TONY BLAIR INSTITUTE FOR GLOBAL CHANGE

Planning for the Worst and Hoping for the Best: Forecasting Covid-19 for Sub-Saharan Africa

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Executive Summary

In this report we present our analysis of the Covid-19 trajectory in 18 countries in sub-Saharan Africa (SSA) – including those the Tony Blair Institute currently supports. Together the countries analysed represent 61 per cent of sub-Saharan Africa's population: Angola, Cameroon, Niger, Nigeria, Mali, Ghana, Kenya, Senegal, Gambia, Sierra Leone, Liberia, Rwanda, South Africa, Mozambique, Guinea, Ethiopia, Burkina Faso and Côte d'Ivoire.

The purpose of this paper is not to provide a prediction or alarmist headline – models are never right in the numbers they predict, rather they provide useful guides for planning by assessing potential future outcomes from different scenarios.[12] The results from various models offer a wide range of forecasts and there is dispute between various modellers.[3] What we have sought to do is assess and recommend realistic interventions that have a palpable impact on outcomes – no matter what the eventual number of cases is.

The report compares forecasts of infections, hospitalisations and deaths due to Covid-19 in Africa, which vary widely. For example, the World Health Organisation Regional Office for Africa (WHO/AFRO) forecasts a final death toll of 87,000 from 145 million Covid-19 infections for the 18 countries analysed in our report, giving a very low case fatality ratio (CFR); while new data from the London School of Hygiene and Tropical Medicine (LSHTM) model analyses 18 countries in sub-Saharan Africa and suggests more than 1 million deaths are possible, even with containment measures in place. We do not argue that either of these numbers is more or less "correct", but rather present the variance as an important planning consideration for governments.

We then analyse five combinations of government intervention to prevent the spread of Covid-19, given the likely peak in the coming weeks, namely social distancing and measures to shield vulnerable people, and compare those impacts to a scenario in which governments make no such interventions.

The analysis finds that the best scenario for mitigating the impact of Covid-19 is a combination of 20 per cent social distancing and 80 per cent shielding vulnerable people. This assumes social distancing measures are in place with moderate impact (20 per cent), restricting movement or limiting contacts with others (for instance, wearing masks, limiting gatherings, etc.) combined with 80 per cent of vulnerable people (in this case, the elderly) shielding by isolating. This reduces the total number of cases from the unmitigated scenario by 31 per cent and the final total death toll by 52 per cent. It would also reduce the peak of hospitalisations by 66 per cent and the peak of ICU bed usage by 67 per cent compared to governments taking no action. This is important, since full lockdowns have been demonstrated to be impractical and unsustainable in many African countries and the wider developing world context. Shielding has been employed by a number of Western countries, including the UK.[4]

Therefore, with six to eight weeks to prepare before the likely peak, we recommend a series of practical measures that governments can and should take now. These include:

- Maintain social distancing requirements and mandatory mask wearing in public and insist that vulnerable groups (elderly, diabetics, hypertension and HIV patients, and those with respiratory illness) shield at home. Clarify and improve communications to this effect.
- Mobilise community support for the behaviour changes required to achieve high compliance with these social distancing and shielding measures.
- Adapt testing strategies to reflect capacity and diagnostic supplies. Utilise the pooled procurement platforms now available to boost supplies, but have a plan in place to anticipate how to adjust if adequate supplies are not available. This may require prioritising health and other frontline workers and critically ill patients for testing and should include introducing antibody testing as a complement to sources of information.
- Discharge asymptomatic patients from isolation facilities after ten days without further testing in accordance with revised WHO guidelines, to save testing supplies and free up isolation space.
- Prioritise the protection of health care and other frontline workers and maintenance of non-Covid-19 health care.
- Ensure reliable, real-time data for decision-making and public communications. This will be critical to guide government strategy and adjustments as the outbreak evolves over time.

1 The Guardian "'A peek into the future': how worst-case scenario coronavirus modelling saved Australia from catastrophe", 21 June 2020

2 The Atlantic, "Don't Believe the COVID-19 Models", 2 April 2020

3 https://www.npr.org/sections/goatsandsoda/2020/06/10/872789379/why-forecasters-cant-make-up-their-mind-about-africa-and-the-coronavirus?t=1593788343915

4 https://www.gov.uk/government/publications/guidance-on-shielding-and-protecting-extremely-vulnerable-persons-from-covid-19/guidance-on-shielding-and-protecting-extremely-vulnerable-persons-from-covid-19

Introduction

Covid-19 has already had a significant economic impact on Africa. On the health front, policymakers on the continent are struggling with a lack of resources – especially in the areas of testing and treatment capacity – to adequately respond to the virus. Modelling work forecasting disease spread has informed policy decisions by governments in many areas of the world, leading many to introduce long periods of lockdowns as they sought to limit the projected pace of infection spread to allow their health care and other systems to cope with the expected number of patients needing critical care. The driving objective has been to "flatten the curve", in other words extend the period of peak infections to prevent sharp spikes that would result in too many patients and too few hospital beds at any one point.

While many African countries also initially introduced periods of lockdown, these have generally been shorter interventions due to the difficulties of keeping large populations confined at home when many need to move to earn the resources required to meet their basic needs on a daily basis, often without any state support via a welfare system. While richer countries have locked down entire populations to save lives, many in Africa have had to lift lockdowns to save livelihoods, even as case numbers continue to rise on the continent.

The following charts demonstrate that African countries have generally posted fewer severe cases and deaths than other parts of the world. However, we know that there is a strong correlation between testing and cases, and that African countries have also not been testing as much as others.

Figure 1

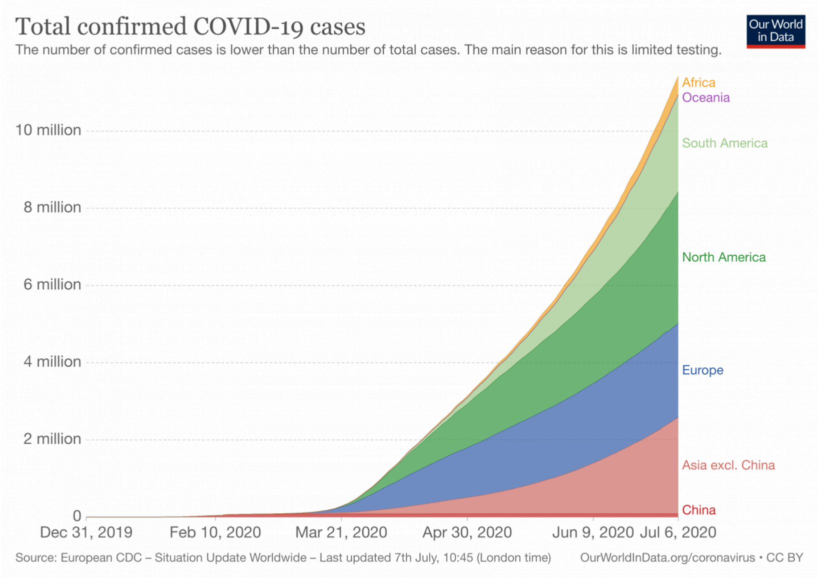


Figure 2

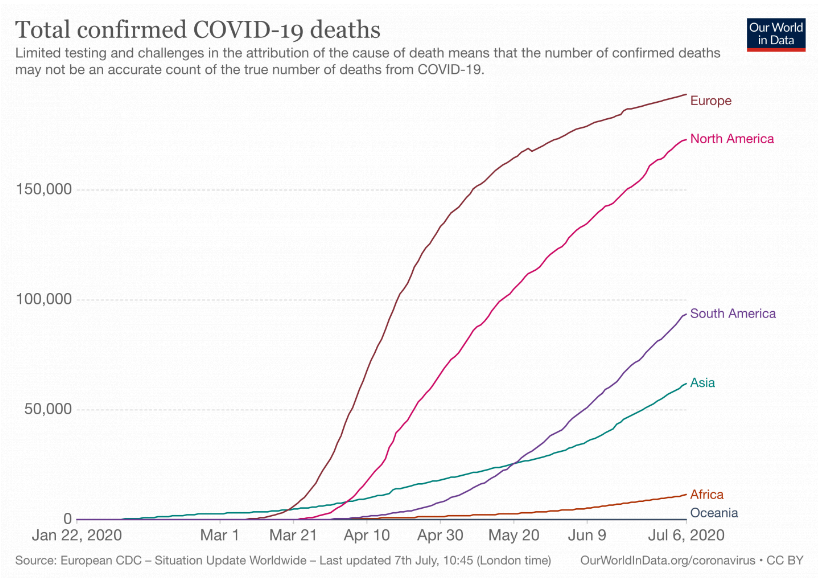
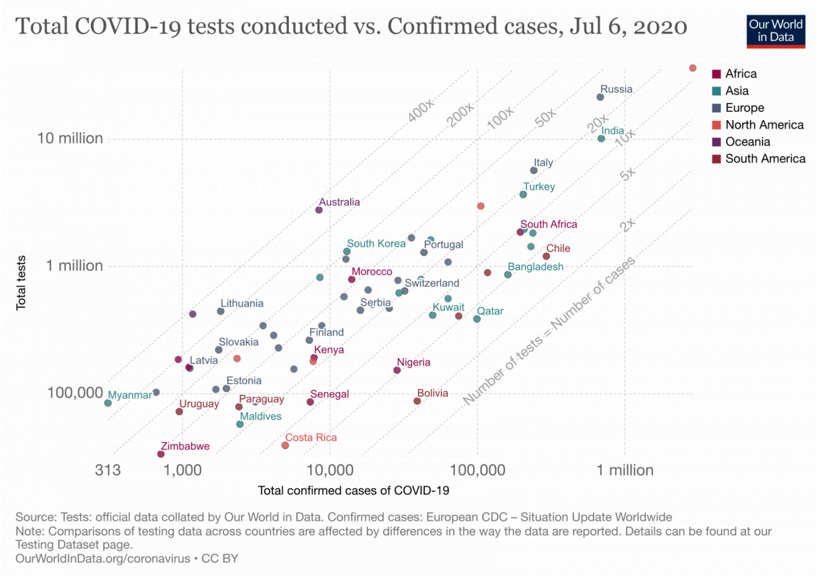
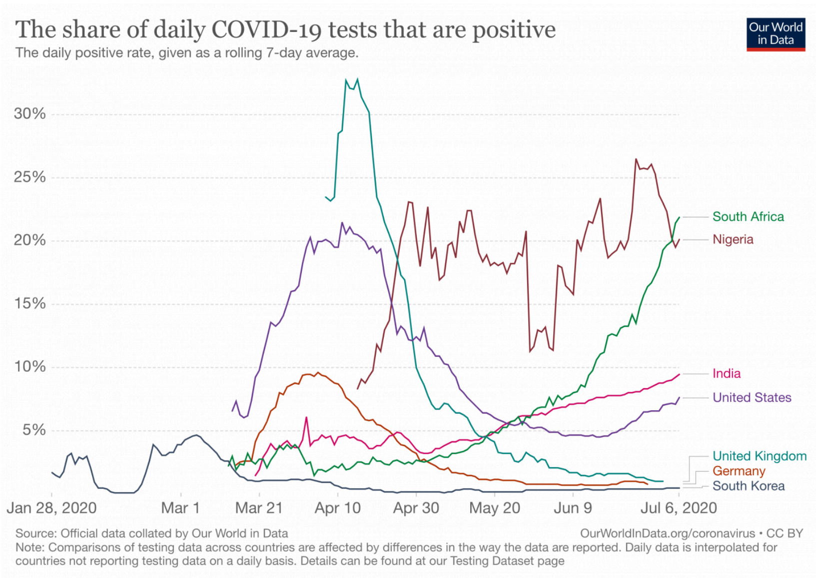


