Situation Report for COVID-19: Afghanistan, 2020-07-07

Download the report for Afghanistan, 2020-07-07 here. This report uses data from the European Centre for Disease Control. These data are updated daily and whilst there may be a short delay, they are generally consistent with Ministry reports. These data are then used to back-calculate an 'inferred number of COVID-19 infections' using mathematical modelling techniques (see Report 12 for further details) to estimate the number of people that have been infected and to make short-term projections for future healthcare needs.

Epidemiological Situation

Total Reported Cases	New Reported Cases	Total Reported Deaths	New Reported Deaths	Estimated R_t
33,384	433	920	56	1.16 (95% CI: 1.12-1.2)

The figure below shows the cumulative reported deaths as a function of the time since the 10th death was reported. Dashed lines show the expected trajectory for different doubling times of the epidemic. For example, with a doubling time of 3 days, if there are currently a total of 20 deaths reported, we would expect there to be 40 deaths in total reported in 3 days-time, 80 deaths in 6 days-time, 160 deaths in 9 days-time etc. For most epidemics, in the absence of interventions, we expect a doubling time of 3-4 days for this disease.

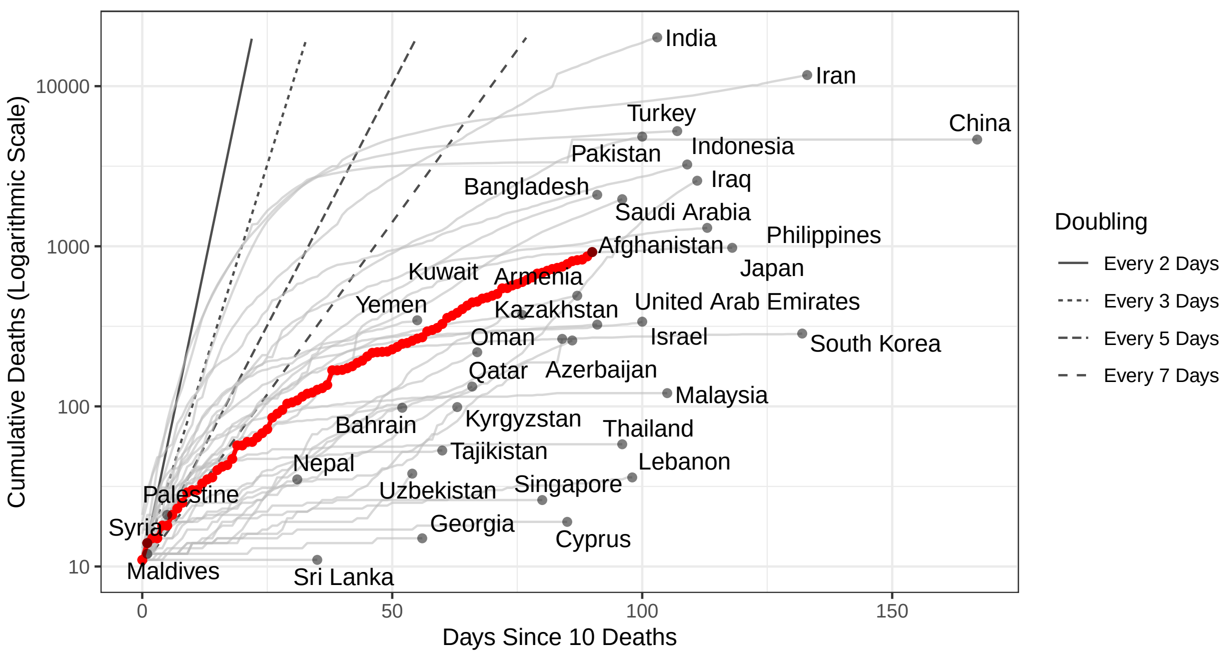

Figure 1: **Cumulative Deaths since 10 deaths.** Country not shown if fewer than 10 deaths.

COVID-19 Transmission Modelling

We assume that the deaths reported to date provide the best indication of the stage of the epidemic, as deaths are more consistently and accurately reported. Our current working estimate is that 1 death indicates that approximately 100 people will have been infected with the other 99 recovering (based on an infection fatality ratio of ~1%). These infections will have happened approximately 21 days previously – capturing a 5-day period from infection to onset of symptoms (the incubation period), 4 days from onset of symptoms to hospitalisation, and 12 days in hospital before death. With a 3-day doubling time, 100 infections that occurred 15 days ago will have generated 200 infections 12 days ago, 400 infections 9 days ago, 800 infections 6 days ago and 1,600 infections 3 days ago resulting in approximately 3,200 infections at the time the first death is observed.

To explore this, we fit our age-structured SEIR model (see Methods) to the time series of deaths in a country, in order to estimate the start date of the epidemic and the baseline R0. We assume that 100% of COVID-19 related deaths have been reported. We have also included the impact of interventions that have been put in place and their effect on human mobility and transmission based on the Google COVID-19 Community Mobility Reports. Using our mathematical model that formalises this approach, we estimate that there has been a total of 311,092 (95% CI: 282,979-339,205) infections over the past 4 weeks.

The figure below shows the estimated number of people infected over the past 4 weeks. The bar charts show, for comparison, the number of reported cases. The right-hand plot shows these data on a different scale as the estimated infections are likely to be much larger than the reported cases. **Importantly**, the estimated infections includes both asymptomatic and mild cases that would not necessarily be identified through surveillance. Consequently, the estimated infections are likely to be significantly higher than the reported cases (see our FAQ for further explanation of these differences and why the reported cases and estimated infections are unlikely to match).

