COVID-19 Zimbabwe models

Comparison of preliminary findings and recommendations from two models on Zimbabwe

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Background

- As of 29 April 2020, more than 3 million cases and 208 112 COVID-19 related deaths were reported worldwide.
- However, to date, its effects have mainly been observed in high income countries with the African region reporting 23 833 cases and 933 COVID-19 related deaths
- Due to differences in demographic, epidemiological and socio-economic factors between African, European and Chinese settings, there is need for models that help inform strategies to:
  - minimise infections and mortality
  - Reduce the burden on health services
  - Safeguard the economical standpoint of the population

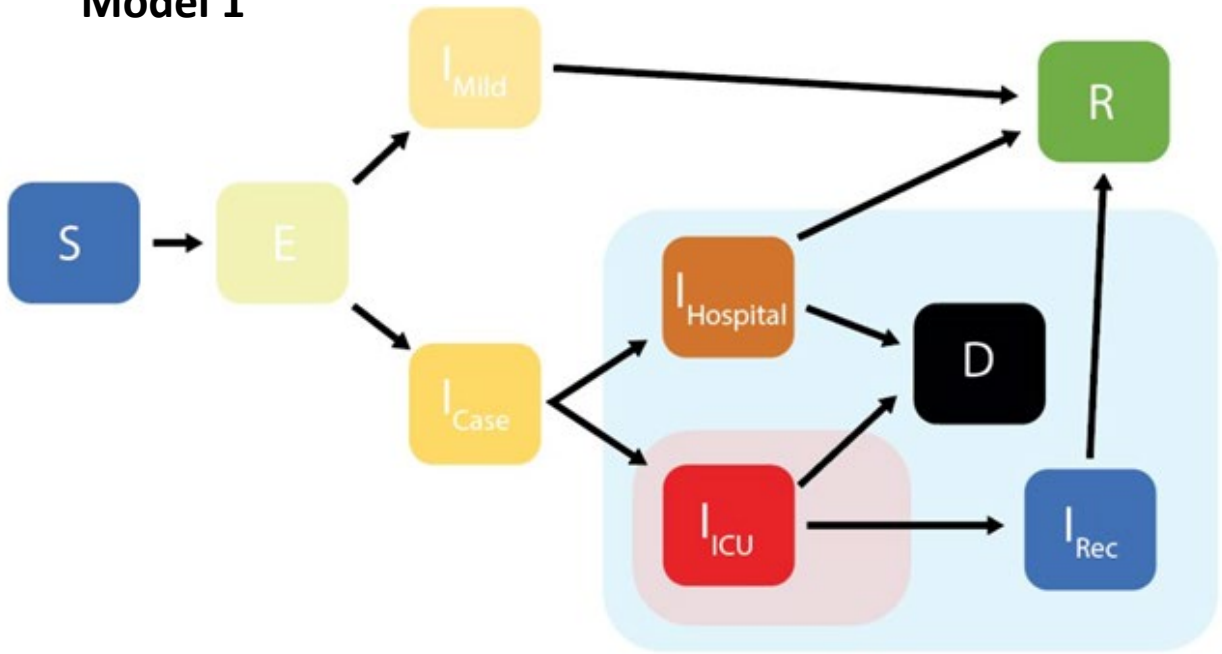
Methods

- Two mathematical models have been developed by the:
  - Imperial College COVID-19 Response Team and MoHCC (Model 1)
  - LSHTM and CMMID (Model 2, Zimbabwe included for sensitivity analysis)
- The aim of the models were to explore the possible effect on COVID-19 hospitalization requirements and mortality after considering interventions like:
  - Self-isolation of symptomatic persons
  - General distancing (reduction of overall contacts) outside the household
  - Intensive lockdown measures
  - Shielding of whereby people at high risk of COVID-19 severe disease

