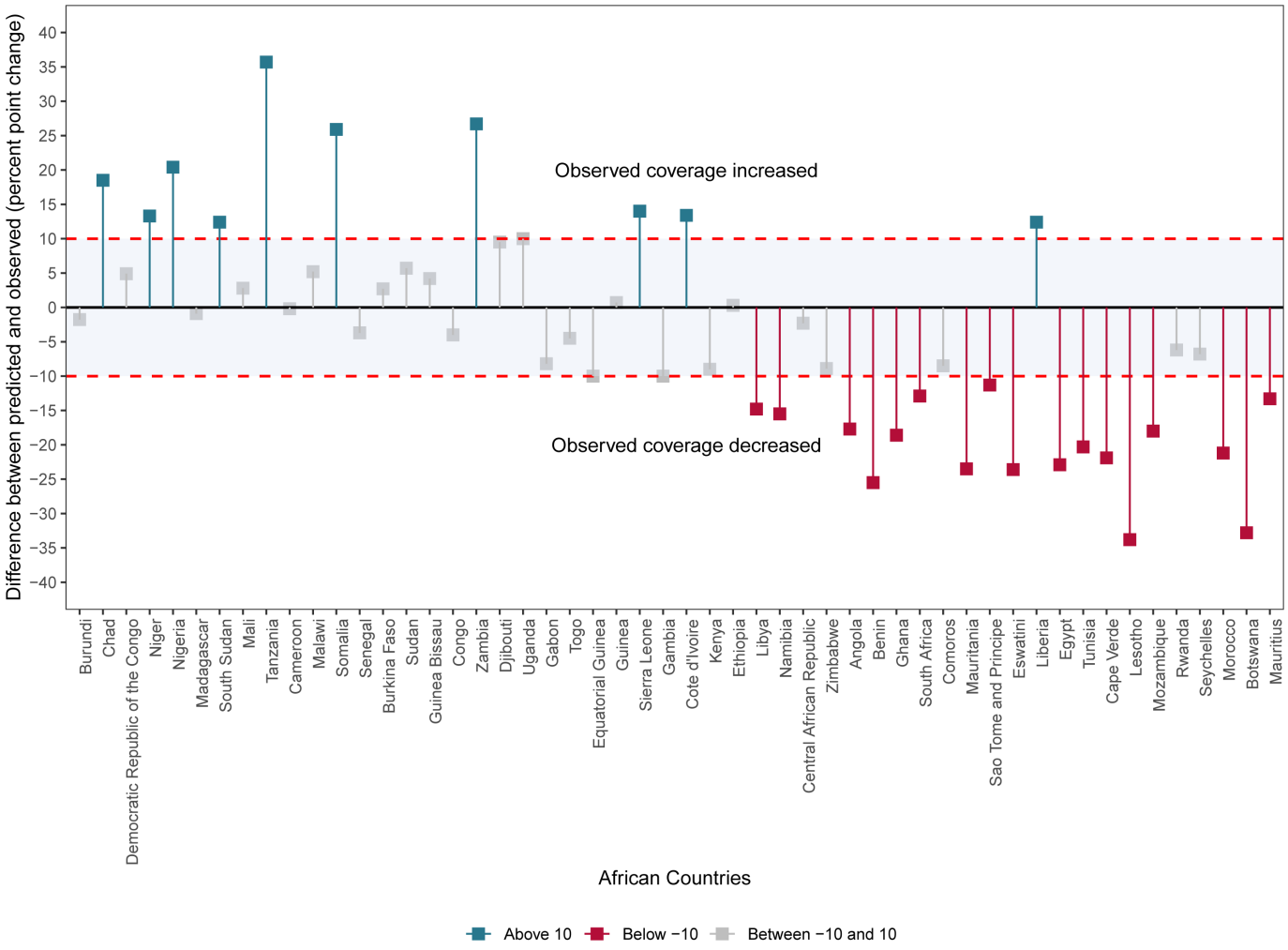

Figure 3 The percentage points difference between the projected and observed or actual COVID-19 vaccination coverage achieved in 52 African countries as of December 2022.