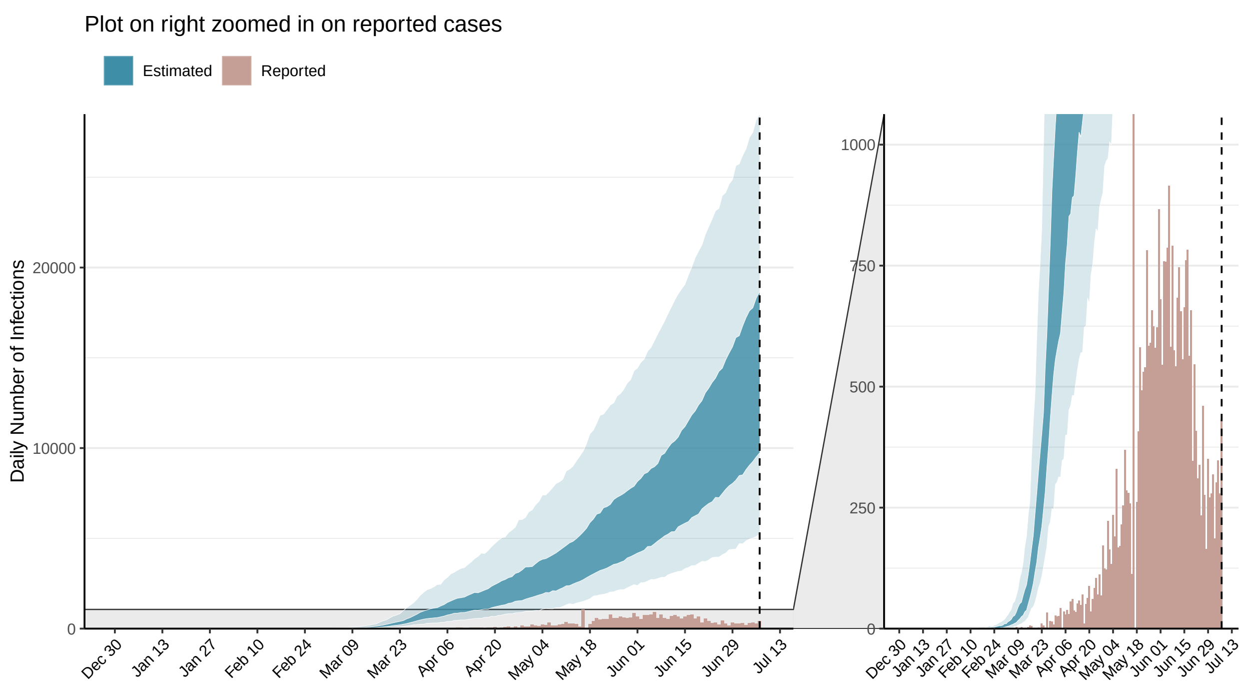

Figure 2: **Daily number of infections estimated by fitting to the current total of deaths.** Reported cases are shown in red. Model estimated infections are shown in blue (dark blue 50% interquartile range, light blue 95% quantile). The dashed line shows the current day.

By fitting to the time series of deaths, we are able to estimate a time-varying reproduction number, R_t. R_t is the the average number of secondary infections caused by a single infected person at a given time. If R_t is above 1, the rate of transmission is increasing and the number of new infections is increasing. R_t is assumed to change in relation to mobility fall in proportion. When fitting our model we assume that 100% of COVID-19 related deaths have been reported (please see our FAQ section for more information about this assumption). We also assume a fixed date at which the impact of mobility on transmission changes from pre-lockdown levels to post-lockdown levels, which may cause large changes in Rt. We are working to refine how this switch occurs and to formally calculate its shape.

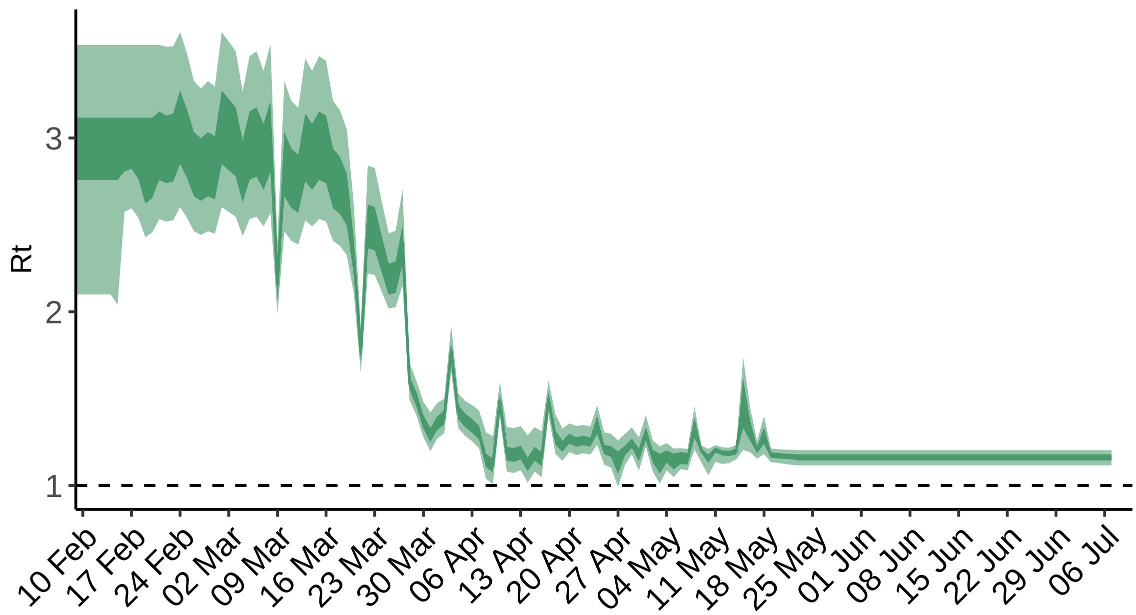

Figure 3: **Time-varying reproduction number, R_t.** R_t is the average number of secondary infections caused by a single infected person at time equal to t. $R_t < 1$ indicates a slowing epidemic in which new infections are not increasing. $R_t > 1$ indicates a growing epidemic in which new infections are increasing over time. Dark green shows the 50% CI and light green shows the 95% CI.

Using the model fit, we can forecast the expected trajectory for cumulative deaths, which is shown in the figure below. This assumes a severity pattern by age that is consistent with that observed in China, Europe and the U.S to date. This projection assumes that transmission is maintained at the current level of transmission as estimated by the final R_t value. **N.B. Afghanistan is forecast to be close to or surpassing our best estimates for healthcare capacity in the next 28 days.** Estimates of deaths in the next 28 days may be inaccurate due to our working assumptions for mortality in individuals who do not receive appropriate treatment. See our methods for more information.