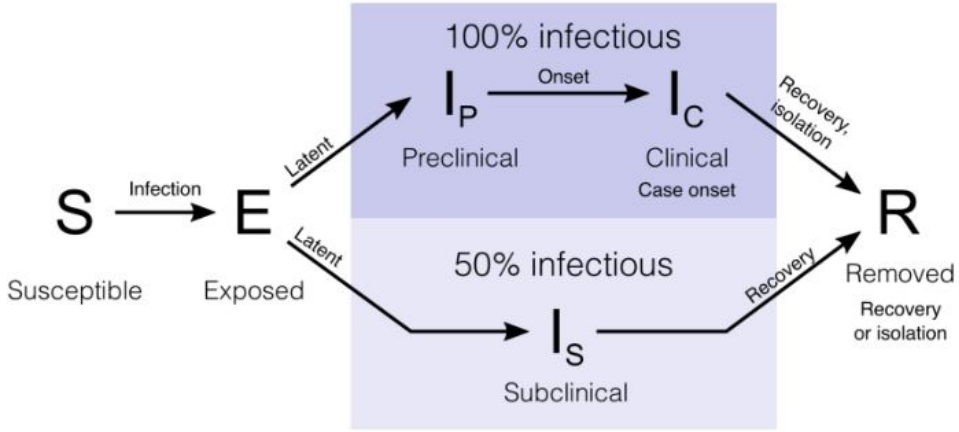
Model structure

- The models were all adapted and age-structured stochastic Susceptible-Exposed-Infectious-Recovered (SEIR)compartmental model.

Model 1



Model 2



Model description

Aspect	Model 1	Model 2
1	Population moves through the compartments but not specified whether continuous or discrete	Population moves through the compartments at time based intervals (6hrs, discrete-intervals)
2	Simulated for 200 days	Simulated for 12 months
3	Age-structured but not specified.	Stratified into 16 age-groups of 5 year age bands, 75+ yrs and disease status(asymptomatic, pre-symptomatic and symptomatic)
4	Though not specified, the models seems open with confirmed dead cases exiting the model	The model is closed with no births or ageing, and deaths remain in the Recovered compartment.

Model description

Assumptions for the models

- Transmissibility assumptions

- Case severity assumptions

Response interventions

Transmissibility assumptions

Aspect	Model 1	Model 2
1	Age-dependent probability of developing clinical symptoms	Age-dependent probability of developing clinical symptoms
2	No assumption on whether symptomatic and asymptomatic cases are equally infectious.	Asymptomatic individuals were assumed to be half as infectious as symptomatic individuals
3	Not specified whether the infectiousness changes as disease severity worsens.	Clinical progression of symptomatic cases, from mild to severe disease is assumed not to affect their infectiousness.
4	Adopted age-specific contact patterns.	Age-specific social mixing pattern were adopted from Europe
5	3 values of Reproduction numbers (R_0 =2.4, 2.7, 3.0) as observed worldwide. (R_0 of 2.7 following lockdown period)	A sampled basic reproduction number R_0 from a normal distribution 2.6(0.5)

Case severity assumptions

- In high-income countries, the severity of COVID infections has been shown to be associated with:
  - increased age
  - presence of comorbidities
- Model 2 assumed that:
- in African and low-income countries, an average person's underlying vulnerability may correspond to that of an individual with greater chronological age in a high-income setting.
- This is due to malnutrition and infections and often un non confirmed communicable diseases.

Case severity assumptions

- There is evidence that shows strong associations between income level and the severity of other respiratory infections, particularly in younger age groups
- Hence the model shifted age-specific severity risks towards younger age by 10 years
- Age-specific case fatality ratios (CFRs) of severe, and critical cases were also multiplied by a factor of 1.5 as compared to Chinese data.
- This was done to capture the effect of increased vulnerability and lack of access to healthcare.
- However there was no assumption on the proportion that will receive appropriate treatment.