Cabo Verde, Lesotho, Mauritius, Morocco, Mozambique, Rwanda, Seychelles and Tunisia had a substantial proportion of their populations fully vaccinated. By February 2022, Mauritius and Seychelles had already achieved more than 70% full vaccination coverage. The trajectory in the remaining seven high-performing countries was promising, indicating that they were on track to achieve at least 70% coverage by December 2022 (figure 1). For detailed information on the vaccination trajectory of all the low-performing countries, please refer to online supplemental figures S2–S43.

Projected vaccination coverage by December 2022 and comparison with observed coverage

Based on the vaccination trajectory after 9 months, only nine of the 52 African countries (Tunisia, Cabo Verde, Lesotho, Mozambique, Rwanda, Seychelles, Morocco, Botswana and Mauritius) were projected to be on course to achieve full COVID-19 vaccination coverage rates ranging from 72% to 97% by the end of December 2022 (figure 2). This means that more than 80% of the African countries included in the study were not on course to reach the target of at least 70% full vaccination coverage by the end of December 2022 if they continued on the trajectory achieved after 9 months of vaccine deployment.

Figure 3 shows the per cent points difference between the projected and actual or observed vaccination coverage as of December 2022. Of the 52 countries, 26 (50%) achieved actual or observed vaccination coverage rates within ±10 percentage points of the projected vaccination coverage. Most of the countries in this category were those projected to have coverage <30% as of December 2022. However, nine countries projected to achieve <30% coverage by December 2022 (Chad, Niger, Nigeria, South Sudan, Tanzania, Somalia, Zambia, Sierra Leone and Côte d'Ivoire) exceeded projected coverage by 12.3 percentage points in South Sudan to as high as 35.7 percentage points in Tanzania. Most of the countries that were projected to achieve >70% coverage by December 2022 did not continue on their trajectory. As a result, the difference between their projected and actual or observed coverage as of December 2022 was lower by 13.3 percentage points in Mauritius to as low as 33.8 percentage points difference in Lesotho (figure 3 and online supplemental table S3).