Figure 3



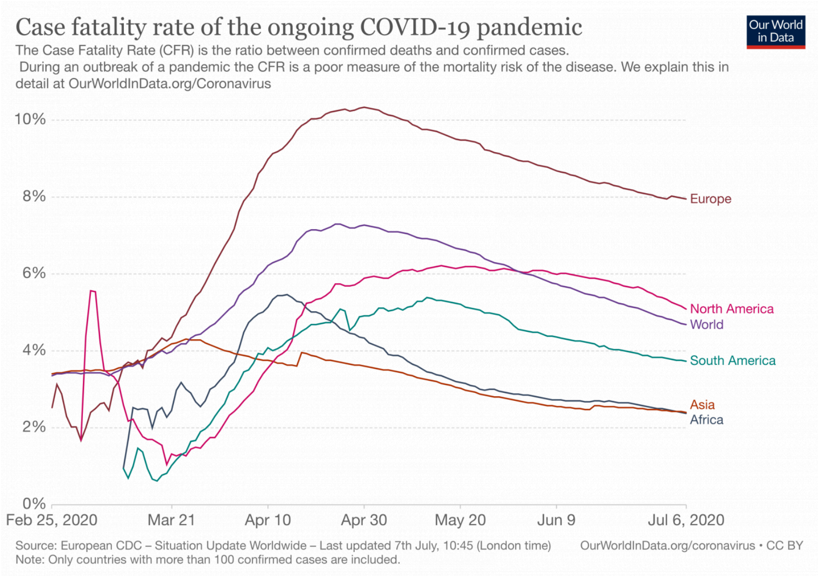
Beyond that, we know that the positivity rate – the proportion of tests that return positive results – varies across countries. This makes widespread testing even more important to find out the extent of infections. Some counties are finding up to 25 per cent of tests are positive, while others have much lower rates.

Figure 4



Case fatality ratios (CFRs) in Africa have also been among the lowest: Like CFRs everywhere they started high, have been declining and will likely stabilise. However, we caution against relying on this number, which is highly sensitive to how many people are tested and whether asymptomatic people and dead bodies are routinely tested. We discuss the risks of CFR as a measure later in this paper.

Figure 5



All the charts above give reason for believing Africa is being spared the worst of the pandemic, which risks causing complacency among both people and policymakers on the continent. The epidemiology of Covid-19 may genuinely be different in Africa, but what if it isn't? What if the worst is yet to come? The best way to deal with public-health emergencies is to plan for the worst and hope for the best.

Four months into the advent of the virus in sub-Saharan African (SSA) countries, policymakers now face difficult choices around what interventions to make and how to prepare for the spread of virus. The objective of this paper is to help inform some of those policy choices as countries come to accept that they have not yet reached the peak and yet long lockdowns like those on other continents are not a realistic option. African countries need to tailor their own responses to the virus that take account of the socio-political, economic and medical realities that they are facing.

Our analyses are based on Covid-19 forecasting for 365 days undertaken by the London School of Hygiene and Tropical Medicine (LSHTM) for 18 countries in sub-Saharan Africa – including those the Tony Blair Institute currently supports. Together the countries analysed represent 61 per cent of sub-Saharan Africa's population: Angola, Cameroon, Niger, Nigeria, Mali, Ghana, Kenya, Senegal, Gambia, Sierra Leone, Liberia, Rwanda, South Africa, Mozambique, Guinea, Ethiopia, Burkina Faso, and Côte d'Ivoire.

The current situation in these countries, as with the rest of Africa shown above, is that *recorded* cases, infections and deaths are relatively significantly lower compared to the rest of the world.

Figure 6 – Actual reported Covid-19 cases (infections) as of 7 July 2020

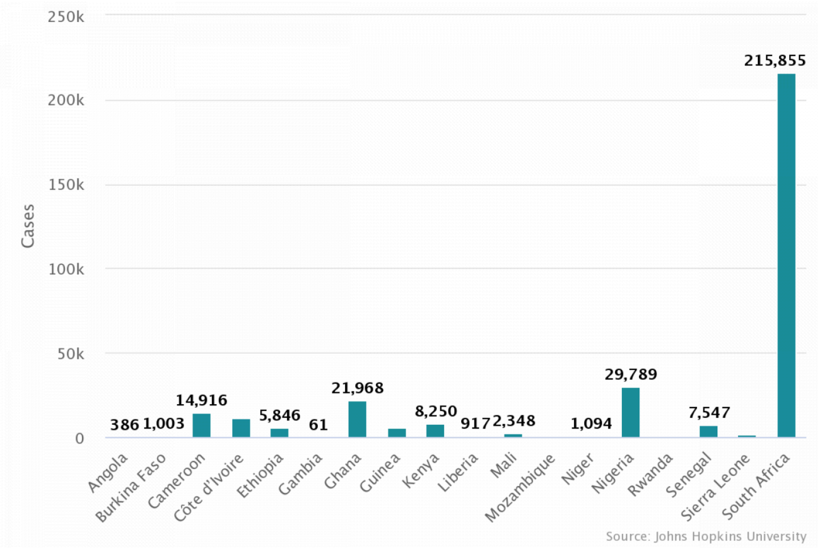


Figure 7 – Actual reported Covid-19 deaths as of 8 July 2020

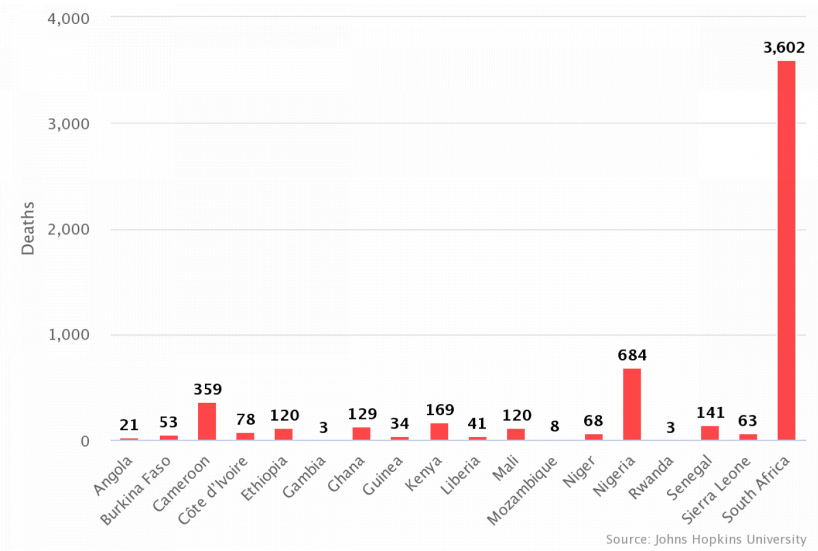
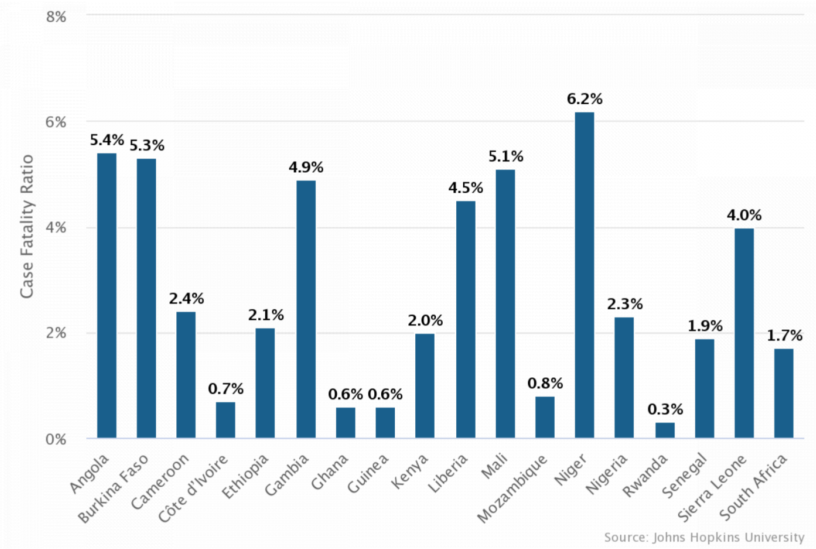


Figure 8 – Actual case fatality ratios (CFRs) as of 8 July 2020



As we highlight above and in this report, the questions that leaders, planners and public-health officials in these countries – as with all others in sub-Saharan Africa – need to contend with are: Will the increase in cases keep steady, rise gently or will we see a surge? What is – for planning purposes – the worst-case scenario, and what are the measures that can reduce or avoid that?

We have applied the LSHTM model to potential disease spread in these countries to see what answers it generates to the following questions:

- Where are these countries on the trajectory of Covid-19 spread?
- When does the model predict they will hit their peak – of infections, deaths and hospitalisations?
- How will cases develop over time and what is the total impact on mortality and morbidity in any one country over the coming months?
- In the absence of total lockdowns, what containment strategies make the most impact on the number of infections, hospitalisations and deaths predicted by the model?

We compare predictions from LSHTM with summarised predictions recently produced by WHO/AFRO regarding the same SSA countries we analyse and discuss the different results.

Caveats to This Analysis

Disease-spread modelling is not about producing right or wrong answers, so the numbers produced by this analysis are not presented as firm predictions. Rather they provide a planning framework for policymakers

by considering various scenarios and the impact of different intervention strategies. No model can produce accurate numbers, and it is important that point is understood by readers of this report: The purpose is not to say what will happen, but rather to help governments to decide what to do – no matter what happens.

The inputs and assumptions in the LSHTM model, which we use in this analysis, are based on what was known about Covid-19 from its early presentations in China and elsewhere. As we learn more about the virus, disease-spread modellers will be able to change these to improve their outputs.

Current cases and deaths observed in the countries we analyse in this report are drastically lower than what the model predicts they should be, or what has been observed in other parts of the world. This large variation can be due to any number of factors:

- The model inputs need to be updated with more granular Africa-specific inputs, as above – the impact of comorbidities, movement patterns, urban vs rural spread and other factors that we discuss in the paper.
- There may be under-reporting of infections and deaths in Africa, partly due to the lower testing rates we observe in sub-Saharan Africa, so observed deaths and infections may be lower than the reality.[5]
- The disease presents differently in Africa due to characteristics of the climate and/or the population.
- Sub-Saharan Africa is also only three months into the epidemiology curve, and it is possible that as community transmission sets in and the virus moves through various demographic groups, its impact will change from what we observe currently.

Other models predict different numbers. For example, while the WHO/AFRO model predicts broadly similar infection rates, it makes fundamentally different assumptions about how severe the disease will be, which in turn leads to vastly lower numbers of predicted deaths. We explain the reasons for the divergence between the two models. While at the time of writing we did not have time series from the WHO/AFRO model to allow us to do similar analyses as we have with LSHTM's model, we have compared their predictions on infections and death rates to ensure that they provide a range for policymakers to consider.