Response interventions

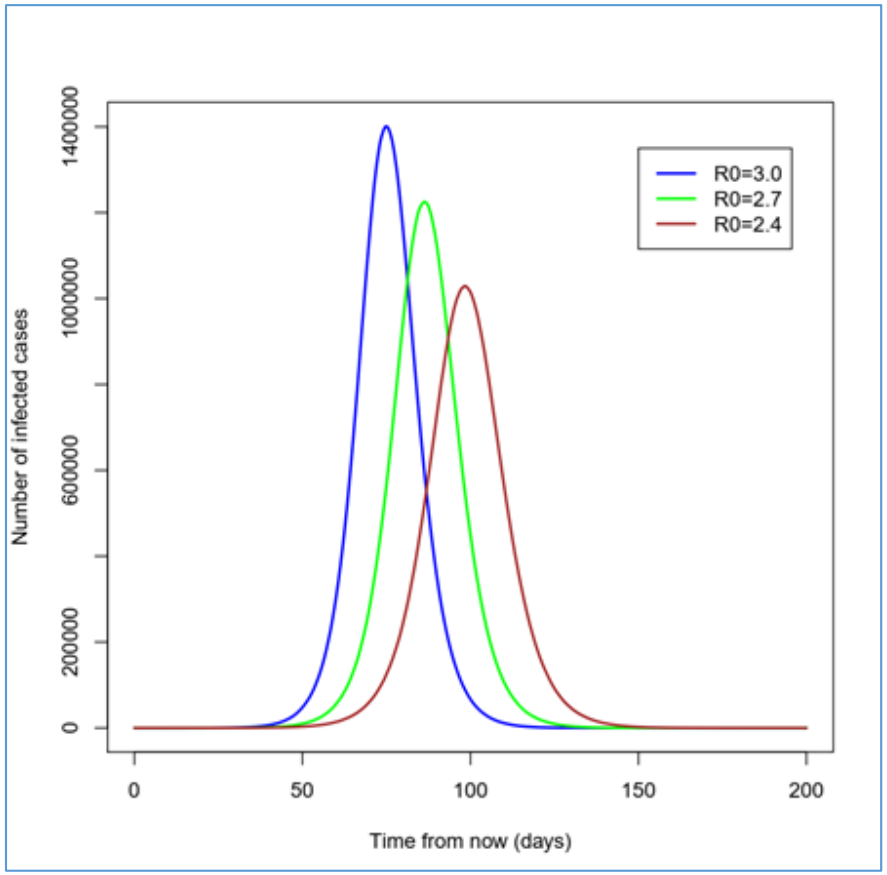
A range of response individual interventions were explored, alone or in combination.

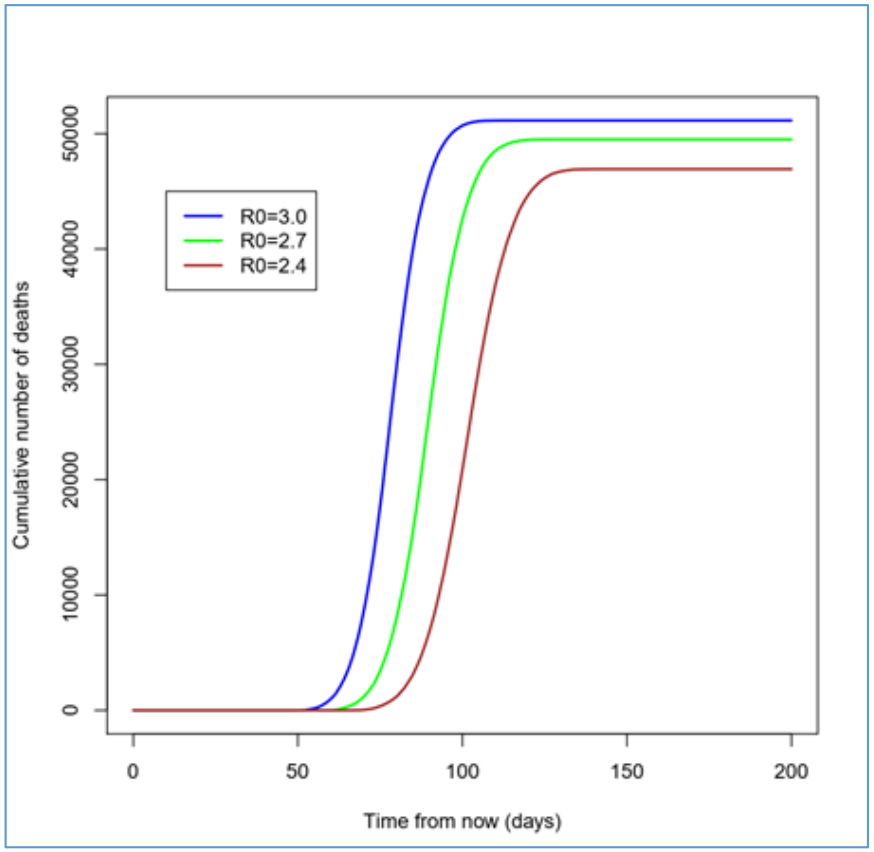
Intervention	**Model 1**	**Model 2**
Self-isolation of Symptomatic people	Not specified	0-100% adherence was explored
General physical distancing including reduction of probability of transmission per contact)	Hygienic practices 15% reduction. Face mask alone 10% Lockdown measures reduces transmission by 75%	lockdown' measures would correspond to an 80% reduction
Shielding of high-risk groups	Not specified	60-100% reduction in transmission in high-risk persons