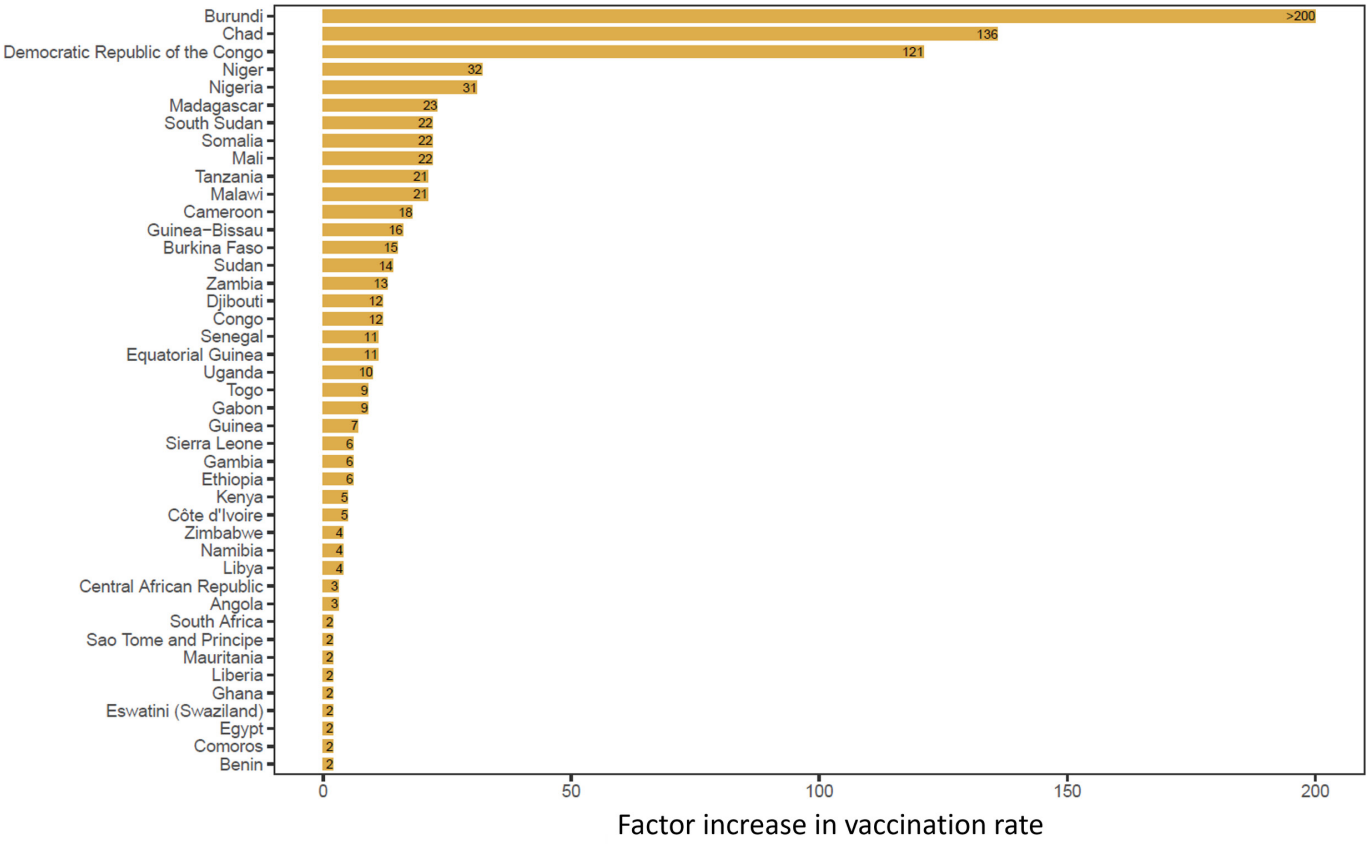

Figure 4 The speed by which the vaccination trajectory after 9 months of vaccine deployment in each African country should be increased to reach a full COVID-19 vaccination coverage of at least 70% by end of December 2022.

The speed needed to reach the WHO 70% target by December 2022

Based on the vaccination trajectory after 9 months of vaccine deployment, figure 4 presents the necessary increase in vaccination speed needed by each country in order to attain full vaccination coverage of at least 70% of their population by the end of December 2022. Burundi, Chad and the Democratic Republic of the Congo faced significant challenges, as they needed to escalate their vaccination efforts by more than 100 times their speed as of 9 months after vaccine deployment to reach the WHO 70% coverage target. Forty-three out of the 52 countries, or 83%, needed to at least double their vaccination speed, based on the trajectory achieved after 9 months of vaccine deployment, to reach the 70% target by December 2022. Within this group, 49% (21 out of 43) needed to increase their vaccination speed by a factor of 10 or more to achieve the WHO 70% target by December 2022 (figure 4).

When will African countries achieve the 70% coverage target?

Based on the trajectory after 9 months of vaccine deployment, Burundi, Chad, the Democratic Republic of the Congo, Niger and Nigeria were unlikely to achieve the WHO 70% target in the near future (figure 5). More than half of the countries (51% or 27/52) were projected to achieve the WHO 70% target between 2025 and 2039, if they continued on the trajectory achieved after 9 months of vaccine deployment. Sixteen of the 52 countries (30.8%) had already achieved or were likely to achieve the target by the end of 2024.

DISCUSSION

To our knowledge, this is the first study reporting COVID-19 vaccine uptake, the projected and actual full vaccination trajectory and the speed needed to achieve the WHO 70% population target, specifically focused on African countries. Based on the projected vaccination trajectory after 9 months of COVID-19 vaccine deployment in Africa, more than eight out of every 10 countries on the African continent would not attain the WHO mid-2022 target of vaccinating at least 70% of the population, even if this timeline was extended to the end of December 2022. When compared with the actual vaccination coverage obtained from the data reported during this period, nine countries achieved a higher coverage than the projected coverage. Conversely, most of the countries projected to achieve >70% coverage by December 2022 did not sustain the momentum, thus they had either a plateaued or a declining trajectory. Careful examination of factors responsible for these contrasting developments is crucial to identify strategies that improved the vaccination coverage in the projected low-performing countries on one hand, and address issues that derailed achieving