5 http://gamapserver.who.int/mapLibrary/Files/Maps/Global_CivilRegistrationDeaths_2007_2016.png

Key Findings Policymakers Should Consider

- The LSHTM's model forecasted 138 million infections over 365 days for the countries we analysed should moderate social distancing be maintained. WHO/AFRO's model predicted 145 million infections for the same countries. While LSHTM's 138 million is entirely symptomatic patients, the WHO/AFRO assumes that 84 per cent of cases are asymptomatic, which later results in very small severe and critical case predictions. WHO/AFRO assumptions produced a case fatality ratio (CFR) of 0.4 per cent, significantly below observed current levels of 1.96 per cent. LSHTM forecast a CFR of 1.7 per cent. Therefore, WHO/AFRO's predictions differ greatly from those of LSHTM, because of one key variable, namely the predicted proportion of those infected who are asymptomatic. Forecasting total additional deaths as a result of Covid-19 is also even harder to do in African countries than elsewhere, and we do not attempt to do so in this paper.
- At the time the analysis presented in this report was completed (22 June 2020), the LSHTM's model results show that the countries in our study were on average 115 days into the outbreak with a further 53 days to reach the collective peak of infections. This assumes moderate social distancing measures are sustained for the modelling period. The number of days to reach peak infections varies by country – for example, the LSHTM model predicts Senegal has 48 days left from 22 June to reach peak cases (infections) while Rwanda has 52 days left.
- Hospitalisations and critical care patient numbers are forecast to peak in a further 72 days, with deaths peaking in 83 days from the date of our analysis.
- Our analyses show that there is a strong relationship between the number of tests done per population and the recorded incidence of the disease. Policymakers should continue to increase testing and treatment capabilities as much as possible in order to understand the spread of the virus.
- Stringent social distancing measures (like total lockdowns) stretch the outbreak duration and significantly cut total cases and peaks. Based on the model, introducing stringent social distancing can cut total projected cases across the countries in the study for the 365 days by 73 per cent and reduce peak hospitalisations and ICU needs by 92 per cent. However, such stringent interventions (like lockdowns) have proved to be difficult to maintain in Africa given living conditions and socio-economic factors.

- At the same time, our results highlight the importance of continuing with moderate social distancing measures, given that hard and enduring lockdowns that restrict most population movements are not a practical policy option. Removing all social distancing measures in the model would expose the countries to 40 per cent more cases and a doubling of case numbers at the peak of infections. With no social distancing in place, infection peaks would occur imminently, overwhelming medical capacity in those countries multiple times over. Hence it is important that policymakers in these countries consider innovative ways to continue with social distancing while allowing economies to function as far as possible.
- Shielding the elderly while at the same time maintaining moderate social distancing measures does not significantly reduce infections, but this combined strategy reduces total projected deaths in the year by 27 per cent, compared to only maintaining moderate social distancing measures.
- The LSHTM model only considers shielding the elderly, who are most affected by Covid-19 and more likely to suffer from comorbidities. However, it does not consider shielding younger vulnerable populations with comorbidities. We think further shielding of younger vulnerable populations would likely avert even more deaths than those forecasted in this analysis.
- We believe the success of shielding and social distancing strategies to be a function of community ownership of the implementation of such strategies. TBI will provide guidance and recommendations for governments and policymakers on how to implement such measures in a separate policy paper on strategies for developing countries to deal with this stage of the pandemic and the reopening of their economies.

Modelling Methodology, Assumptions and Scenarios

To predict the progression of Covid-19 in African countries over a 12-month time horizon from the start of an outbreak, LSHTM used the widely accepted methodology of disease modelling – the *Susceptible-Exposed-Infectious-Recovered* mathematical model. The modelling was stratified by age, given the age group breakdown of each country's population. Once infected, disease attack rates varied by age and country. Modelling results produced are for symptomatic infections (cases), patients needing hospitalisations (hospitalised), patients needing intensive care (needing ICU) on each day and deaths. The model does not link actual cases to projected cases – rather it generates 365-day forecasts from the start of the outbreak in a particular country. We have related the actual start date of the epidemic to our results and analyses.

A strong feature of the LSHTM's methodology is that the reproductive number's (R0) modelling allows for a range of estimates of its value (centred around the value of 2.7), hence we were able to extract lower-range scenarios below the median at the 25th percentile point for our scenarios implying a lower R0. We did not use the median scenarios due to mounting perceptions that infection levels in sub-Saharan Africa are lower than first expected. According to LSHTM's scenarios at the 25th percentile, total cases across the modelling period across these countries would be 138 million with moderate social distancing. At the median this rises as high as 162.7 million.

Age Dependency of the Probability of Disease Severity

The model assumes age-dependant probabilities of disease severity, an important assumption for sub-Saharan Africa, where the population is younger. In a separate study conducted by LSHTM to enrich their model assumptions, they found that those younger than 20 are roughly half as susceptible to infection as those older than 20.[6] Evidence from South Africa shows that 4.1 per cent of Covid-19 hospitalisations were younger than 20 years of age, while 14.9 per cent were older than 70 by the end of May 2020 (according to the National Institute of Communicable Diseases in South Africa).[7]

LSHTM estimated age-dependant probabilities of becoming severely or critically ill from Covid-19 using severe and critical case data from China and the Diamond Princess outbreak. They increased these probabilities for each age group in Africa by shifting them ten years towards the younger population groups. No assumptions were made about what proportion of the population would receive appropriate treatment, hence the model does not predict recoveries.

LSHTM assumes higher age-dependant probabilities for severe and critical cases which impact case fatality ratios (CFRs) and for African countries to capture the countries' lack of means to suppress transmission and deaths due to poor health-system capacity and socio-economic factors, as well as due to comorbidities present in the continent. LSHTM has justified this by saying:

"In these and other low-income settings, two factors (younger age distributions and, potentially, warmer temperatures) may help to attenuate the pandemic's severity. However, other factors may plausibly combine to worsen its impact: these include demography (larger household sizes and more intergenerational mixing within households), environmental conditions (overcrowded urban settlements, inadequate water and sanitation), pre-existing disease burden (higher prevalence of undiagnosed or unmanaged non-communicable diseases, tuberculosis and, if confirmed to be risk factors for Covid-19 severity, HIV and undernutrition), and, critically, a very low baseline of and access to hospitalisation capacity, particularly intensive and sub-intensive care. In several African countries, armed conflict, food insecurity and resulting forced displacement further worsen societal resilience."[8]

To test this decision by LSTHM to assume higher age-dependent CFRs, we looked at evidence from Nigeria Centre for Disease Control (NCDC), which shows that Nigeria's actual Covid-19 CFRs as of 23 June increase as you go through older age groups. Nigeria reported higher CFRs by age group than China, for example. We looked at China's results in mid-March, when at a similar point in the epi-trajectory (three to four months) to Nigeria in June. NCDC's results provide anecdotal, observed evidence that LSHTM's modelling on rising CFRs in African age groups is not unreasonable.

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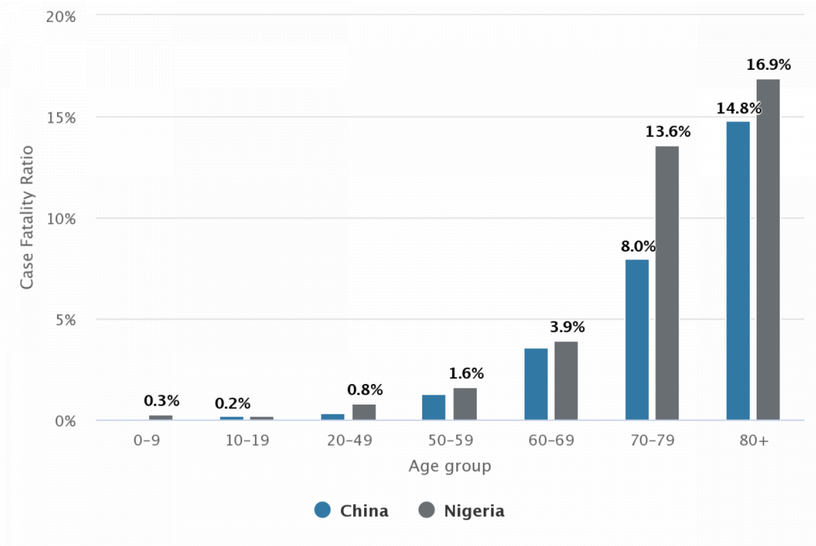
6 "Age-Dependent Effects in the Transmission and Control of Covid-19 Epidemics", Nicholas G. Davies, Petra Klepac, Yang Liu, Kiesha Prem, Mark Jit, CMMID Covid-19 working group & Rosalind M. Eggo

7 https://www.timeslive.co.za/news/south-africa/2020-06-08-race-gender-and-age-what-the-early-covid-19-infections-in-sa-show/

8 "Response Strategies for Covid-19 Epidemics in African Settings: A Mathematical Modelling Study", Kevin van Zandvoort, Christopher I Jarvis, Carl A B Pearson, Nicholas G Davies, CMMID Covid19 working group, Timothy W Russell, Adam J Kucharski, Mark Jit, Stefan Flasche, Rosalind M Eggo, Francesco Checchi

Figure 9 – Actual case fatality ratio (CFR) comparison, Nigeria and China as of 23 June 2020



Sources: Nigeria Centre for Disease Control

Symptomatic vs Asymptomatic

LSHTM does model asymptomatic patients, but they did not provide outputs for those in the model we have applied. It assumes that asymptomatic cases are not severe enough to come to attention and require care, but the model still considers them as a source of transmission, which means the ultimate impact on deaths and hospitalisations via those they infect is captured in the model results. The model assumes asymptomatic cases are 50 per cent less likely to cause transmission than symptomatic cases – which is reasonable because they are unlikely to present fluids via sneezes and coughs, which are the key mode of Covid-19 transmission.[9]

Nonetheless, LSHTM still considers asymptomatic cases to be sources of transmission, albeit less infectious than symptomatic cases. This means they ultimately impact the death and hospitalisations figures in the model results presented here, via those they infect. The model has an age-dependent probability that each infected person will be symptomatic or asymptomatic.[10] We discuss asymptomatic patient assumptions further in this paper when we evaluate and compare LSHTM to WHO/AFRO modelled results.

Comorbidities

Comorbidities are expected to be a major factor in the severity of Covid-19 in SSA. This is one of the reasons why LSHTM models higher disease severities in these countries due to the higher numbers for comorbidities, especially for those older populations that are assumed to have more comorbidities.

Data from selected hospitals in South Africa showed that from March to the end of May, 79 per cent of Covid-19 patients had comorbidities, with 35 per cent of these presenting with two or more. The most reported conditions were hypertension (56 per cent), Type 1 diabetes (48 percent), HIV (19 per cent), active TB (4 per cent) and previous history of TB (11 per cent); 4 per cent were reported to be obese.[11] Latest estimates show around 15.9 million people are living with HIV in these countries,[12] with a further 1.6 million estimated to be living with TB.[13]

Contacts

Contact patterns describing how the population would infect each other by age group were extrapolated from European data, but using African household, workplace, and school composition data. Assumptions on contacts were incorporated using synthetic contact matrices.