Impact of potential control strategies

Unmitigated scenarios

Model 1





Intervention options for model 1

1. Do nothing (comparator scenario)
2. Lockdown extended to 35 days, with no further mitigation measures following the end of the lockdown period (extended lockdown scenario)
3. A break of 1 week followed by a second lockdown lasting an additional 21 days (repeat lockdown scenario)
4. Following the end of the current lockdown, an aggressive policy on masks and handwashing (enhanced hygiene scenario)

Results for interventions post lockdown:

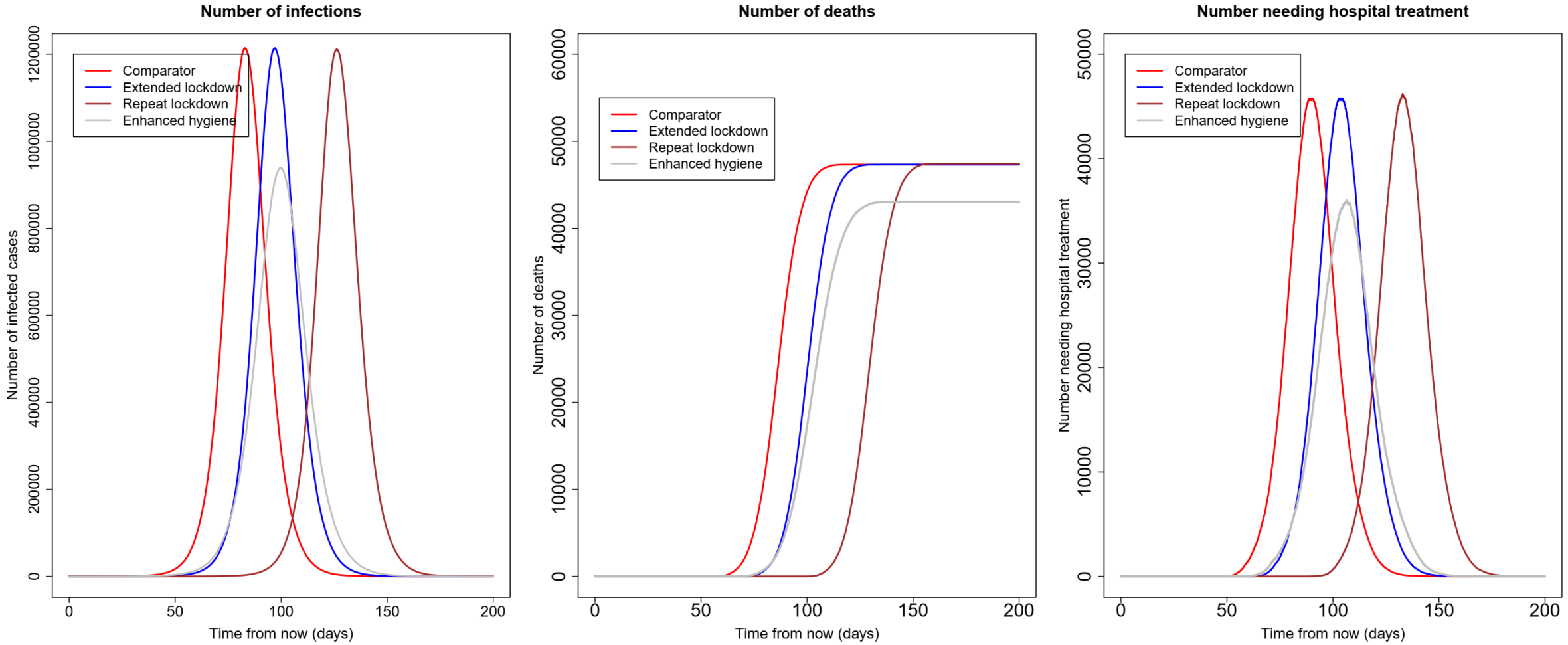
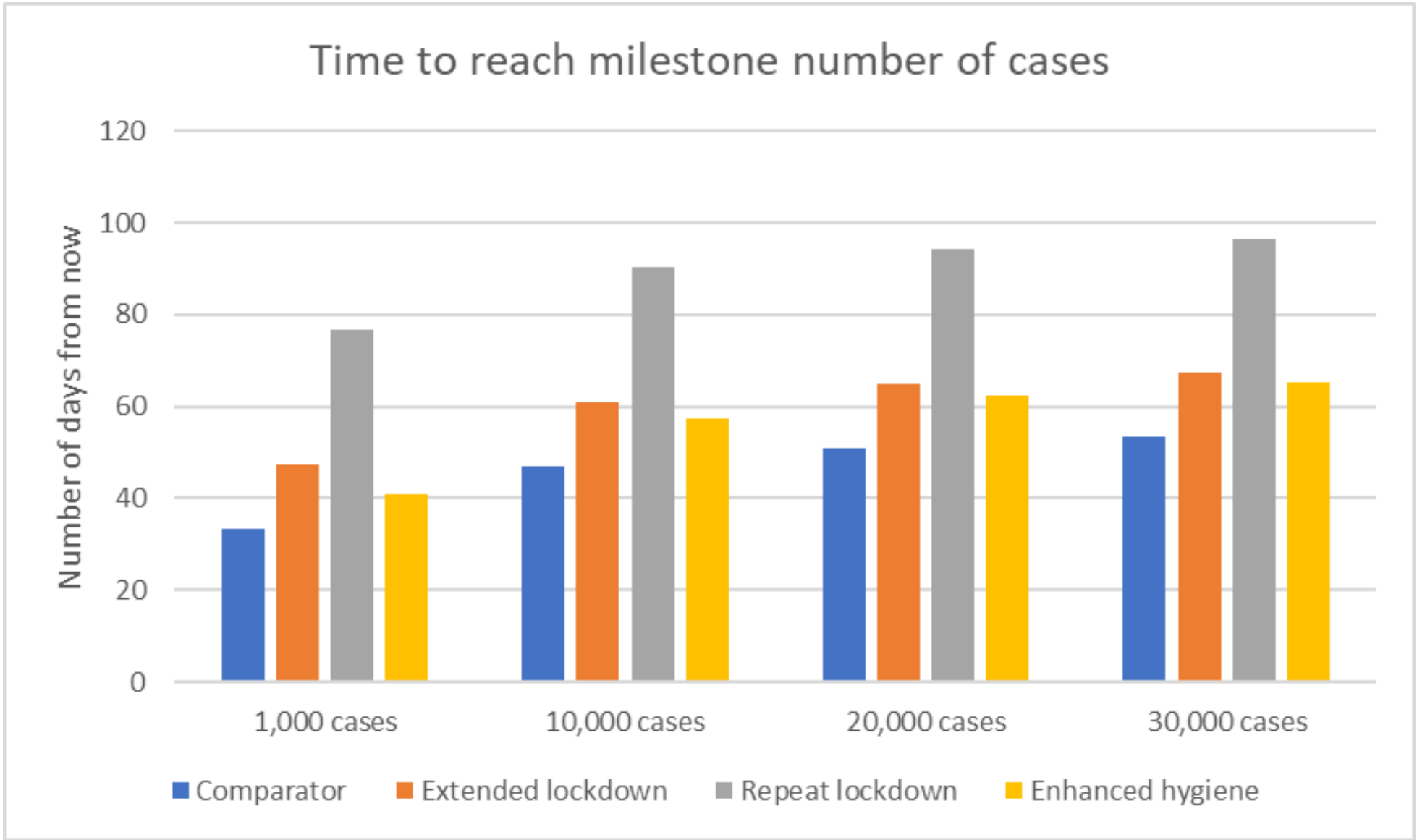