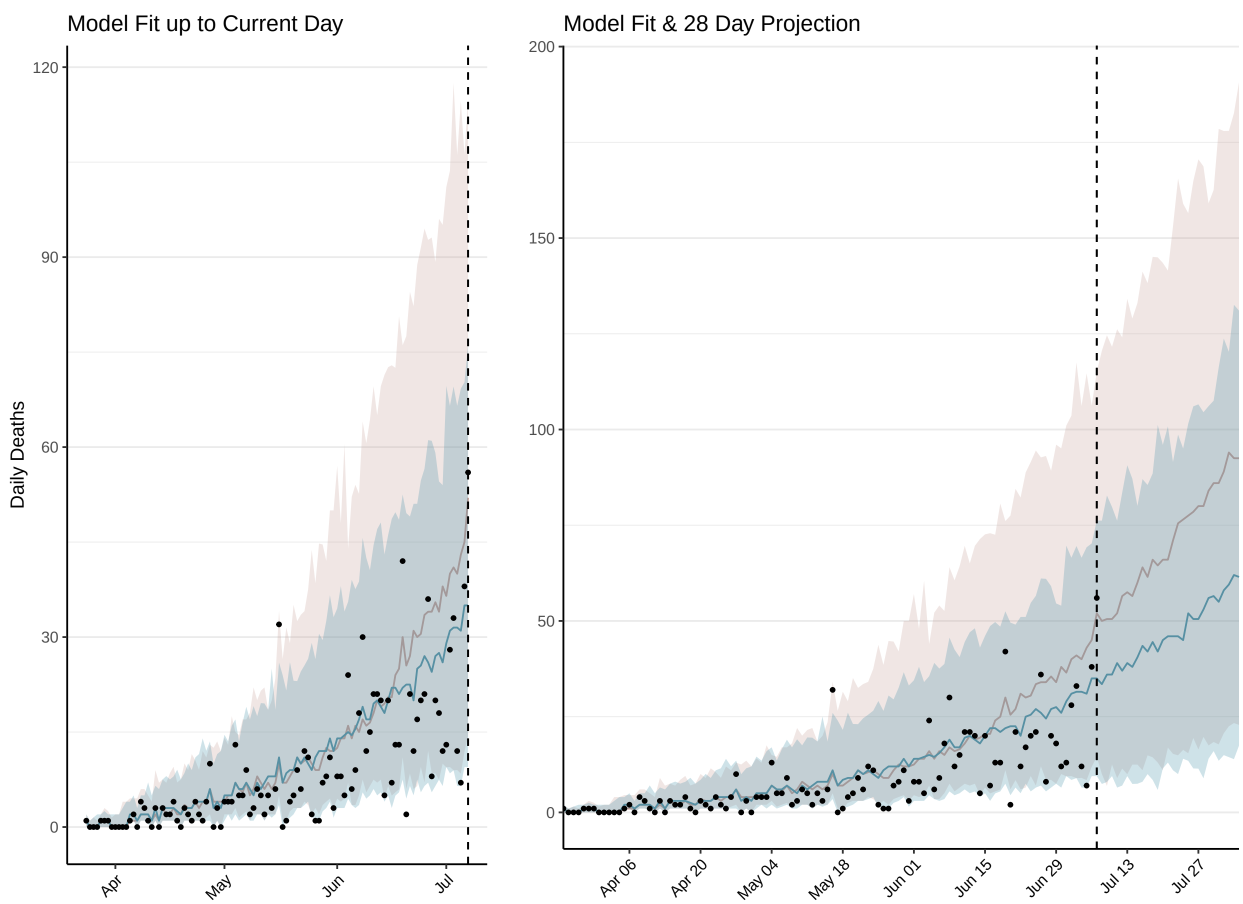

Figure 4: **Estimated daily deaths.** Projected deaths assuming the current level of interventions are maintained are shown in red (median and 95% quantile). Reported deaths are plotted in black. The plot on the left is focussed on the model fit prior to today, while the plot on the right forecasts the next 28 days. The forecasted deaths in blue assumes healthcare capacity has been surged to ensure sufficient supply of ICU and hospital beds. The red curve assumes no surging in healthcare capacity and subsequently projects increased deaths.

Short-term Epidemic Scenarios

We make the following short-term projections of healthcare demand and new infections under the following three scenarios:

- **Scenario 1.** The epidemic continues to grow at the current rate.
- **Scenario 2.** Countries will further scale up interventions (either increasing current strategies or implementing new interventions) leading to a further 50% reduction in transmission.
- **Scenario 3.** Countries will relax current interventions by 50%

N.B. These scenarios currently assume that the impact of mobility on transmission will remain the same in the future as it has in the past. We are working to extend methods to estimate the impact of increases in mobility on transmission as lockdown and interventions are reversed. Consequently, projection are likely to represent an upper estimate of the healthcare demand and case load for each scenario

We estimate that over the next 4 weeks demand for hospital beds will change from 1,748 (95% CI: 1,595-1,900) patients requiring treatment with high-pressure oxygen at the current date to 3,084 (95% CI: 2,835-3,333) hospital beds being required on 2020-08-04 if no further interventions are introduced (Scenario 1). Similarly, we estimate that over the next 4 weeks demand for critical care (ICU) beds will change from 309 (95% CI: 297-321) patients requiring treatment with mechanical ventilation at the current date to 368 (95% CI: 354-382) by 2020-08-04. These projections assume that approximately 5% of all infections will require treatment with high-pressure oxygen and that approximately 30% of hospitalised cases will require treatment with mechanical ventilation (based on analysis of ongoing epidemics in Europe). **N.B. These scenarios are unlikely to show significant differences for the first week since there is a delay of approximately 10 days between infection and hospital admission. Consequently, the effectiveness of a change in policy is likely to be better captured by hospital admission data approximately 2 weeks after the policy change is implemented.**

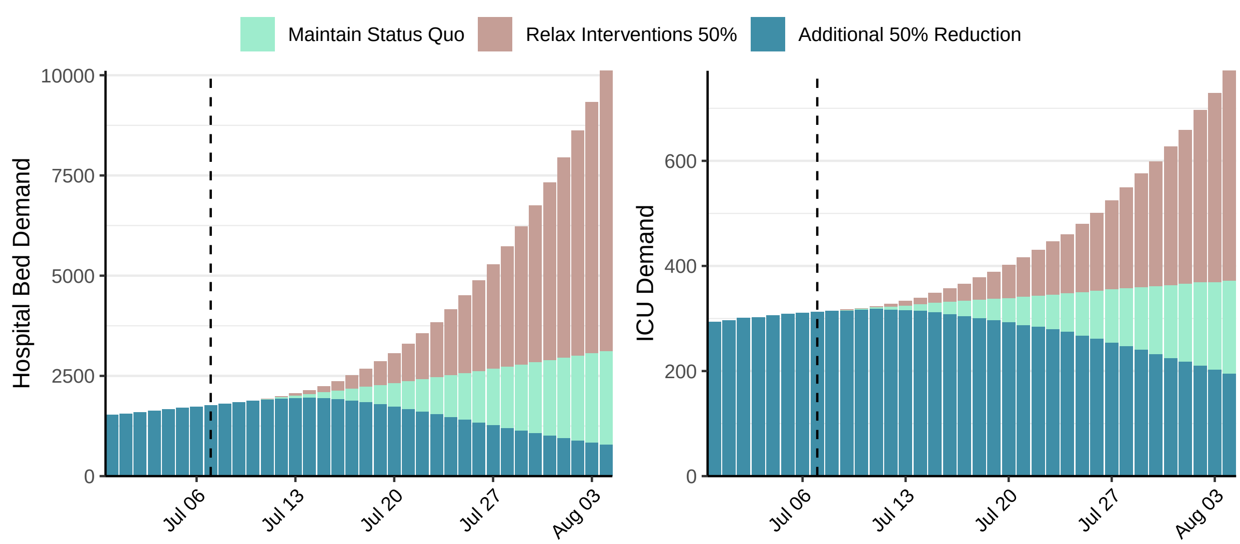

Figure 5: **Healthcare demands in the next 28 days.** Individuals needing an ICU bed are assumed to need mechanical ventilation. Projected demand for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

The impact of each scenario has a more immediate effect on the daily number of infections. The figure below shows the impact of each scenario on the estimated daily incidence of new infections. If interventions are scaled up (Scenario 2), the daily number of infections will change from 14,653 (95% CI: 13,374-15,932) at the current date to 1,985 (95% CI: 1,822-2,147) by 2020-08-04. If current interventions were relaxed by 50%, we estimate the daily number of infections will change from 14,653 (95% CI: 13,374-15,932) at the current date to 146,290 (95% CI: 135,330-157,251) by 2020-08-04.