Intervention Scenarios

LSHTM modelled 50 non-pharmaceutical intervention scenarios (NPIs) as well as the unmitigated scenario with no interventions. These comprise differing levels of social distancing measures and varying levels of shielding of the vulnerable (elderly) strategies and combinations of the two types of NPIs. Each intervention scenario was repeated for various reproductive number assumptions.

It was found that, in particular, six specific scenarios would best demonstrate the impact of interventions. We extracted those for our analysis in this paper.

9 "Effects of Non-Pharmaceutical Interventions on Covid-19 Cases, Deaths, and Demand for Hospital Services in the UK: A Modelling Study", Nicholas G Davies, DPhil, Adam J Kucharski, PhD, Rosalind M Eggo, PhD, Amy Gimma, MSc, Prof W John Edmunds, PhD

10 "Age-Dependent Effects in the Transmission and Control of Covid-19 Epidemics", Nicholas G. Davies, Petra Klepac, Yang Liu, Kiesha Prem, Mark Jit, CMMID Covid-19 working group & Rosalind M. Eggo

11 https://www.nicd.ac.za/wp-content/uploads/2020/06/NICD-Covid-19-Weekly-Sentinel-Hospital-Surveillnace-update-Week-22-2020-003.pdf

12 https://www.unaids.org/en/regionscountries/countries

13 https://data.worldbank.org/indicator/SH.TBS.INCD?locations=ZG-1W-8S

Table 1 – The six intervention scenarios analysed in this paper

Scenario	Description
1. Unmitigated	No governmental intervention is applied
2. 20% Social Distancing	Assuming moderate social distancing measures are in place with moderate impact (20%) restricting movement or limiting contacts with others (e.g. wearing masks, limiting gatherings, etc.)
3. 50% Social Distancing	Assuming strong social distancing impact often achieved by lockdowns or other stringent measures
4. 80% Shielding of the Vulnerable	In this case the vulnerable are the elderly and shielding is isolating those, shielding 80% of the vulnerable population
5. 80% Shielding & 20% Social Distancing	Combining the two measures in Scenarios 2 and 4
6. 80% Shielding & 50% Social Distancing	Combining the two measures in Scenarios 3 and 4

We assumed that **Scenario 2** – moderate social distancing that results in 20 per cent less population interaction – represents the current reality in many of the countries in our study, where mask wearing is recommended or mandatory, some movement restrictions apply, borders are closed and large gatherings are prohibited. Variations in stringency of these measures exist in those countries, including school closures and working from home. However, it is widely accepted that social distancing is harder to achieve on the continent due to population densities in urban areas and larger households. We have therefore avoided absolute strict social distancing as a feasible option – especially as this takes us back into lockdown territory, which is not a realistic option for many governments.

We also assume that no shielding of the vulnerable populations has taken place to date in these countries, but we strongly recommend this as an aspiration for governments. Covid-19 has high transmissibility, but with most cases being mild or asymptomatic, averting deaths by limiting the exposure of those most likely to be fatally infected is a more realistic strategic outcome for policymakers. This can be achieved by various shielding strategies. In this case, we think **Scenario 5** should be the aspiration for sub-Saharan African countries, where 80 per cent of people aged 60 and older are shielded – in other words, for 80 per cent of the older population, interaction is reduced outside and inside the home, combined with a reduction in interactions among the general population by 20 per cent through social distancing.

Modelled Results

We extracted total figures and peaks under each of the six scenarios. Results are aggregated across the countries analysed, and estimated times in days (including dates) to when peak cases, deaths and hospitalisations would occur are also presented. Similar results are extracted by country for Angola, Cameroon, Niger, Nigeria, Mali, Ghana, Kenya, Senegal, Gambia, Sierra Leone, Liberia, Rwanda, South Africa, Mozambique, Guinea, Ethiopia, Burkina Faso, and Côte d'Ivoire. Total forecasts show results aggregated across a 365-day time horizon from the start of the outbreak in any country. Analyses are run as of 22 June 2020.

Cases (Infections)

Table 2 – Forecasted total and peak Covid-19 cases by intervention scenario ("days from peak" counted from 22 June 2020)

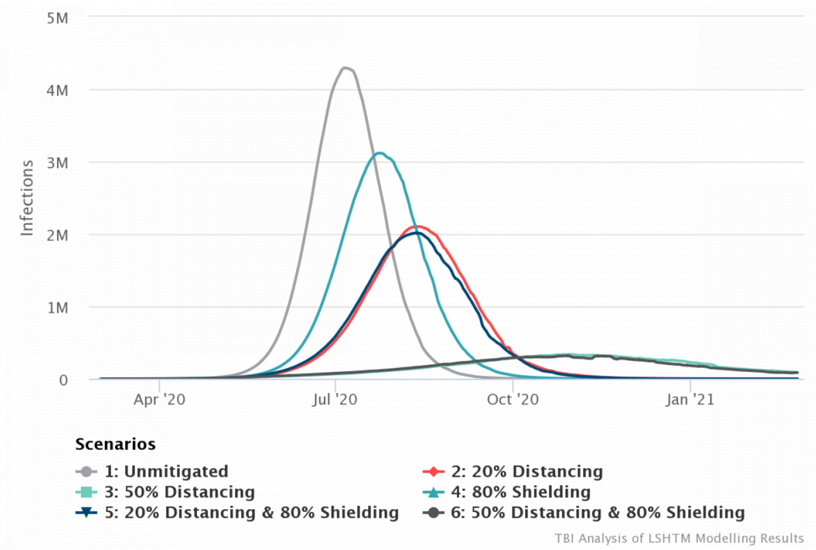
Scenario	Total Forecasted	Δ%	Peak Cases	Δ%	Days From Peak†	Δ%
1. Unmitigated	193,867,307	–	4,290,736	–	16	–
2. 20% Social Distancing	138,062,147	−29%	2,099,643	−51%	53	+231%
3. 50% Social Distancing	52,153,274	−73%	334,921	−92%	132	+725%
4. 80% Shielding of the Vulnerable	163,808,494	−16%	3,115,678	−27%	33	+106%
5. 80% Shielding & 20% Social Distancing	133,297,062	−31%	2,013,622	−53%	53	+231%
6. 80% Shielding & 50% Social Distancing	50,160,825	−74%	317,137	−93%	131	+719%

Source: TBI Analysis of LSHTM Modelling Results

† Days left to reach peak (from 22 June)

The results show that moderate social distancing (Scenario 2) would improve total infection levels by 29 per cent from the unmitigated case. Stricter social distancing in Scenario 3 would reduce total infection levels by 73 per cent. However, this would involve further lockdowns, which would impact livelihoods more severely and which are difficult to implement. If we accept that moderate social distancing measures are kept in place, then peak infections at the time of the analysis in this report (22 June 2020) would be reached in a further 53 days, in August. A strategy of shielding the vulnerable, when combined with social distancing, has a small impact on total infections beyond only social distancing NPIs being applied. However, the impact of shielding would reduce the total death toll by a further 27 per cent compared to solely following a moderate social distancing strategy.

Figure 10 – Forecasted number of infections by scenario (incremental)



The graph above shows that the unmitigated scenario's peak and duration are reduced by policy interventions. All curves are flattened by interventions (their peaks reduced, and cases delayed in time). In the scenarios that call for 50 per cent social distancing, the duration of the outbreak is increased beyond the 365 days.

Patients Needing Hospitalisation and ICU Beds

Table 3 – Forecasted number of patients needing hospitalisation and ICU beds by intervention scenario

Scenario	Peak Hospital Admissions	Δ%	Days from Peak†	Δ%	Peak ICU Patients	Δ%	Days from Peak†	Δ%
1. Unmitigated	1,838,705	–	32	–	637,135	–	31	–
2. 20% Social Distancing	865,787	−53%	72	+125%	300,534	−53%	72	+132%
3. 50% Social Distancing	138,254	−92%	142	+344%	47,970	−92%	149	+381%
4. 80% Shielding of the Vulnerable	966,616	−47%	52	+63%	335,308	−47%	52	+68%
5. 80% Shielding & 20% Social Distancing	617,004	−66%	67	+109%	213,082	−67%	65	+110%
6. 80% Shielding & 50% Social Distancing	97,105	−95%	144	+350%	33,185	−95%	140	+352%

Source: TBI Analysis of LSHTM Modelling Results

† Days left to reach peak (from 22 June)

Figure 11 – Forecasted number of hospitalisations by scenario (incremental)

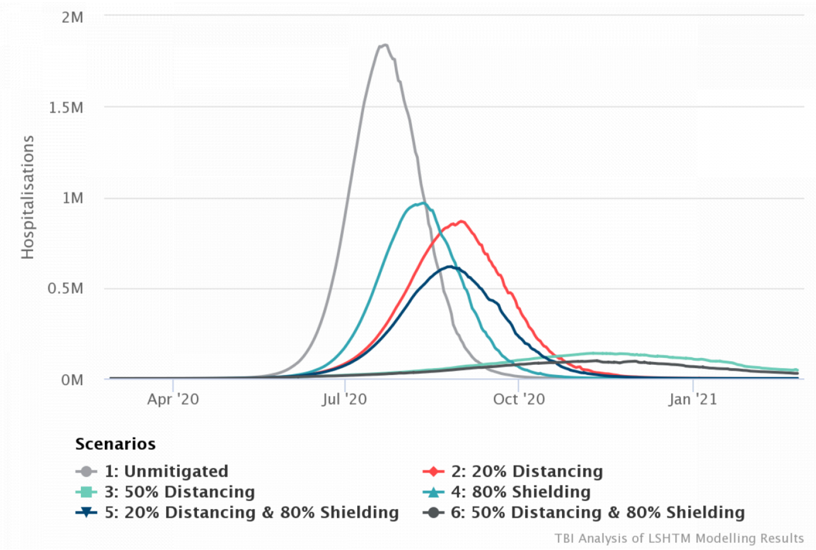
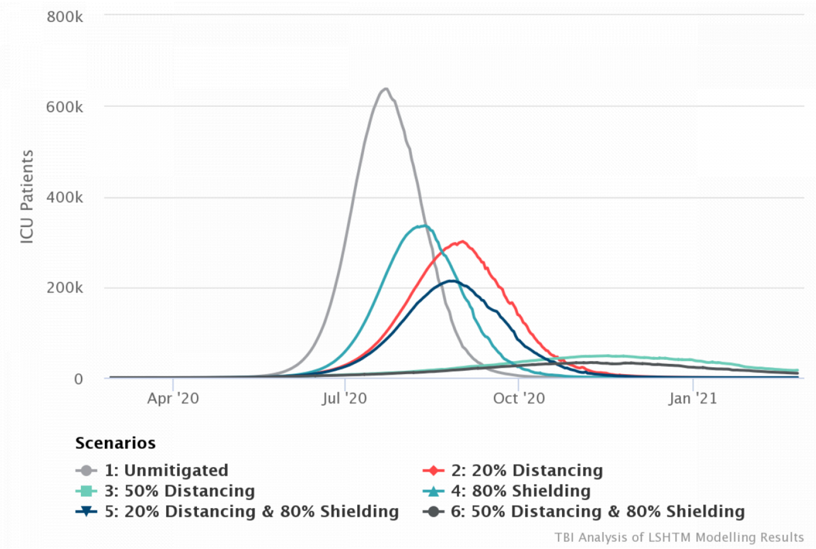


Figure 12 – Forecasted number of patients in ICU by scenario (incremental)



The impact of mitigation scenarios on peak hospitalisations and peak number of patients needing ICU beds is equally significant as it helps countries plan ahead as far as possible. Assumed mitigation measures of moderate social distancing show that countries can avert 53 per cent of peak hospital and peak ICU needs. Adding shielding of the vulnerable would reduce hospitalisations by 66 per cent and ICU needs by 67 per cent.