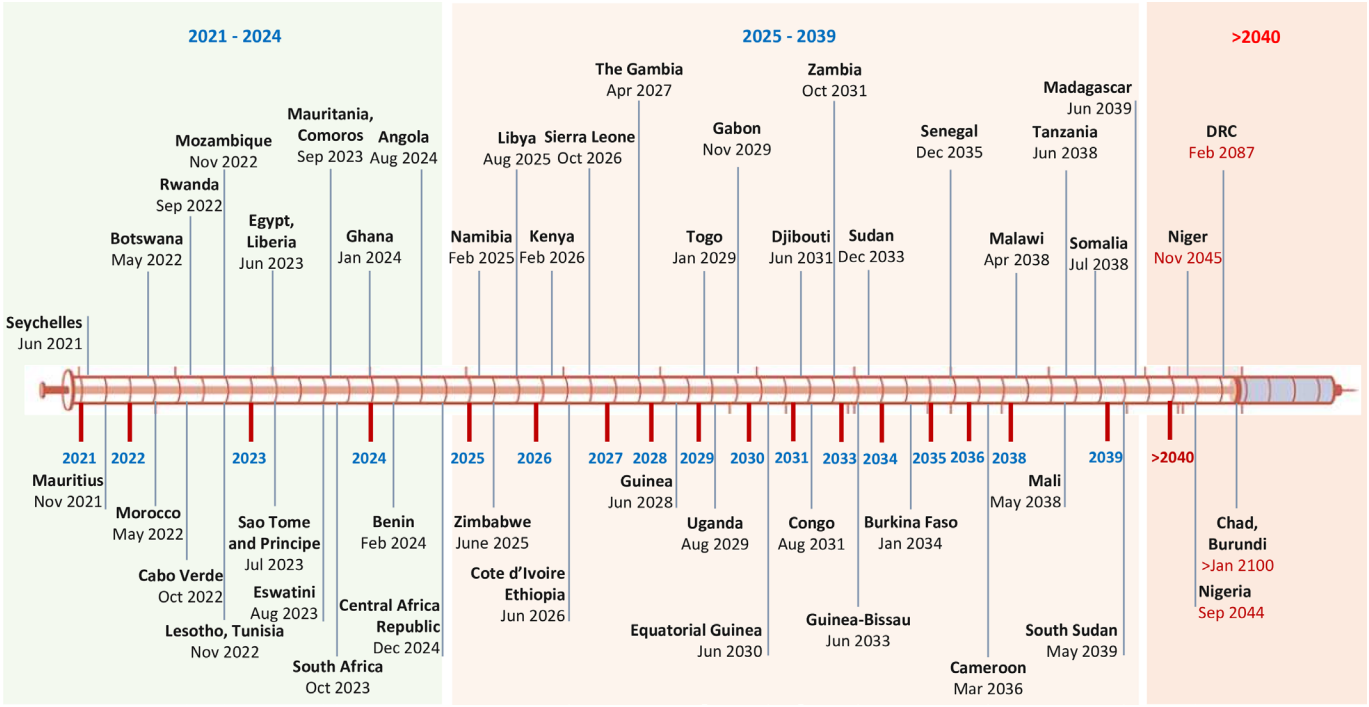

Figure 5 The date by which each country is expected to reach the 70% COVID-19 vaccination coverage target based on the vaccination trajectory achieved after 9 months of vaccine deployment in 52 African countries. DRC, Democratic Republic of the Congo

the 70% target in high-performing countries on the other hand. For example, following a reprieve from the vaccine supply and distribution challenges that characterised the early phase of COVID-19 vaccine roll-out in Africa,[23] the Chadian government and health authorities addressed the widespread hesitancy and low vaccine uptake[24] by implementing intense awareness campaigns and tailored public health messaging to promote COVID-19 vaccination. High-quality cold chain solar-powered vaccine storage and transport units were installed to address the challenges of cold chain equipment coverage. Easily accessible vaccination sites, including mobile clinics and vaccination centres in urban and rural areas, were also established across the country to remove barriers to access and encourage more people to get vaccinated.[25] These strategies could partly explain why Chad made significant improvements in their vaccination trajectory despite a poor start in the initial 9 months.