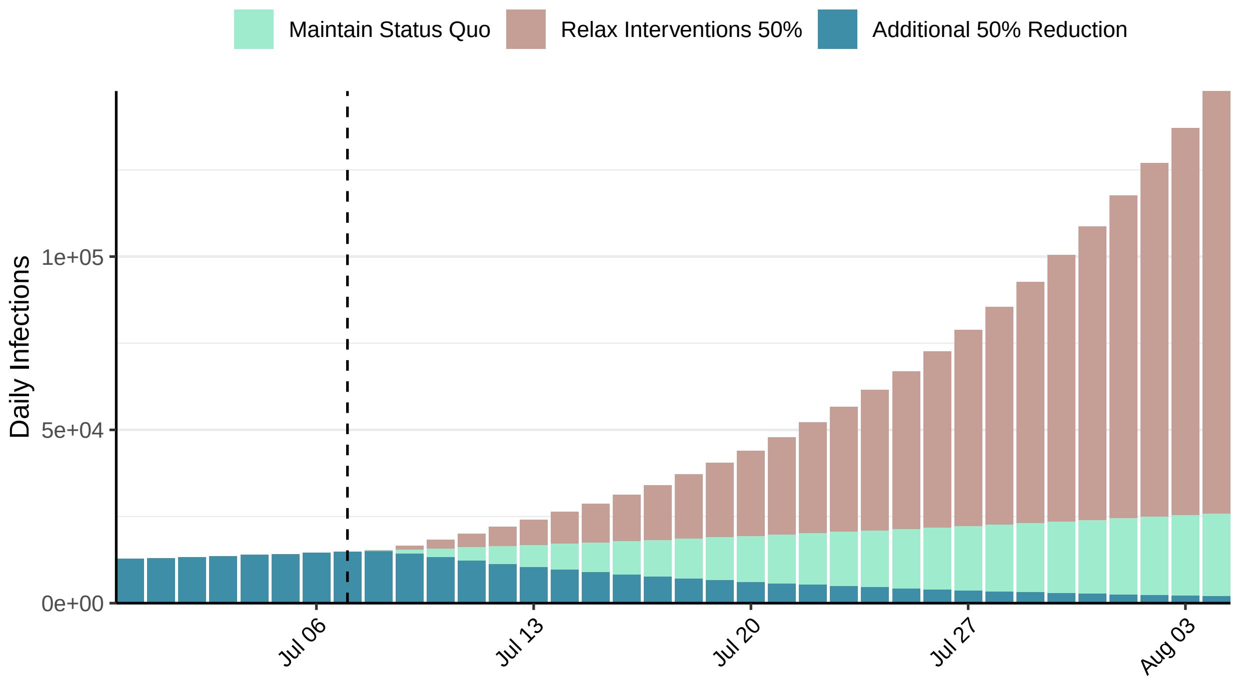

Figure 6: **Daily number of infections estimated by fitting to deaths.** Projected infections for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

To explore different scenarios, we recommend using our COVID-19 Scenario Analysis Tool - https://covidsim.org/, which can be used to simulate different intervention scenarios and explore the long term impact on healthcare demand.

Situation Report for COVID-19: Angola, 2020-07-07

Download the report for Angola, 2020-07-07 here. This report uses data from the European Centre for Disease Control. These data are updated daily and whilst there may be a short delay, they are generally consistent with Ministry reports. These data are then used to back-calculate an 'inferred number of COVID-19 infections' using mathematical modelling techniques (see Report 12 for further details) to estimate the number of people that have been infected and to make short-term projections for future healthcare needs.

Epidemiological Situation

Total Reported Cases	New Reported Cases	Total Reported Deaths	New Reported Deaths	Estimated R_t
353	7	19	0	1.58 (95% CI: 1.3-1.84)

The figure below shows the cumulative reported deaths as a function of the time since the 10th death was reported. Dashed lines show the expected trajectory for different doubling times of the epidemic. For example, with a doubling time of 3 days, if there are currently a total of 20 deaths reported, we would expect there to be 40 deaths in total reported in 3 days-time, 80 deaths in 6 days-time, 160 deaths in 9 days-time etc. For most epidemics, in the absence of interventions, we expect a doubling time of 3-4 days for this disease.

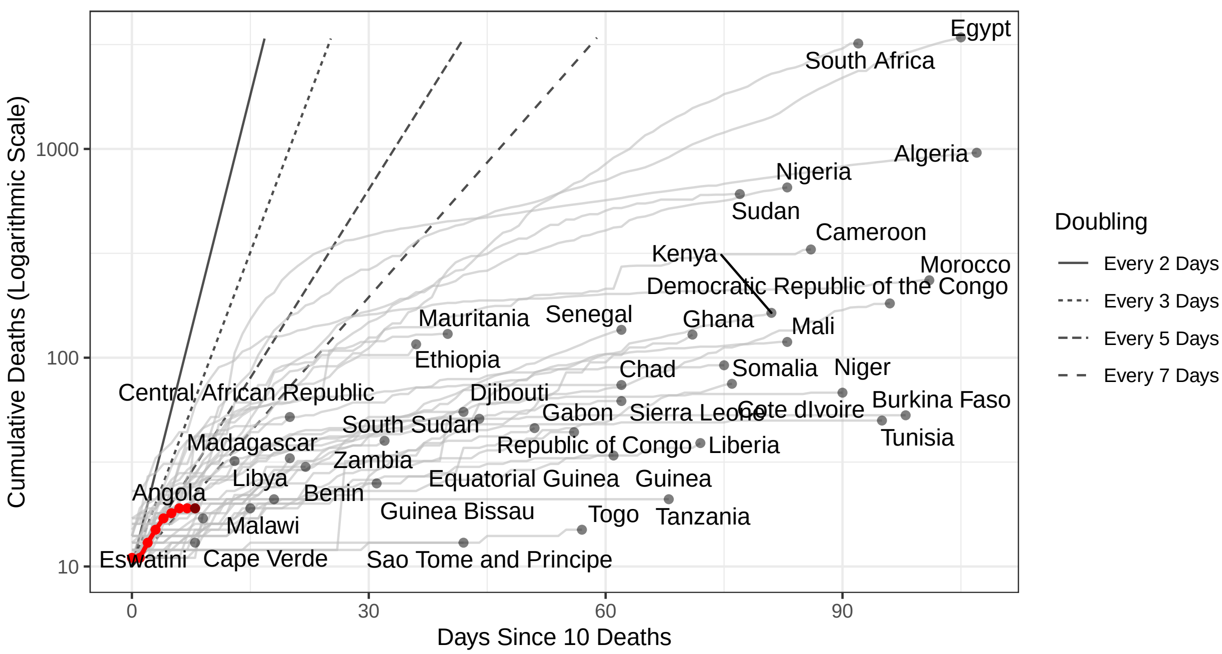

Figure 1: **Cumulative Deaths since 10 deaths.** Country not shown if fewer than 10 deaths.