Figure 2: Number of cases, number of deaths and number needing hospital treatment over time for the different intervention scenarios


Time to reach milestone number of cases
Number of days from now
120
100
80
60
40
20
0
1,000 cases
10,000 cases
20,000 cases
30,000 cases
Comparator
Extended lockdown
Repeat lockdown
Enhanced hygiene

Effect of individual interventions

Model 2

Intervention	**Effect over 12 months**
Self-isolation of symptomatic individuals	A maximum of 30% reduction in severe cases if there is 100% reduction in all contacts while having clinical symptoms.
Population-wide physical distancing	Reducing all contacts outside the household by upto 100% could result in a median reduction in severe cases by over 90%. However, this only delays rather than prevent if measures relaxed since there will be insufficient levels of herd-immunity.
Shielding of high-risk individuals	At least 60% reduction in contacts between shielded and unshielded people will achieve ≥10% reduction in severe cases Reduction of severe cases also increased with a higher proportion of ≥ 60 years old shielded.

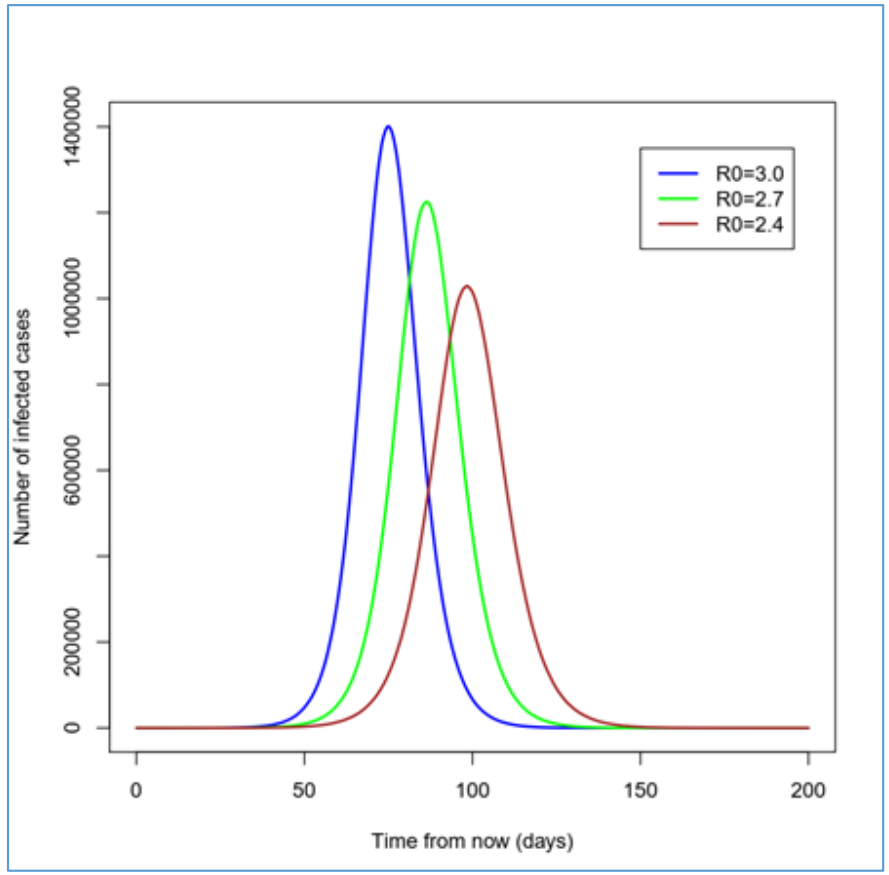
Intervention options for model 2

- Reduction in contacts during symptomatic period
- Reduction in contacts outside household