Similarly, the Sierra Leone government and public health agencies leveraged their experience with Ebola outbreak response by deploying community health workers and volunteers who had strong community ties to disseminate COVID-19 vaccine information and address concerns bordering on misconceptions about the vaccines.[26] Other countries with initial poor performance also improved their coverage by integrating the COVID-19 vaccination programme with the existing platforms provided by the Expanded Programme on Immunization and other primary healthcare services to address bottlenecks in service delivery, communication, accountability and logistics,[27–29] especially due to extended duration of the vaccination campaigns in the face of an apparent decrease in COVID infection rates and emergence of other equally important events of national interest that might distract the COVID-19 vaccination efforts in these countries.

More than half of the African countries were projected to reach the 70% target between 2025 and 2039, while about a third were projected to be on track to achieve the target by the end of 2024. While a comparison with actual or observed vaccination coverage would be expedient, leveraging the strategies adopted by countries which improved their vaccination coverage remarkably and avoiding the likely hindrances and pitfalls in turning the available vaccines into vaccinations will ensure that all resources are efficiently and effectively used. To rapidly ramp up vaccination coverage at the projected rates, it is evident that a 'one-size-fits-all' approach for vaccine deployment is unlikely to achieve the desired results. This is because, despite a reported increase in the shipment of COVID-19 vaccines to African countries, there still remains a huge gap in vaccine supply. If these supply gaps are not addressed, many of the countries that are already performing poorly are likely to fall further behind. The recent designation of six vaccine-producing centres across Africa is a step in the right direction, although this will take time to fully implement. As of 2023, only 1% of the vaccines deployed in Africa were manufactured on the continent. A clear plan to scale up vaccine production has been outlined in the Partnership for Africa Vaccine Manufacturing Framework for Action with interim goals of producing 10% and 30% of

all vaccine doses required on the continent by 2025 and 2030, respectively.[30] Despite these ambitious plans, there have been concerns around the sustainability as certain countries might still prefer vaccines manufactured in foreign countries.[31]

Overall, the sobering trajectory for many African countries calls for a closer scrutiny of the ambitious goal of vaccinating at least 70% of the population by mid-2022. Given the current epidemiology and transmission dynamics of SARS-CoV-2 infection in Africa, a context-specific and evidence-based target that aligns vaccination coverage with the epidemiological scenarios across Africa would be a more realistic approach to the COVID vaccination strategy. Furthermore, due to repeated infections, high SARS-CoV-2 seropositivity rates have been reported in many parts of Africa,[32] suggesting that these populations might have developed natural protective immunity to COVID-19, and may not be included in the priority groups for primary COVID-19 vaccinations. Also, given that COVID-19 vaccines do not prevent transmission of the infection,[33] and the rate of SARS-CoV-2 reinfection is low,[34] the ambitious target of vaccinating 70% of the African population by mid-2022 appears an inappropriate priority for Africa's COVID-19 prevention and control strategy.

Tailoring the COVID-19 vaccination efforts to target the most vulnerable groups within the African population would achieve the goal of reducing the risk of severe diseases and deaths, instead of the current widespread practices of vaccinating all age groups including low-risk groups such as children. More importantly, the supply of variant-adapted vaccines to African countries to combat the new COVID variants has not reflected the COVAX priority actions of ensuring equitable distribution of the vaccines to all countries and across income groups. Many African countries are still being supplied the first-generation vaccines which may not be generating protective immunity for newer variants. Therefore, continuing to prioritise the uphill task of achieving the WHO target of 70% in the face of the current epidemiological scenarios in most African countries poses a considerable risk of reversing the hard-won gains of routine childhood immunisations. The recent WHO/UNICEF estimates of national immunisation coverage showed that 25 million children did not receive at least one dose of diphtheria-tetanus-pertussis during the pandemic,[35] and lends credence to the unintended consequences of the 'one-size-fits-all' approach of the current COVID-19 vaccination strategy. Despite the critique of the current strategy, our findings provide useful insights for future pandemic preparedness, as we now know African countries that are likely to lag behind in delivering life-saving interventions in future global health emergencies. To address the current gaps in most African countries, national vaccine deployment plans and the processes for their development must be revised to reflect the lessons from the challenges of initial vaccine deployment phases and peer learning from countries that are currently on the right trajectory. All resources and efforts towards optimising COVID vaccinations should be channelled through a system approach that strengthens the existing structures for routine immunisations. If this is not carefully done, many African countries could face a potential double burden of SARS-CoV-2 and other vaccine-preventable disease outbreaks.