COVID-19 Transmission Modelling

We assume that the deaths reported to date provide the best indication of the stage of the epidemic, as deaths are more consistently and accurately reported. Our current working estimate is that 1 death indicates that approximately 100 people will have been infected with the other 99 recovering (based on an infection fatality ratio of ~1%). These infections will have happened approximately 21 days previously – capturing a 5-day period from infection to onset of symptoms (the incubation period), 4 days from onset of symptoms to hospitalisation, and 12 days in hospital before death. With a 3-day doubling time, 100 infections that occurred 15 days ago will have generated 200 infections 12 days ago, 400 infections 9 days ago, 800 infections 6 days ago and 1,600 infections 3 days ago resulting in approximately 3,200 infections at the time the first death is observed.

To explore this, we fit our age-structured SEIR model (see Methods) to the time series of deaths in a country, in order to estimate the start date of the epidemic and the baseline R0. We assume that 100% of COVID-19 related deaths have been reported. We have also included the impact of interventions that have been put in place and their effect on human mobility and transmission based on the Google COVID-19 Community Mobility Reports. Using our mathematical model that formalises this approach, we estimate that there has been a total of 20,195 (95% CI: 16,908-23,482) infections over the past 4 weeks.

The figure below shows the estimated number of people infected over the past 4 weeks. The bar charts show, for comparison, the number of reported cases. The right-hand plot shows these data on a different scale as the estimated infections are likely to be much larger than the reported cases. **Importantly**, the estimated infections includes both asymptomatic and mild cases that would not necessarily be identified through surveillance. Consequently, the estimated infections are likely to be significantly higher than the reported cases (see our FAQ for further explanation of these differences and why the reported cases and estimated infections are unlikely to match).

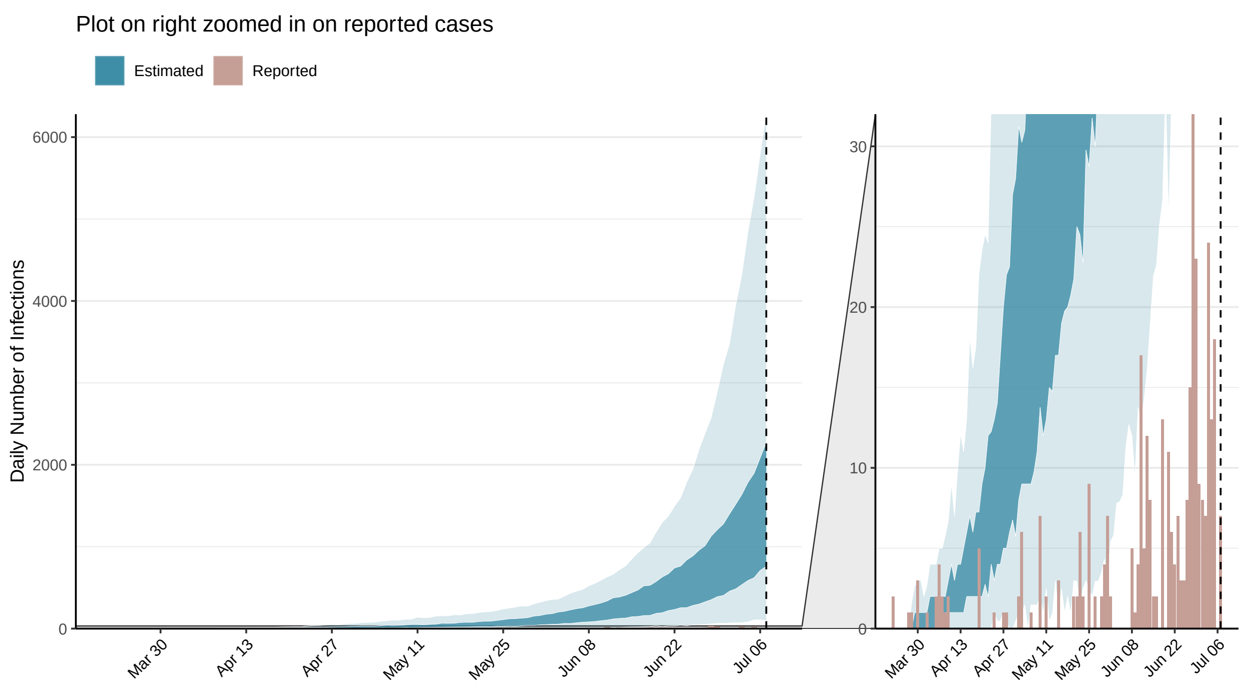

Figure 2: **Daily number of infections estimated by fitting to the current total of deaths.** Reported cases are shown in red. Model estimated infections are shown in blue (dark blue 50% interquartile range, light blue 95% quantile). The dashed line shows the current day.

By fitting to the time series of deaths, we are able to estimate a time-varying reproduction number, R_t. R_t is the the average number of secondary infections caused by a single infected person at a given time. If R_t is above 1, the rate of transmission is increasing and the number of new infections is increasing. R_t is assumed to change in relation to mobility fall in proportion. When fitting our model we assume that 100% of COVID-19 related deaths have been reported (please see our FAQ section for more information about this assumption). We also assume a fixed date at which the impact of mobility on transmission changes from pre-lockdown levels to post-lockdown levels, which may cause large changes in Rt. We are working to refine how this switch occurs and to formally calculate its shape.