Actual Versus Expected Results Comparison

How do the model's predictions compare to actual observations to date and why should policymakers use these model results as a guide for planning?

Below is a summary of what the model predicts at this point in the epidemic (expected) versus what is observed (actual). For both cases and deaths, the model estimates significantly higher numbers than have been recorded at this stage of the outbreak.

While we emphasise that the purpose of this model is to guide planning and not provide precise predictions, we have nonetheless explored some of the reasons that could account for these variations. We also make recommendations for improving model suitability in the section of this report on Implications for Governments, below.

Cases

Table 4 – Forecasted total infections by scenario versus actual cases as of 22 June 2020

LSHTM's Expected Spread as Forecasted Given Current Date

Scenario	Forecasted Total Infections to 22 June 2020
1. Unmitigated	35,025,001
2. 20% Social Distancing	4,122,216
3. 50% Social Distancing	1,493,553
4. 80% Shielding of the Vulnerable	9,471,745
5. 80% Shielding & 20% Social Distancing	4,844,206
6. 80% Shielding & 50% Social Distancing	1,764,301

Actual Cases	184,450

Source: TBI Analysis of LSHTM Modelling Results

On 22 June 2020, actual recorded case numbers across the countries analysed were 184,450. Under Scenario 2 (moderate social distancing) which most closely approximates measures in place in these countries, cases predicted by the model at this point in time is 4.1 million. The model is assuming that roughly four months into the epidemic, the disease transmission is accelerating rapidly at this point. This large discrepancy between what the model predicts and what is observed could be explained by a number of factors.

One of these is the low rates of testing in sub-Saharan Africa – meaning they could have large numbers of unrecorded positives in the population. Analysis conducted by TBI in June 2020 on testing levels[14] found that average tests per 1,000 of the population across sub-Saharan Africa was 2.2 across the duration of the epidemic, compared to a total of 18.6 per 1,000 for the rest of the world. In other words, SSA trails the world in testing by a factor of nine. This suggests that the current infection total may be as high as 1.67 million in SSA countries analysed, if all things are equal. We also note that the undertesting factor would have been higher had we excluded South Africa, which tests four times more than other sub-Saharan African countries analysed here.

There is evidence from actual data that the disease progression has been accelerating, suggesting that policymakers should be cautious about assuming that infection will continue at the rates they have seen so far.

We have presented analysis below (see Table 5) that shows that for the 18 countries in our study, between May and June total cases have increased by 350 per cent, from around 52,000 to 184,000 overall, over the past month alone. What these numbers suggest is that it would be unwise for policymakers to plan for Covid-19 capacity based on early low numbers of the disease. To further emphasise this, we undertook analysis from other countries in Asia and South America that could be reasonably considered to be similar to SSA in certain respects (climate, socio-economics). We found that in Bangladesh, India, Indonesia, Brazil, Peru and Argentina, cases have increased by between 230 per cent to 420 per cent in the past month.

This table shows the growth in cases in our 18 countries and the others mentioned above over the past four months, with the growth rates for the last month alone. When we observe the initial numbers in March and where they stand now, the increase is stark.

14 https://www.finddx.org/covid-19/test-tracker/ and https://humandata.org/event/Covid-19

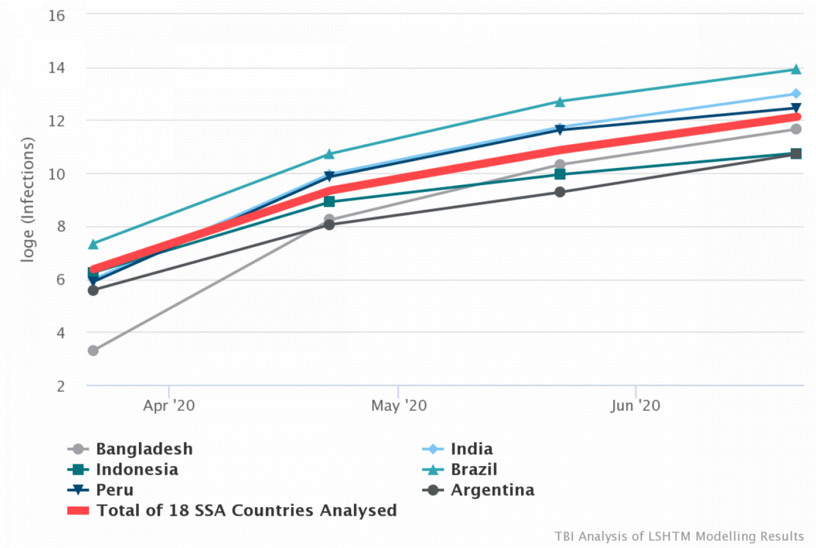
Table 5 – Cases for March to June, and percentage growth May to June

	22 March	22 April	22 May	22 June	Δ%
Bangladesh	27	3,772	30,205	115,786	+383%
India	396	21,370	124,794	440,215	+353%
Indonesia	514	7,418	20,796	46,845	+225%
Brazil	1,546	45,757	330,890	1,106,470	+334%
Peru	363	19,250	111,698	257,447	+230%
Argentina	266	3,144	10,649	44,931	+422%
Total of 18 SSA Countries Analysed	579	11,354	52,328	184,450	+352%

Source: TBI Analysis of LSHTM Modelling Results

Since March it is clear that the compound growth rates (log scale) of the case numbers in the 18 SSA countries we analysed fall in the middle of the range of the size of countries we selected for comparison from Asia and South America and follow the same trajectory. The results are plotted in the graph below.

Figure 13 – Actual infection compound growth rate



To dig deeper and examine the argument that Africa's relatively low case numbers may be influenced by its low levels of testing, we wanted to know by how much. So, we looked at the total number of tests per 1,000 of the population and compared that to the total number of cases per thousand in the comparative set of countries above. We found that the gap between cases per thousand closely tracks the gap between testing per thousand.

Table 6 – Total number of tests per 1,000 of the population versus total number of cases per 1,000 of the population

	Total Tests	June Cases
Bangladesh	3.83	0.70
India	5.04	0.32
Indonesia	1.44	0.17
Brazil	53.22	5.21
Peru	45.62	7.81
Argentina	6.31	0.99
Total of 18 SSA Countries Analysed	2.16	0.26

Source: TBI Analysis of LSHTM Modelling Results

Brazil, which is testing 25 times (53.22 versus 2.16) more people per thousand of their population, has 20 times more cases per thousand than the 18 countries in our study (5.21 versus 0.26). The same applies to the other countries: The additional number of cases they have per thousand people is similar to the factor by which they test more per thousand people. Indonesia, which is the only one that tests less, also shows a similar relationship – it tests 0.66 times fewer people per thousand than our 18 SSA countries; and it has 0.65 fewer cases per thousand.

Deaths

Actual deaths in the countries in our study currently stand at 3.6K versus modelled predicted deaths of 11.2K at this point in the epidemic.

We repeated our comparative exercise with the same countries from Asia and South America, to see if deaths have been growing as cases have. The results were similar: The growth in deaths in the past month closely track overall case growth.

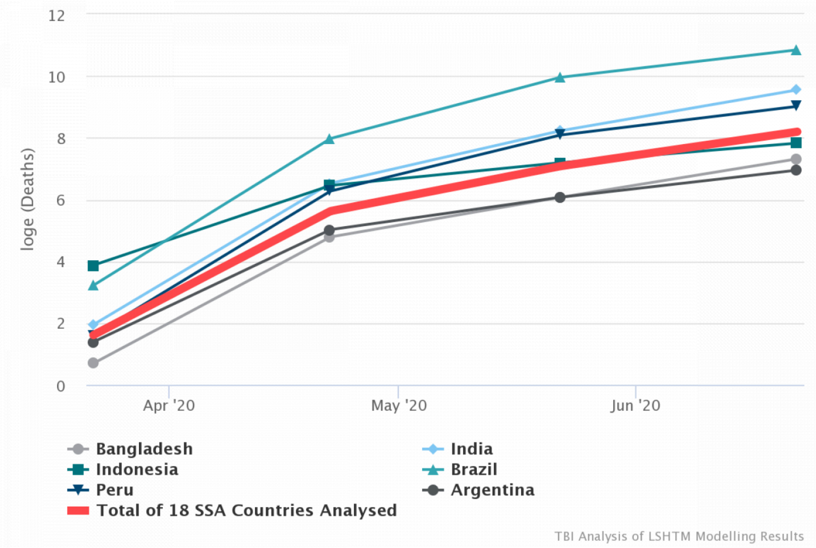
Table 7 – Reported deaths March to June, and percentage growth in deaths May to June

	22 March	22 April	22 May	22 June	Δ%
Bangladesh	2	120	432	1,502	+348%
India	7	681	3,726	14,011	+376%
Indonesia	48	635	1,326	2,500	+189%
Brazil	25	2,906	21,048	51,271	+244%
Peru	5	530	3,244	8,223	+253%
Argentina	4	152	433	1,043	+241%
Total of 18 SSA Countries Analysed	5	277	1,184	3,617	+305%

Source: TBI Analysis of LSHTM Modelling Results

The compound death rates (log) are plotted below as they follow the same trend as those for cases.

Figure 14 – Actual deaths compound growth rate



A further point to make is that these reported deaths are likely to be lower than the real number of Covid-19 deaths. Under-reporting of Covid-19 deaths is very likely, especially as we know many countries are not routinely testing all deaths in hospital and in the community. In Nigeria's northern Kano State, authorities found that deaths spiked in April – to 43 per day from the typical average of 11 per day. After initially attributing them to other causes (hypertension, diabetes, meningitis and acute malaria), authorities conducted an investigation that led to the reclassification of between 50 per cent and 60 per cent as due to Covid-19.[15] It is reasonable to assume that there will be further instances of deaths being wrongly attributed to pre-existing conditions. In some countries, deaths in the community – especially those in rural areas – are not tracked by authorities, so it is unlikely any unusual uptick will be recorded.

We have not in this study sought to analyse total additional deaths, which is a more complex exercise due to poor data. There is evidence of under-reporting of deaths even in more developed countries like the UK. It was reported in May 2020 that the UK Office of National Statistics (ONS) recorded almost 55,000 more deaths than expected in an average year. Of these excess deaths, three-quarters were believed to have been Covid-19 related.[16]

Current vs Expected CFR

Actual CFR for countries analysed is 1.96 per cent, which is close to the total CFR of 1.72 per cent across the epidemic, with moderate social distancing. The model predicts that CFRs will be low in the early stages mainly because of the lag between the onset of symptoms and any deaths

15 https://news.trust.org/item/20200608163112-ibaoo/

for early groups of infections. At the peak the model predicts an aggregated CFR of 1.72 per cent across the countries analysed.