The datasets and methods used in our study might be subject to some limitations. The available country-level COVID-19 datasets may vary due to differences in reporting methods, retrospective consolidation and reporting delays, thus might not be directly comparable or reflective of the same timeframe. We demonstrated these differences by comparing the projected and actual vaccination coverage over the same timepoints. This allowed us to situate our projected vaccination trajectories with the actual coverage to draw contextual lessons that may strengthen the response efforts of African countries to future global health emergencies. We also observed some inconsistencies and gaps in the reporting of the COVID vaccination data in many African countries, especially in situations where a low vaccination coverage was followed by a period of gaps in the reporting and a subsequent sudden and rapid rise in the vaccination coverage. Our observations aligned with a growing body of evidence that raised concerns about the integrity and reliability of COVID-19 vaccination data reported officially by African governments.[36 37] Weak routine data systems and misrepresentation of administrative data in sub-Saharan Africa have also been reported to be driven by the incentives to over-report development progress.[38] Nevertheless, despite the indicative evidence of flaws and weaknesses in the administrative data reporting that might have affected COVID-19 vaccination rates reported across African countries, the use of phone surveys recommended as a robust alternative tool[37] will be logistically difficult to deploy in an African-wide COVID-19 vaccination coverage survey due to wide age, gender-related and socioeconomic variations in mobile phone ownership, penetration of mobile phones and phone usage patterns in Africa.[39] To minimise the limitations inherent in our sources of vaccination data in Africa, we made use of data extracted from 'Our World in Data' repository which complemented official data obtained from government sources with data gathered from international institutions or statistical agencies, specialised institutes and research articles.[20] The use of these combined data sources may explain why our findings mirror, to a large extent, current actual vaccination coverage in Africa.

We used a simple model which assumed the risk of COVID-19 infections and vaccination uptake were homogeneous within each country. We did not consider infection by different variants and did not take into account uncertainty in vaccine efficacy because of lack of data on the type of vaccines individuals in each country received. The population size for each country was assumed to remain relatively constant. This assumption would not affect the short-term projections; however, it may lead to

an overestimation of the longer term projections because most African countries have a rapidly growing population. Effects of other control measures such as lockdown or social distancing were not also included because the focus of the study was to determine vaccination rates and trajectory. Despite the shortfalls of the model, the vaccine coverage projections obtained from the analysis are important to the individual countries to put more effort in scaling up vaccination in their respective countries and protect the most vulnerable populations from SARS-CoV-2 infections.

CONCLUSION

The vaccination rates and our modelled vaccination trajectory support the report that over 80% of countries in Africa did not attain the 70% COVID-19 vaccination coverage target, even if this timeline was extended to December 2022. Our findings may inform continent-wide strategies and shared learnings as countries that did not achieve the targets can learn from those that achieved the WHO mid-2022 target. Evidence from our study can guide African governments and policymakers in planning and implementation of COVID-19 vaccination programmes in their countries, with focus on aligning their vaccine deployment plans with specific epidemiological scenarios while addressing contextual issues around vaccine demand and uptake.

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Contributors OW and MOA conceived the study. CM, YS, ODB, EAO, OAU and BK contributed to refinement of the concept note and approved the final version. YS and OW extracted the data. OW, MOA, YS, CM and OAU have accessed and verified all the data in the study. CM and OAU performed the data analysis. OW, MOA, CM, OAU and TN wrote different sections of the first draft of the manuscript. OW, MOA, CM, YS, ODB, EAO, OAU and BK reviewed the draft manuscript and made significant intellectual inputs. All authors approved the final manuscript before submission. All authors accept responsibility to submit the manuscript for publication. OW and MOA are responsible for the overall content as the guarantor of this manuscript. We accept full responsibility for the work and/or the conduct of the study, had access to the data, and controlled the decision to publish.

Competing interests None declared.

Patient and public involvement Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

Patient consent for publication Not applicable.

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