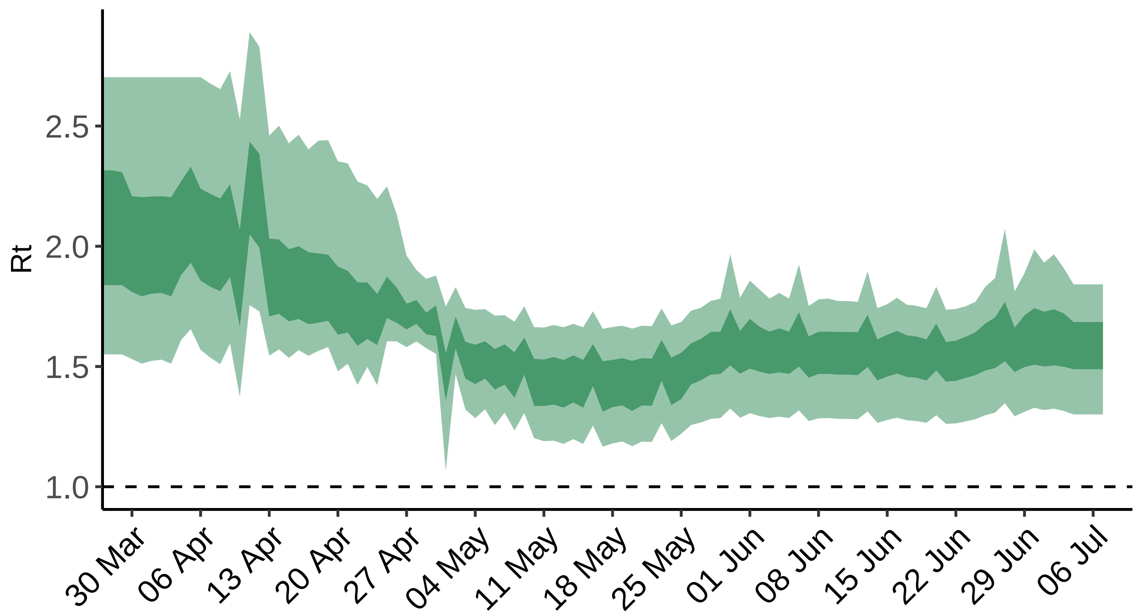

Figure 3: **Time-varying reproduction number, R_t.** R_t is the average number of secondary infections caused by a single infected person at time equal to t. $R_t < 1$ indicates a slowing epidemic in which new infections are not increasing. $R_t > 1$ indicates a growing epidemic in which new infections are increasing over time. Dark green shows the 50% CI and light green shows the 95% CI.

Using the model fit, we can forecast the expected trajectory for cumulative deaths, which is shown in the figure below. This assumes a severity pattern by age that is consistent with that observed in China, Europe and the U.S to date. This projection assumes that transmission is maintained at the current level of transmission as estimated by the final R_t value.

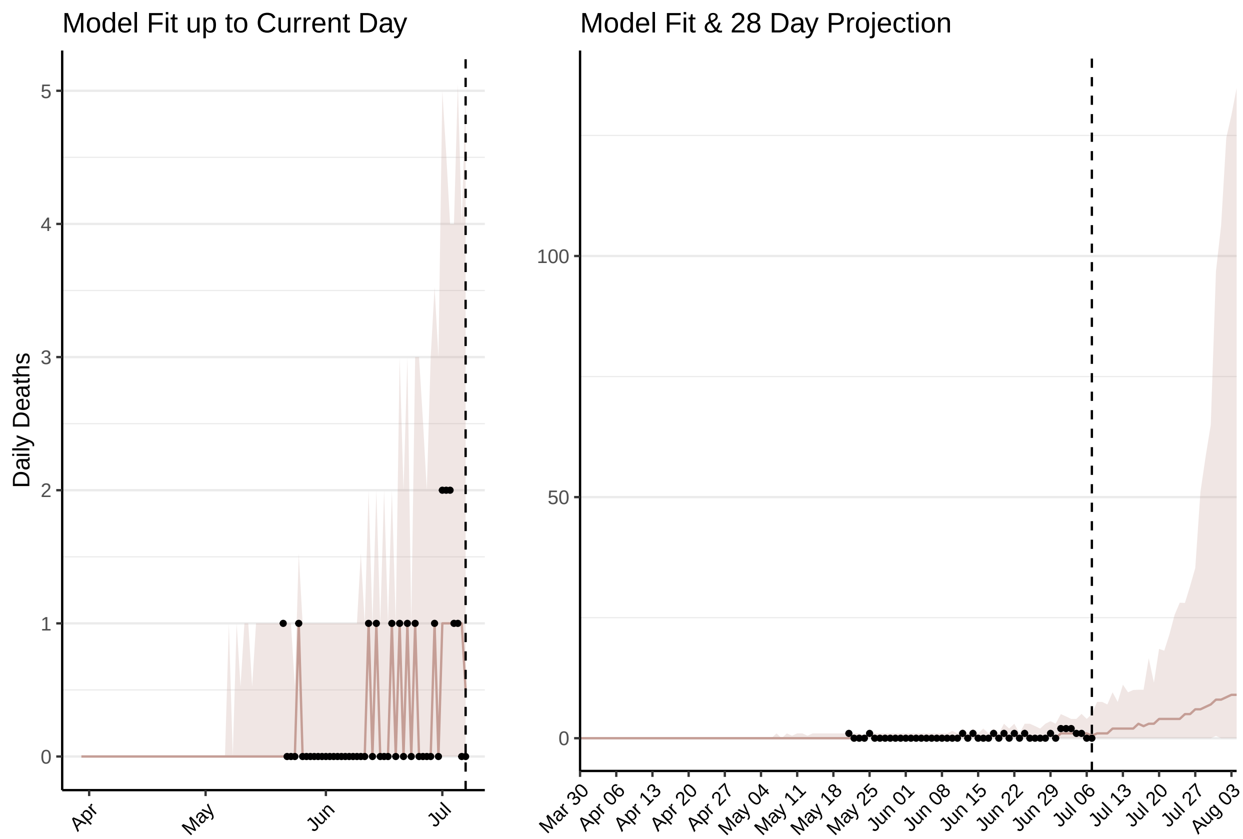

Figure 4: **Estimated daily deaths.** Projected deaths assuming the current level of interventions are maintained are shown in red (median and 95% quantile). Reported deaths are plotted in black. The plot on the left is focussed on the model fit prior to today, while the plot on the right forecasts the next 28 days.

Short-term Epidemic Scenarios

We make the following short-term projections of healthcare demand and new infections under the following three scenarios:

- **Scenario 1.** The epidemic continues to grow at the current rate.
- **Scenario 2.** Countries will further scale up interventions (either increasing current strategies or implementing new interventions) leading to a further 50% reduction in transmission.
- **Scenario 3.** Countries will relax current interventions by 50%

N.B. These scenarios currently assume that the impact of mobility on transmission will remain the same in the future as it has in the past. We are working to extend methods to estimate the impact of increases in mobility on transmission as lockdown and interventions are reversed. Consequently, projection are likely to represent an upper estimate of the healthcare demand and case load for each scenario

We estimate that over the next 4 weeks demand for hospital beds will change from 110 (95% CI: 92-129) patients requiring treatment with high-pressure oxygen at the current date to 1,043 (95% CI: 808-1,279) hospital beds being required on 2020-08-04 if no further interventions are introduced (Scenario 1). Similarly, we estimate that over the next 4 weeks demand for critical care (ICU) beds will change from 27 (95% CI: 23-32) patients requiring treatment with mechanical ventilation at the current date to 233 (95% CI: 192-274) by 2020-08-04. These projections assume that approximately 5% of all infections will require treatment with high-pressure oxygen and that approximately 30% of hospitalised cases will require treatment with mechanical ventilation (based on analysis of ongoing epidemics in Europe). **N.B. These scenarios are unlikely to show significant differences for the first week since there is a delay of approximately 10 days between infection and hospital admission. Consequently, the effectiveness of a change in policy is likely to be better captured by hospital admission data approximately 2 weeks after the policy change is implemented.**