Table 8 – Forecasted ultimate case fatality ratios (CFRs) by intervention scenario as of 22 June 2020 (actual deaths, cases and CFR included below for reference)

LSHTM's expected spread as forecasted (as of 22 June)

Scenario	Ultimate Case Fatality Ratio
1. Unmitigated	1.85%
2. 20% Social Distancing	1.72%
3. 50% Social Distancing	1.64%
4. 80% Shielding of the Vulnerable	1.33%
5. 80% Shielding & 20% Social Distancing	1.30%
6. 80% Shielding & 50% Social Distancing	1.21%

Actual Deaths	3,617
Actual Cases	184,450
Actual CFR	1.96%

Source: TBI Analysis of LSHTM Modelling Results

We must emphasise that accurate CFRs are hard to predict and compare[17], and we note the following additional caveats:

- Many countries have a different definition of what is officially reported as a Covid-19 death. There is no consensus and there are huge variations affecting the reporting of deaths across countries, which makes it hard to compare CFRs.
- Some countries report anyone who dies and is Covid-19 positive (even if Covid-19 was identified in a post-mortem swab), some countries aren't testing dead bodies so don't identify these, and some countries only

16 https://inews.co.uk/news/uk-55000-deaths-year-ons-429367

report deaths deemed to be caused by Covid-19 (meaning there is a medical review of the death to determine if Covid-19 caused the death or if the person would have died even without Covid-19).

- Some countries are only publicly reporting deaths that are confirmed by a medical review board as caused by Covid-19. Some have continued swabbing suspicious dead bodies, but these don't show in public figures because medical teams don't have the time/capacity to undertake autopsies. Additionally, there are a number of community deaths that are not reported publicly for the same reason. This means that reported deaths are in some cases lower than what their surveillance is finding. A transparent review of the discrepancies would be needed to analyse those gaps.
- Finally, the CFR is an outcome of both the number of deaths as well as the total number of cases. Where there is a high positivity rate of testing and low testing numbers, for example in Sierra Leone, the denominator will be less accurate than countries with higher levels of testing, such as Ghana or Rwanda, in this study. This means the CFR will automatically be higher. We think this is a possible reason why countries in the West have such a significantly higher CFR – they aren't testing asymptomatic people. If they were, their denominator would be exponentially higher.

Consequently, while the CFR is an important number, we should be cautious about comparing these across countries.

Hospitalisations and ICU Patients

17 https://www.nature.com/articles/d41586-020-01738-2

Table 9 – Forecasted hospitalisations and ICU beds needed by intervention scenario as of 22 June 2020 (WHO/Imperial estimated total hospital bed capacity included below for reference)

LSHTM's Expected Spread as Forecasted

Scenario	Forecasted Hospital Admissions	Forecasted ICU Beds Needed
1. Unmitigated	446,113	146,979
2. 20% Social Distancing	45,285	15,178
3. 50% Social Distancing	14,742	4,981
4. 80% Shielding of the Vulnerable	81,531	27,132
5. 80% Shielding & 20% Social Distancing	40,919	13,647
6. 80% Shielding & 50% Social Distancing	13,237	4,439

WHO/Imperial Estimated Total Hospital Bed Capacity

Hospital bed capacity	555,554
ICU bed capacity	14,798

Source: TBI Analysis of LSHTM Modelling Results

The WHO Covid-19 Medical Supplies Calculation tool [18] (WHO Covid-19 Essential Supplies Forecasting Tool v1.2), estimates hospital bed capacities (using Imperial College economic modelling assumptions) for countries analysed here to be 555,500. The model predicts that at the date of our analysis (22 June 2020) under Scenario 2, that 45,300 hospital beds would be needed. Adding shielding of the vulnerable to moderate social distancing (Scenario 5), does not seem to hugely impact hospitalisation (40,900). Not adopting any intervention measures brings the hospitalisation needs close to estimated capacity (not withstanding variations in these figures across countries between actual capacity and the estimated figures).

For ICU patients, the WHO Medical Supplies Calculation tool estimates a total of 14,800 ICU beds are available across countries analysed. Under Scenario 2, 15,200 ICU beds would be needed. Adding shielding of the vulnerable in Scenario 5 would bring demand just under the estimated supply of ICU beds at 13,600. This does not consider that a proportion of ICU facilities are already in use by non-Covid-19 patients. Peak ICU needs under Scenario 2 are 300,500 outstripping supply of ICU facilities by 20 times. Results will vary by country. Individual governments in SSA that are close to full capacity can plan towards managing their peak exposure, which is projected to be reached in this model on 31 August.

18 WHO Covid-19 Essential Supplies Forecasting Tool v1.2 published 30th March 2020

Suitability of the LSHTM Model and Comparison to WHO/AFRO Forecasting Model for Africa

LSHTM Model Suitability and Future Analysis

We believe LSHTM's modelling of African countries to be a useful tool to aid planning for intervention strategies post-lockdowns. We used the lower range estimates on the basis that the 25th percentile may be closer to reality than what is projected by LSHTM at the median. This is because current reported infections are significantly below levels expected given other countries' disease trajectory and what is predicted by LSHTM at this point. Improved testing levels will likely bring reported cases closer to those predicted in the model. We discuss below forecasts conducted by WHO/AFRO that predict significantly less Covid-19 disease severity and deaths compared to LSHTM.

Modelling at sub-national resolution with reference to population density or type of terrain in various districts (rural, urban, and dense low-income settlements in urban or other areas) would improve predictability but not necessarily decrease the modelled outputs. We have attempted to split countries' populations into districts or regions in our efforts to aid African countries in their Covid-19 response planning. These population splits could be applied to LSHTM's national-level modelling output to split the modelled cases across districts for better governmental medical and logistical planning and resourcing of various regions. However, the accuracy of predictions would be hugely improved if the modelling incorporated those population splits as inputs before the scenarios are run.

The inclusion of detailed health-capacity data at sub-national resolution would improve the model further. Such data is not available or collected for many countries at this point. Our recommendation for future work would be to begin to map health centres and medical capacities (doctors, nurses, medical equipment, types of health facilities) at district level. This would not only aid in modelling the Covid-19 outbreak and future outbreaks, it would allow governments to plan resources and improve its pandemic response capabilities as well as aid in resource mobilisations.

It is difficult to assess how mobility and contact patterns assumption have impacted the results based on LSHTM's assumptions unless the models are presented with and without such assumptions. It is expected that due to poor road networks in Africa, populations do not move as much as they do in more developed countries. In this model the LSHTM's contact matrices are incorporated to capture this impact. While these do use Africa-specific data, they are derived from European contact patterns. Incorporating mobility of populations based on African mobile-phone data, for example, may be useful in improving predictability of the model as they would more closely approximate how people interact in these countries.

The model is predicting at this point an acceleration of cases and deaths towards the peak as further community transmission is expected over the coming two to three months. It is important to note that assumptions about time to peaks are highly sensitive to the R0 and intervention assumptions and may prove to vary from reality for SSA countries. Estimates of when in real time corresponds to model day zero are also subject to uncertainty.

Age-dependant disease severities assumptions are extremely important as demonstrated by observed CFR data from China and Nigeria in this paper and data on the prevalence of comorbidities in countries in our study. LSHTM's model adjusts disease severities upwards to account for comorbidities among other socio-economic reasons. However, if the model explicitly included actual numbers of people with known comorbidities in every age group in the population, the impact of shielding the vulnerable in the model would be amplified further.

WHO/AFRO Model Comparison

The WHO/AFRO team have developed a simplified Covid-19 model to capture the projected impact over a 12-month period.[19] This model assumes African countries' current transmission levels are clustered in various communities. The model attempts to predict what happens when clusters of community transmission turn into widespread transmission across Africa, like in the case of the UK or Italy.

WHO/AFRO Model Forecasts

Table 10 – The potential effects of widespread community transmission of SARS-CoV-2 infection in the WHO African Region: a predictive model

Country	Total Estimated Infections	Asymptomatic Infections	Mild Infections	Moderate Infections	Severe Infections	Critical Infections	Total Symptomatic Infections	Hospital Admissions
Angola	9,374,921	7,811,646	744,559	744,559	3,762	2,462	1,495,342	184,918
Burkina Faso	1,811,521	1,507,818	143,757	143,757	1,154	476	289,144	36,131

Country	Total Estimated Infections	Asymptomatic Infections	Mild Infections	Moderate Infections	Severe Infections	Critical Infections	Total Symptomatic Infections	Hospital Admissions
Cameroon	8,650,261	7,206,950	687,117	687,117	4,791	2,990	1,382,015	172,690
Côte d'Ivoire	7,192,921	5,992,069	571,224	571,224	3,475	2,304	1,148,227	142,872
Ethiopia	4,254,002	3,539,877	337,525	337,525	2,497	1,636	679,183	85,139
Gambia, The	503,998	419,826	40,015	40,015	199	129	80,358	9,931
Ghana	4,783,076	3,981,908	379,663	379,663	2,789	1,767	763,882	95,675
Guinea	2,764,527	2,302,216	219,489	219,489	1,470	946	441,394	55,094
Kenya	6,157,172	5,125,709	488,663	488,663	3,445	1,805	982,576	122,529
Liberia	1,155,575	962,431	91,753	91,753	585	386	184,477	22,991
Mali	1,154,252	960,677	91,588	91,588	602	398	184,176	22,981
Mozambique	5,380,072	4,479,773	427,085	427,085	2,773	1,843	858,786	107,116
Niger	166,248	138,369	13,189	13,189	71	46	26,495	3,283
Nigeria	56,941,648	47,438,888	4,522,073	4,522,073	25,771	17,103	9,087,020	1,128,172
Rwanda	5,197,581	4,332,265	413,005	413,005	2,599	1,689	830,298	103,409
Senegal	3,937,580	3,279,437	312,654	312,654	2,136	1,293	628,737	78,467
Sierra Leone	1,810,218	1,507,815	143,729	143,729	843	501	288,802	35,839
South Africa	24,023,691	20,007,604	1,908,888	1,908,888	21,692	14,028	3,853,496	493,853
Total 18 Sub-Saharan African Countries	145,259,264	120,995,278	11,535,976	11,535,976	80,654	51,802	23,204,408	2,901,090
Total Africa (47 Countries Modelled)	231,281,401	192,651,016	18,369,484	18,369,484	139,521	89,043	44,624,330	4,637,240

Source: WHO/AFRO

The premise of the WHO/AFRO modelling starts by looking at the available evidence to date of infection and death levels in Africa in

19 "The Potential Effects of Widespread Community Transmission of SARS-CoV-2 Infection in the WHO African Region: A Predictive Model", Joseph Waogodo Cabore, Humphrey Karamagi, Hillary Kipruto, James Avoka Asamani, Benson Droti, Aminata Binetou-Wahebine Seydi, Regina Titi-Ofei, Benido Impouma, Michel Yao, Zabulon Yoti, Felicitas Zawaira, Prosper Tumusiime, Ambrose Talisuna, Francis Kasolo, Matshidiso Moeti Author affiliations. World Health Organization, Regional Office for Africa, Brazzaville, Republic of Congo: https://gh.bmj.com/pages/wp-content/uploads/sites/58/2020/05/BMJGH-The_potential_effects_of_widespread_community_transmission_of_SARS-CoV-2_infection_in_the_WHO_African_Region_a_predictive_model-Copy.pdf

comparison to other countries. At the time of model calibration (March), Africa had suffered disproportionately fewer cases than expected (0.77 per cent of world cases given it represents 13.7 per cent of the world population). Such evidence led the team to create a unique methodology to capture the spread of disease that is not in line with widely used scientific methodologies. The WHO/AFRO model assumes country-specific risk factors that impact the probabilities of being exposed to the disease and hence infected. These risk factors include things such as gatherings, social interaction, mobility of population, disease seasonality, weather and hygiene levels. While detailed analysis has gone into the creation of the risk factors, methods of incorporating them have not been extensively validated. Intervention measures with regards to hygiene and social distancing have also been incorporated, impacting disease attack rates. A number of other simplifying assumptions were added, such as having a static exposed population across the modelling period. This assumption would likely impact the predictability of the model quite significantly and was questioned by the wider scientific community, because as more people are infected, more people would be exposed to Covid-19.