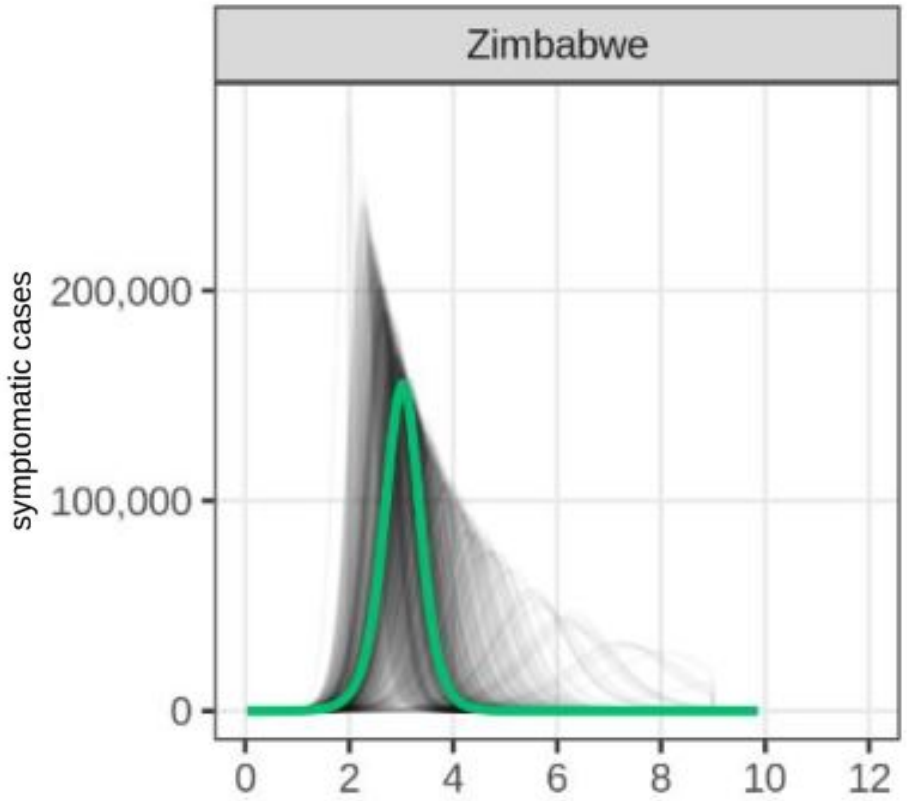
Impact of potential control strategies

Unmitigated scenarios

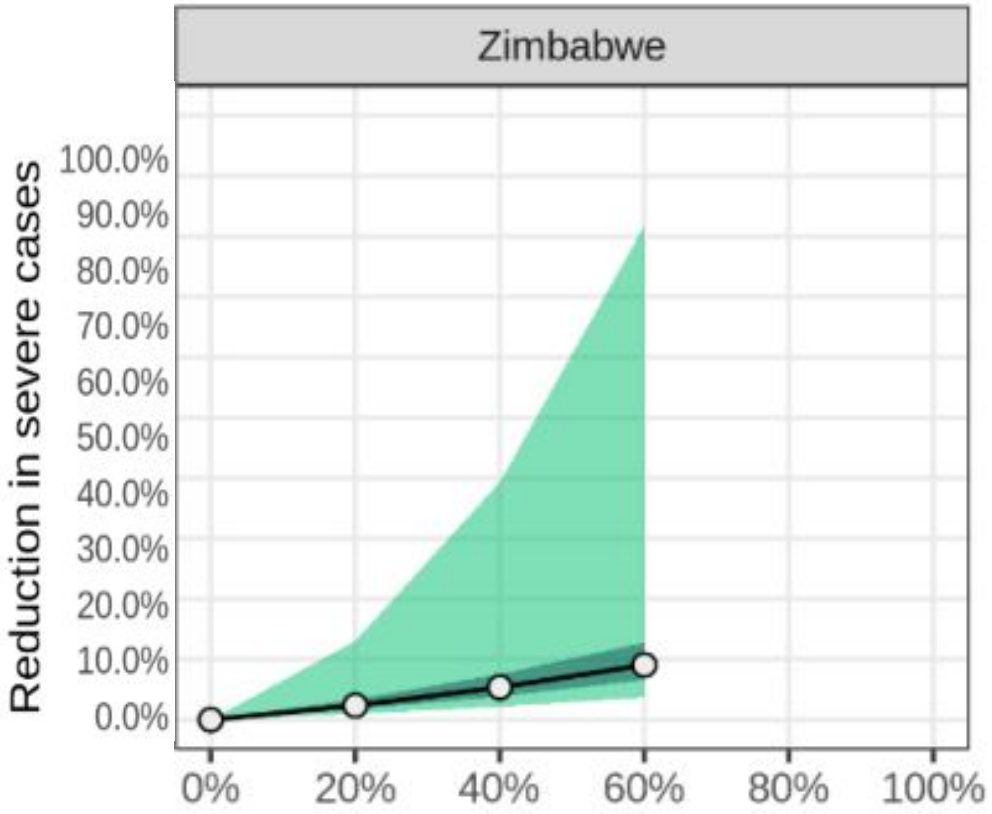
Model 1



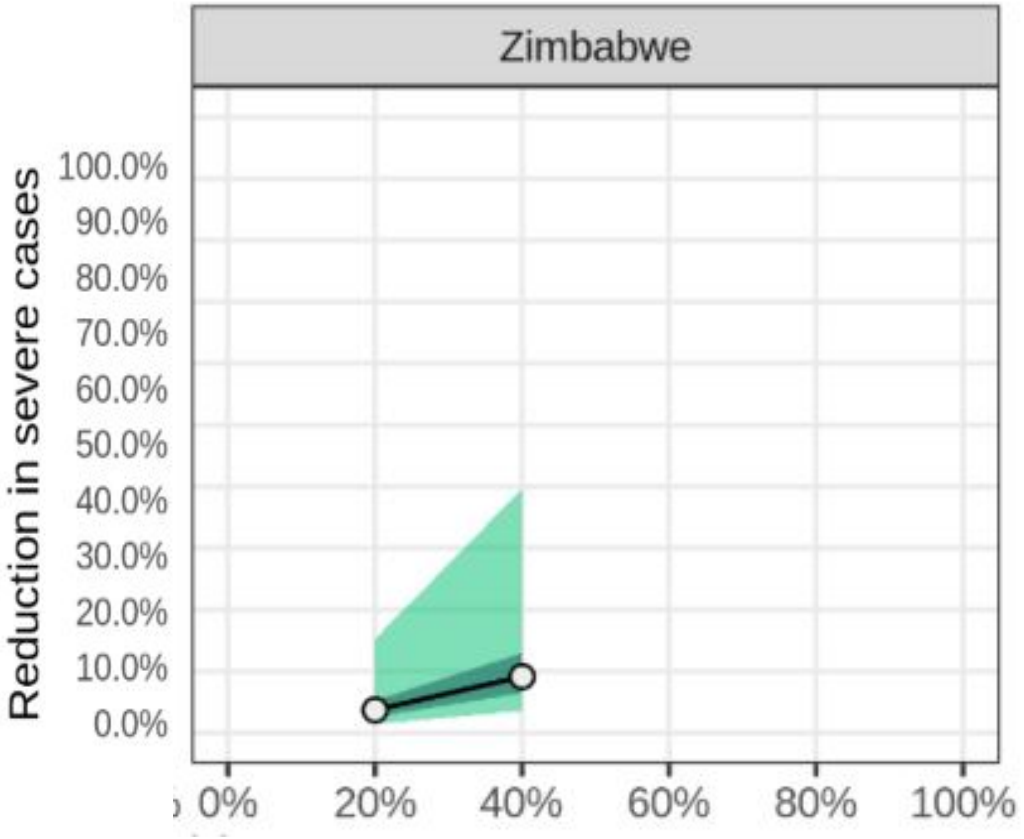
Model 2



Interventions models for model 2



Reduction in contacts during symptomatic period



Reduction in contacts outside household

Interventions models for model 2

- For Niger with population size of around 24 million, a 2 months lockdown + 80% shielding+ 50% distancing, resulted in 8000 deaths.

Interpretation of results

- Self-isolation and moderate physical distancing can be effective interventions.
- The shielding option can be proactively explored to test locally appropriate solutions.
- In the absence of further interventions, lockdowns will delay the peak of transmission, **but will not reduce the peak nor number of deaths**.
- Preventive strategies should therefore be used in combination to reduce the peak of transmission an slowing the pace.