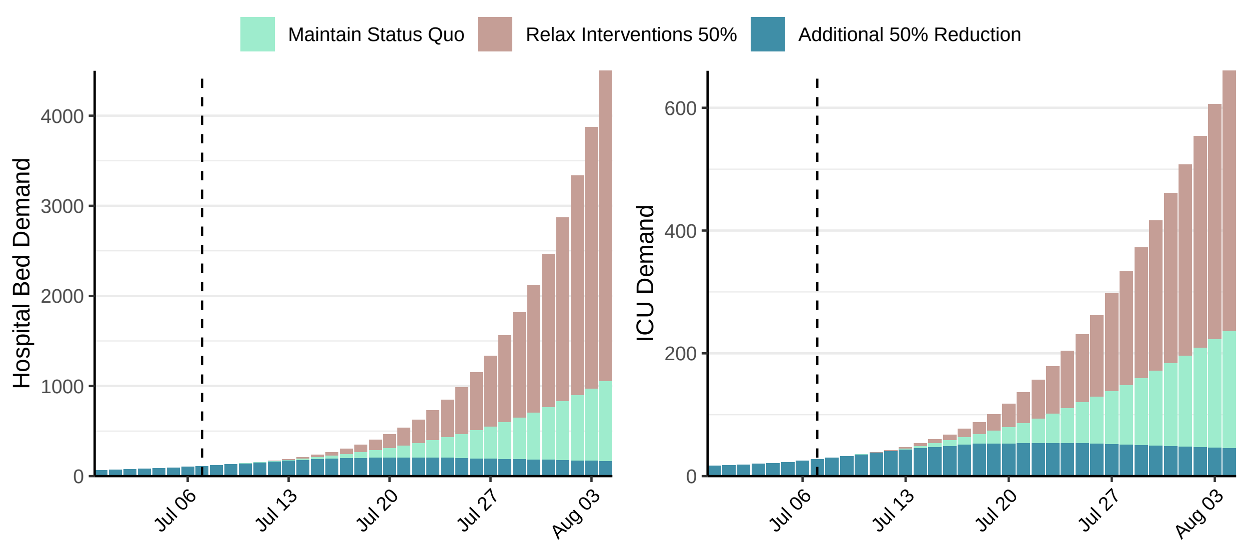

Figure 5: **Healthcare demands in the next 28 days.** Individuals needing an ICU bed are assumed to need mechanical ventilation. Projected demand for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

The impact of each scenario has a more immediate effect on the daily number of infections. The figure below shows the impact of each scenario on the estimated daily incidence of new infections. If interventions are scaled up (Scenario 2), the daily number of infections will change from 1,716 (95% CI: 1,408-2,024) at the current date to 899 (95% CI: 686-1,113) by 2020-08-04. If current interventions were relaxed by 50%, we estimate the daily number of infections will change from 1,716 (95% CI: 1,408-2,024) at the current date to 118,408 (95% CI: 90,974-145,842) by 2020-08-04.

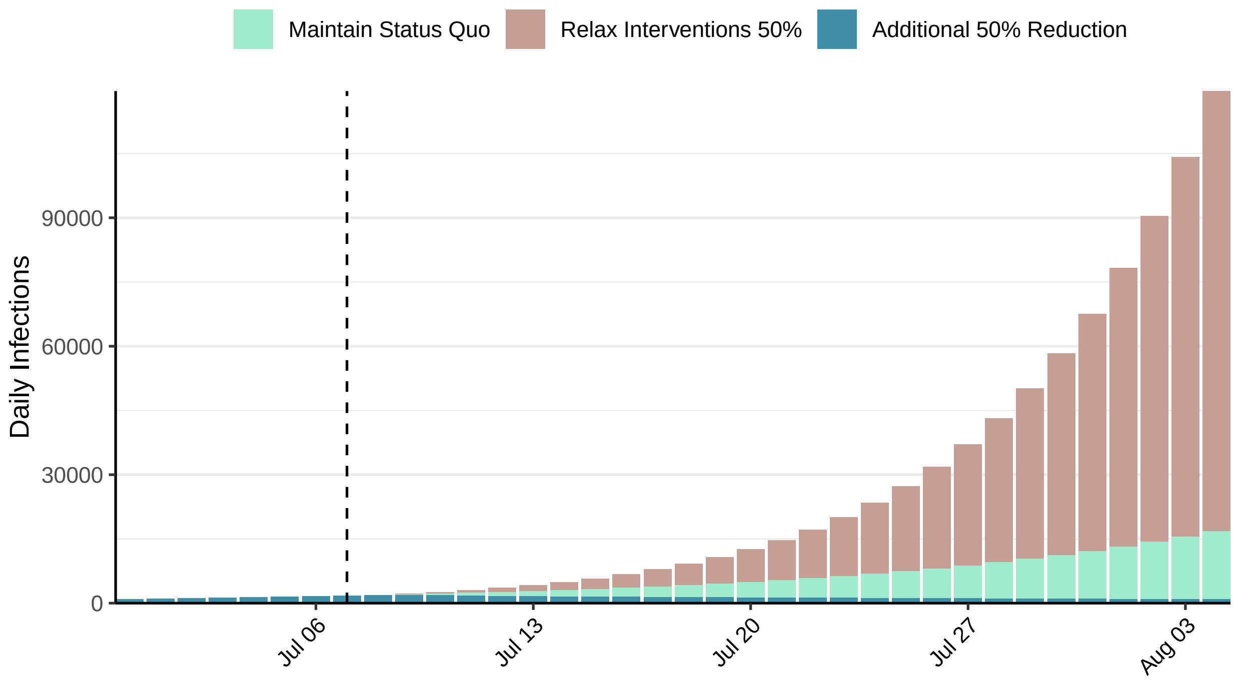

Figure 6: **Daily number of infections estimated by fitting to deaths.** Projected infections for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

To explore different scenarios, we recommend using our COVID-19 Scenario Analysis Tool - https://covidsim.org/, which can be used to simulate different intervention scenarios and explore the long term impact on healthcare demand.

Situation Report for COVID-19: Albania, 2020-07-07

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Epidemiological Situation

Total Reported Cases	New Reported Cases	Total Reported Deaths	New Reported Deaths	Estimated R_t
2,964	71	79	3	1.65 (95% CI: 1.52-1.77)

The figure below shows the cumulative reported deaths as a function of the time since the 10th death was reported. Dashed lines show the expected trajectory for different doubling times of the epidemic. For example, with a doubling time of 3 days, if there are currently a total of 20 deaths reported, we would expect there to be 40 deaths in total reported in 3 days-time, 80 deaths in 6 days-time, 160 deaths in 9 days-time etc. For most epidemics, in the absence of interventions, we expect a doubling time of 3-4 days for this disease.