The model's prediction of total infections at 145 million is close to what LSHTM's model predicts: 138 million at the 25th percentile with moderate social distancing. This is in line with expectations as the R0 assumptions in both models are similar. However, WHO/AFRO assumes that 84 per cent of cases are asymptomatic while LSHTM's modelling in this report is in respect of all symptomatic patients.

For the countries we analysed, the WHO/AFRO model predicts 0.4 per cent CFR of symptomatic cases (86,800 deaths out of 23.4 million symptomatic cases), while the observed total CFR is currently at 1.96 per cent. The LSHTM model predicts 1.7 per cent CFR with moderate social distancing with 2.4 million deaths forecast over 12 months. The science and medical research used in other models such as LSHTM are not yet fully informed on changing disease severity assumptions that impact modelled mortality in SSA. It is perceived that it is still early in the outbreak in African countries to recalibrate models on observed evidence coupled with the low testing levels. However, WHO/AFRO does rely on many sources of research that could lead us to estimate that the final death toll from Covid-19 is likely to be between 86,800 and 2.4 million. We have not sought to model total additional deaths, which is challenging due to poor data.

We compare actual CFR by country to predicted CFRs in both models. We present WHO/AFRO's CFRs as a percentage of symptomatic cases below to allow a comparison to LSHTM's CFRs. The WHO/AFRO CFRs are considerably lower than the actual CFRs as of 22 June 2020 in these countries.

Table 11 – Comparison of actual case fatality ratios (CFRs) to LSHTM CFRs and WHO/AFRO CFRs by country

Country	Actual CFR 22 Jun	LSHTM's CFRs	WHO/AFRO CFRs
Angola	5.4%	1.2%	0.3%
Burkina Faso	5.9%	1.4%	0.3%
Cameroon	2.6%	1.4%	0.4%
Côte d'Ivoire	0.7%	1.6%	0.3%
Ethiopia	1.6%	1.6%	0.4%
Gambia	4.9%	1.6%	0.3%
Ghana	0.6%	1.8%	0.4%
Guinea	0.5%	1.7%	0.4%
Kenya	2.6%	2.2%	0.3%
Liberia	5.2%	1.7%	0.3%
Mali	5.7%	1.1%	0.4%
Mozambique	0.7%	1.3%	0.4%
Niger	6.4%	1.1%	0.3%
Nigeria	2.5%	1.6%	0.3%
Rwanda	0.3%	1.6%	0.3%
Senegal	1.4%	1.7%	0.4%
Sierra Leone	4.1%	1.6%	0.3%
South Africa	2.0%	2.6%	0.6%

While increased testing would likely reduce the actual CFR due to increases in reported cases, reporting of deaths would also increase, albeit not proportionately, partly due to lack of routine testing of deaths in the community or those in hospital that were not admitted for Covid-19.

WHO/AFRO's significantly lower death numbers flow directly from its assumption that 84 per cent of Covid-19 cases are asymptomatic. This assumption impacts severe and critical case predictions out of which death predictions flow. The assumption of asymptomatic patients relies first on the rationale that current testing in many countries is focused on suspected symptomatic cases. It quotes the experience with the recent MERS-CoV outbreak that showed increasing identification of asymptomatic case numbers over time as surveillance and testing strategies expanded. It also relies on Covid-19 evidence from South Korea and Germany, where wider testing showed more asymptomatic cases. It claims that early results of US and European data point to asymptomatic cases representing 50 to 95 per cent of total reported cases.

Asymptomatic statistics are not often reported for SSA countries, however when they are, they tend to show or imply a large range. For example, Mozambique currently reports that 52 per cent of cases are asymptomatic; in Ethiopia, cumulative cases to 24 June show that 70 per cent who tested positive were in treatment centres or in ICU, implying that known asymptomatic patients are significantly lower than 30 per cent in Ethiopia.

Table 12 – Mozambique Covid-19 non-critical non-severe case split

Age Group	Split of Cases
Asymptomatic	52%
Light symptoms	40%
Moderate symptoms	8%

Source: Covid-19 Guru

Table 13 – Ethiopia Covid-19 split of cases, 24 June

Type of Cases	Split of Cases	Percentage of Total Cases
Total	5,034	100%
Active (In treatment centre)	3,468	68.9%
Critical (ICU patients)	38	0.8%
Total Non-Mild Symptomatic Cases	3,506	69.6%

Source: Ethiopian Health Data

An early June 2020 media briefing by the WHO's Covid-19 technical lead Maria Van Kerkhove commented that around 40 per cent of coronavirus transmission may be due to asymptomatic cases, according to certain recent estimates from some countries.[20]

Analysis conducted by LSHTM (using a delay-adjusted case fatality ratio to estimate under-reporting), points to under-reporting of symptomatic cases in sub-Saharan African countries of 40 per cent and over.[21]

This leads to the conclusion that there is significant uncertainty around asymptomatic patient percentages and that the 84 per cent adopted by the WHO/AFRO is potentially overstated. If the asymptomatic percentage was reduced, that would significantly increase severe and critical cases and hence increased deaths in the WHO/AFRO model.

Similarly, there is a large discrepancy between WHO/AFRO's assumptions on severe and critical cases, when compared to LSHTM. WHO/AFRO predicts that only 16 per cent of cases are symptomatic (including mild cases) based on perceived evidence at the time of calibrating the model, then applying widely used disease attack rates to a much smaller set of cases (the symptomatic). Severe and critical cases represent only 0.6% of all symptomatic cases, totalling 132,500 cases.

A separate recent study by WHO on a number of countries suggested that 15 per cent are severe infection, requiring oxygen, and 5 per cent are critical infections, requiring ventilation. At 20 per cent, these proportions contradict the assumptions in the WHO/AFRO study.[22]

In a detailed analysis paper that included modelling for Niger, Nigeria and Mauritius, LSHTM produced comparable results demonstrating how different its assumptions are on severe and critical cases. Median results are presented. From the symptomatic cases, critical and severe are between 3.7 per cent to 12.9 per cent of symptomatic populations. The large variations by country are due to substantially different age profiles of those populations and hence disease severity, with Niger being the youngest and Mauritius the oldest.

Table 14 – LSHTM's severe and critical cases as a percentage of symptomatic cases

	Niger	Nigeria	Mauritius
Severe Cases	2.6%	3.3%	9.0%
Critical Cases	1.1%	1.4%	3.9%
Total Severe and Critical	3.7%	4.7%	12.9%

Source: Response strategies for Covid-19 epidemics in African settings: a mathematical modelling study

Reported cases from the National Institute of Communicable Diseases in South Africa, where testing levels are higher, show that by the end of May 2020, 14.4 per cent of cases were hospitalised (hence severe or critical). This is more in line with symptomatic attack rates projected by LSHTM, where Niger was 17 per cent and Nigeria was at 24 per cent.

Conclusions on Modelling

We believe that the LSHTM's model presents a reasonable framework to inform policy interventions, resourcing and planning. Taken together with WHO/AFRO's model, we think the final death numbers are likely to be somewhere between the two. However, given current CFRs, the final numbers may be closer to those of LSHTM subject to improved testing.

Time series modelling results as presented by LSHTM can also be used to project – even if not perfectly accurately – medical needs and be compared against exiting capacity. This would aid in resource mobilisation and

20 https://www.standard.co.uk/news/uk/41-coronavirus-cases-asymptomatic-world-health-organisation-a4464321.html

21 Using a delay-adjusted case fatality ratio to estimate under-reporting (LSHTM): https://cmmid.github.io/topics/covid19/global_cfr_estimates.html

22 https://www.who.int/docs/default-source/coronaviruse/situation-reports/20200306-sitrep-46-covid-19.pdf?sfvrsn=96b04adf_4

budgeting across the epidemic curve. When we conducted this analysis, WHO/AFRO did not provide time series with their model.

It is clear from the LSHTM modelling results that combining a strategy of moderate sustained social distancing and the shielding of the elderly or shielding of all the vulnerable populations would substantially reduce transmission and hence avert deaths.

We believe the more granular the underlying model assumptions are the better the predictability and usability of the model. LSHTM's focus on age dependant modelling is extremely important for Africa given the age profile of populations being significantly younger. This should reduce the impact of the disease, however comorbidities prevalent in Africa would account for greatly increased disease severity. Separate modelling of the elderly who tend to suffer more comorbidities captures some of the impact of comorbidities on Covid-19 progression in SSA.

Implications for Governments

Based on this analysis and our other observations about emerging best practice we recommend that African governments take the following practical actions in advance of the coming peak in order to reduce transmission now, alleviate the pressure on health systems and ultimately save lives:

1. Maintain social distancing requirements and mandatory mask wearing in public and insist that vulnerable groups (elderly, diabetics, hypertension and HIV patients, and those with respiratory illness) shield at home. Clarify and improve communications to this effect.
2. Mobilise community support for the behaviour changes required to achieve high compliance with these social distancing and shielding measures.
3. Adapt testing strategies to reflect capacity and diagnostic supplies. Utilise the pooled procurement platforms now available to boost supplies but have a plan in place to anticipate how to adjust if adequate supplies are not available. This may require prioritising health and other frontline workers and critically ill patients for testing and should include introducing antibody testing as a complement to your sources of information.
4. Discharge asymptomatic patients from isolation facilities after ten days without further testing in accordance with revised WHO guidelines, to save testing supplies and free up isolation space. Once it becomes necessary, due to extreme shortage of isolation space, move to self-isolation and management of symptoms at home, with community support.
5. Prioritise the protection of health-care and other frontline workers and maintenance of non-Covid-19 health care.
6. Ensure you have reliable, real-time data for decision-making and public communications. This will be critical to guide your strategy as the outbreak evolves over time.

Further guidance on executing these recommendations in practice:

1. **Maintain social distancing requirements and mandatory mask wearing in public and insist that vulnerable groups (elderly, diabetics, hypertension and HIV patients, and those with respiratory illness) shield at home.**

Social distancing measures, if applied and followed with about 20 per cent effectiveness, are shown by the model to have a significant effect on lowering transmission rates. Essentially this is about increasing distance between people and improving basic hygiene:

- Consider circumstances where people may come into contact with each other and introduce effective distancing measures. High-risk environments include public transport, which should be running with reduced passenger numbers; schools; retail including marketplaces; offices; places of worship; areas and anywhere else where there could be large gatherings. Mandating a strict distancing rule (limiting numbers in proximity to each other) will help to minimise contact and lower transmission.
- Reorganise public markets to ensure adequate protection by vendors, distancing between stalls, and grouping of product types to ensure single flow of shopper traffic into and out of markets.
- As well-ventilated outdoor areas are less conducive to transmission than poorly ventilated, or inside spaces, consider other adjustments that could lower risk levels, for instance relocating local marketplaces to larger, more ventilated spaces or holding some classes outdoors when schools reopen.
- Mandating the wearing of masks in public at all times may have a significant impact in slowing transmission, particularly given the high percentage of asymptomatic carriers who might otherwise transmit the virus without knowing they are contagious. Given there are many spaces where maintaining strict distance from others is particularly difficult, requiring the wearing of masks in public offers additional protection. Governments can support this both through repurposing industrial manufacturing and encouraging local production providing livelihood support.
- Insist on shielding of the vulnerable at all times, to save lives and alleviate the pressure on the health service from those who are at greatest risk of becoming severely ill. Requiring or encouraging those who are at highest risk of Covid-19 to remain at home, with support and care from their families and communities would have a significant impact on mortality rates.
- Those who should be shielded include the over-60s, as demonstrated within the model. To extend this effect, we recommend that shielding also be extended to those in high-risk demographic groups, for instance those with known comorbidities including diabetes, hypertension, HIV and respiratory conditions such as tuberculosis.

- Mandate hand-washing at all public buildings, places of work and shops.

While mandating shielding by itself is not likely to be effective, Government can encourage and facilitate shielding to be done successfully, including through:

- Providing additional WASH (water, sanitation and hygiene) facilities to assist with infection prevention and control measures within the home.
- Where the person being shielded is otherwise economically active and cannot work, or the burden of their care will require others in the household to miss work, governments could offer economic support, for example through cash transfers.
- Ensuring that there is effective community health support to monitor those who are shielding and provide services and medicines.

Neither social distancing nor shielding can be introduced effectively solely through measures to enforce compliance. For either to work will require positive acceptance and behaviour change, which will only be achieved through community education and ownership.

2. **Mobilise community support for the behaviour changes required to achieve high compliance with these social distancing and shielding measures, in order to achieve sustained, lower transmission at community levels.**

Testing, tracing and isolating is important to keep track of and curb transmission, particularly in the early stages of an outbreak, and in the latter stages to eliminate cases when they are at a manageable level. However, once there is widespread community transmission, in the absence of a cure or vaccine, unless people stop infecting each other, the outbreak will not end. Some countries across Africa already face acute constraints to scaling up testing, further exacerbating this challenge.

Reducing transmission therefore requires behaviour change among individuals, which is most effectively achieved through local community mobilisation. It requires communities, not just government, to own and control the chains of transmission and to support people to come forward who require care or support.

In practical terms, what is needed will vary community to community. Government's role is to engage actors with influence in local communities, listen to what is required in their specific context, and ensure they are supported and resourced to take those actions, empowering communities and businesses to do social distancing, shielding and infection prevention and control. Mandating wearing of masks in public and improving access to hygiene and sanitation are important but not sufficient. These will have no effect in the absence of real behaviour change, and monitoring and enforcement are expensive while compliance will be low. Community mobilisation is the proven approach to successfully curbing transmission of infectious diseases on the continent and was the key to ending major Ebola and HIV outbreaks.

In addition to what communities say they need, governments should plan now to address gaps in public services to protect people from Covid-19:

- Provide water and sanitation facilities – especially for dense urban areas.
- Ramp up distribution of masks, gloves and basic disinfection kits – heavily targeting low-income and densely populated areas.
- Accelerate water purification and where possible borehole provision in rural areas.
- Consider economic support measures to allow public transport and other key sectors to implement these requirements – fuel subsidies for transport operators to allow them to reduce passenger numbers, for example.
- Support communities to shield the vulnerable and provide assistance to those who need to self-isolate, if they become symptomatic, to do so at home safely. The national health authorities should also design and implement outreach, education and monitoring programmes for patients known to have underlying vulnerabilities.

3. Adapt testing strategies to reflect capacity and diagnostic supplies.

Issues with both the procurement of diagnostic supplies and limits to in-country technical capacity are already affecting governments' ability to keep testing at the pace of transmission. Once this happens and backlogs occur the traditional test, trace, isolate strategy ceases to be effective because it cannot provide information quickly enough for infection control, tracing, hospital flow and government isolation facilities. We have seen this in South Africa where a shortage of test kits and reagents, plus rising case numbers, led to significant testing backlogs and it became clear elimination of the virus could not be achieved through test, trace, isolate alone. As a result, the government has stopped testing certain populations (those considered less at risk) and is redirecting resources to focus on stopping community transmission and supporting community health initiatives.

Governments will need to be prepared to have a more focused testing strategy if case numbers rise and the current approach becomes unfeasible. Governments should plan now for how to adjust and what will trigger that adjustment, including:

- How to bring in enough tests and reagents to match maximum diagnostic capacity (labs and technicians). The launch of the new WHO pooled procurement platform is an important step forward in this regard, but there are also other platforms such as the Africa Pandemic Response Alliance,[23] which are already up and running and can provide essential supplies.
- How to prioritise tests if testing capacity is constrained. Governments may need to make trade-offs and decisions about how to balance competing priorities. They might decide to target based on vulnerability (for instance, age or comorbidities), sample in particular areas to ensure that resources are being directed to hotspots, and/or ensure continued testing bodies of the deceased to confirm mortality rates. No matter how they decide to configure testing, the priority for governments should always be safeguarding health and frontline workers.
- How to use rapid antibody testing to alleviate the pressure on and provide complementary data to PCR testing. Antibody testing can be used for broader surveillance purposes, to better understand how the virus has already spread in different parts of the country and different segments of the population.
- How to communicate changes in the strategy to citizens. As capacity to test everyone who displays symptoms becomes more constrained, there will need to be an increased onus on citizens to take responsibility for isolating themselves and protecting their communities. Governments will need to consider how to support citizens to do this proactively and safely.

4. **Discharge asymptomatic patients from isolation facilities after ten days without further testing in accordance with revised WHO guidelines, to save testing supplies and free up isolation space. Once it becomes necessary, due to extreme shortage of isolation space, move to self-isolation and management of symptoms at home, with community support.**

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23 https://www.africapra.org/

As isolation facilities begin to fill with rising case numbers, governments may have to adjust policies for patient management within these facilities and discharge patients as quickly as it is safe to do so. The WHO has recently updated its guidance on discharging patients and is now recommending discharge[24]:

> *"For symptomatic patients: 10 days after symptom onset, plus at least 3 additional days without symptoms (including without fever and without respiratory symptoms)*
>
> *For asymptomatic cases: 10 days after positive test for SARS-CoV-2"*

This allows patients to be moved out of isolation or health setting more quickly as it no longer relies on two negative PCR tests spaced at 24 hours apart, which both saves test supplies and frees up space that may be required by others sooner than current protocols would allow. Ghana has already revised its de-isolation strategies based on this guidance. While discharging without negative PCRs is not entirely without risk, the risk level is judged to be sufficiently low and outweighed by providing tests and isolation space for those who are symptomatic and require immediate care and/or isolation.

If case numbers continue to rise, there may be too many cases to manage solely within government isolation facilities. This could be addressed by preparing communities now to support individuals with no or mild symptoms safely at home, if required, so that those with more severe presentations are given priority to treatment/isolation facilities. Governments could facilitate this by the provision of:

- Adequate supplies of PPE so that families can manage infection prevention and control more safely within the home environment, and isolate themselves.
- Food/cash transfers if families are unable to work if caring for someone who is isolating.
- WASH facilities/access to clean water for families where this is not easily available or would require travel and in doing so potentially increase transmission risks.

5. Prioritise the protection of health-care and other frontline workers and maintenance of non-Covid-19 health care.

Frontline health workers are essential, and governments should continue to prioritise their protection. Maintaining their trust will be critical. To ensure their protection, governments should maintain a

24 https://www.who.int/publications/i/item/criteria-for-releasing-covid-19-patients-from-isolation

pipeline of PPE for health (and other frontline) workers and prioritise health workers for PCR and antibody testing.

It is also critical to protect health facilities as far as possible. This means that where possible, Covid-19-specific isolation facilities should be maintained. If these become either under-utilised (as too few people come forward for help), or too expensive to maintain, governments could consider a shift to triage and isolation within shared-use (normal) health facilities.

As case numbers rise, there may need to be further adaptation of isolation policies if facilities become overcrowded, especially if many people are asymptomatic or have only mild symptoms. At this stage governments may want to prepare to shift to self-isolation approaches by necessity (again, community engagement is critical to support people to do this properly and safely, and local leaders will need resourcing from government to achieve this).

Finally, Covid-19 is not the only enemy. There are a range of other equally devastating health conditions that will take their toll on communities, particularly if non-Covid-19 care is not available, or citizens are anxious about seeking help at health facilities. For example, the WHO are suggesting half a million more people may die of AIDS-related illnesses in sub-Saharan Africa this year and next[25], more than double current rates, without efforts to overcome disruptions to health services and supplies. If governments reach a point where contact tracing is no longer possible, because the case numbers are too high, they should consider redeploying community health resources back to offering essential care within the communities for issues like diabetes, hypertension and HIV, etc. (South Africa has started to do this through the use of mobile clinics.) This will help governments build trust, protect the most vulnerable and save lives.

6. **Ensure reliable, real-time data for decision-making and public communications. This will be critical to guide strategy as the outbreak evolves.**

In order for community mobilisation to work and for health systems to keep pace with and get ahead of transmission, data needs to be accurate, accessible and timely. Governments need to be able to explain to citizens that things may get worse before they get better and set out the strategies they will employ. These will need to adapt with and to the burden of the disease.

Citizens need to understand the severity and growth of disease in order to understand why it is necessary for them to adapt their behaviours or accept changes to their daily routines. Where this hasn't been communicated effectively, or there is a disconnect between citizens' own experiences and what the government has said, it is easy for trust to erode. Recent episodes of civil unrest and protests against the measures in place are a reminder of how easily this can happen.

Investing in accurate data collection and reporting will allow governments to make effective decisions, ensure citizens understand the strategy and can play their part, and will build credibility and relationships necessary to reopen economies as swiftly as possible.

25 https://www.who.int/news-room/detail/11-05-2020-the-cost-of-inaction-covid-19-related-service-disruptions-could-cause-hundreds-of-thousands-of-extra-deaths-from-hiv

Conclusion

There remain many unknowns about the spread of Covid-19 in Africa, and other parts of the developing world. However, while this report does not set out to make firm predictions, we believe governments and international actors should not assume the current low levels of the disease will continue. We observe that the spread of the disease is increasing rapidly as community transmission takes hold, in line with experience elsewhere, and the peak is likely to be reached in the next six to eight weeks. At the same time, while governments in African countries and economies do not have the ability to return to or prolong hard lockdowns, significant impact on death rates and hospitalisation can be achieved through policy measures that amount to 20 per cent effective social distancing and 80 per cent effective shielding of the vulnerable. We set out practical measures as to how this can be achieved. In a future report we will consider further how countries in Africa and the developing world can continue to reopen their economies and play a full part in the interconnected global economy while contending with the wide spread of Covid-19.

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