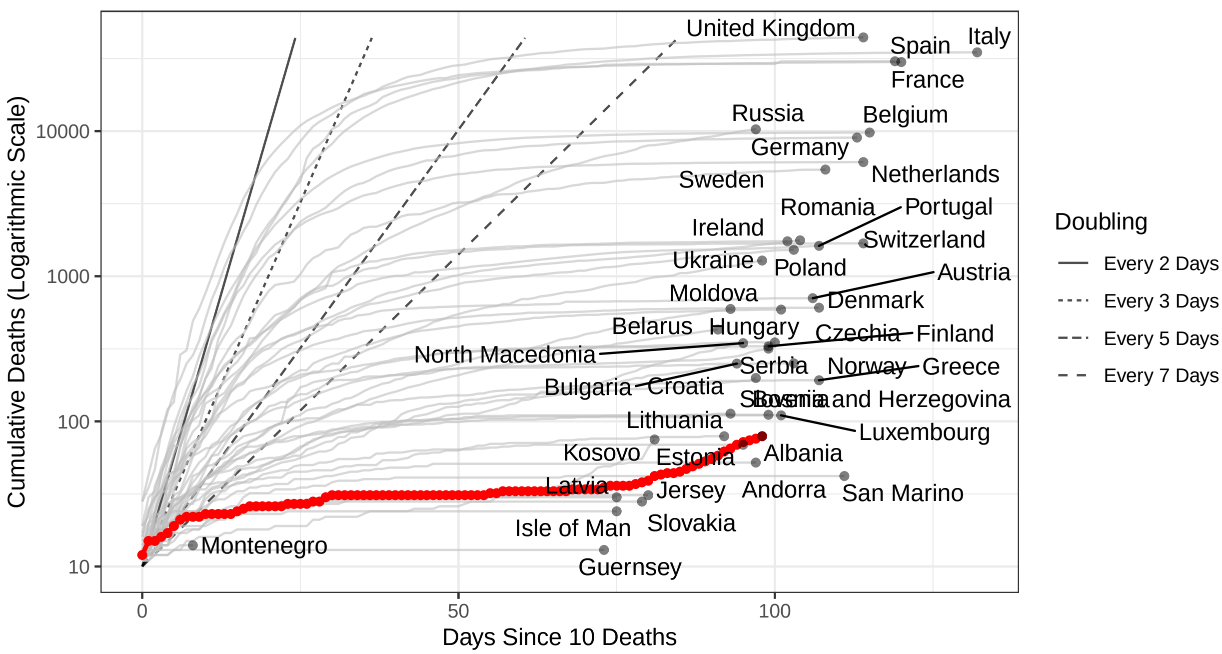

Figure 1: **Cumulative Deaths since 10 deaths.** Country not shown if fewer than 10 deaths.

COVID-19 Transmission Modelling

We assume that the deaths reported to date provide the best indication of the stage of the epidemic, as deaths are more consistently and accurately reported. Our current working estimate is that 1 death indicates that approximately 100 people will have been infected with the other 99 recovering (based on an infection fatality ratio of ~1%). These infections will have happened approximately 21 days previously – capturing a 5-day period from infection to onset of symptoms (the incubation period), 4 days from onset of symptoms to hospitalisation, and 12 days in hospital before death. With a 3-day doubling time, 100 infections that occurred 15 days ago will have generated 200 infections 12 days ago, 400 infections 9 days ago, 800 infections 6 days ago and 1,600 infections 3 days ago resulting in approximately 3,200 infections at the time the first death is observed.

To explore this, we fit our age-structured SEIR model (see Methods) to the time series of deaths in a country, in order to estimate the start date of the epidemic and the baseline R0. We assume that 100% of COVID-19 related deaths have been reported. We have also included the impact of interventions that have been put in place and their effect on human mobility and transmission based on the Google COVID-19 Community Mobility Reports. Using our mathematical model that formalises this approach, we estimate that there has been a total of 26,316 (95% CI: 23,129-29,502) infections over the past 4 weeks.

The figure below shows the estimated number of people infected over the past 4 weeks. The bar charts show, for comparison, the number of reported cases. The right-hand plot shows these data on a different scale as the estimated infections are likely to be much larger than the reported cases. **Importantly**, the estimated infections includes both asymptomatic and mild cases that would not necessarily be identified through surveillance. Consequently, the estimated infections are likely to be significantly higher than the reported cases (see our FAQ for further explanation of these differences and why the reported cases and estimated infections are unlikely to match).

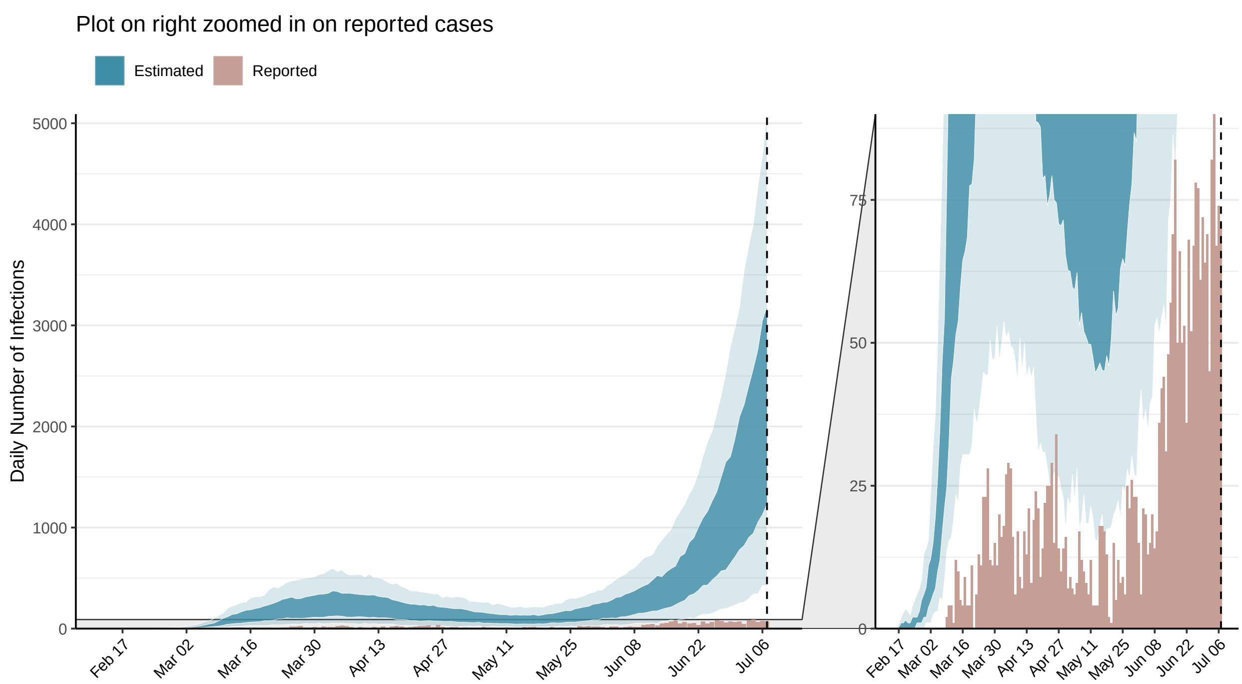

Figure 2: **Daily number of infections estimated by fitting to the current total of deaths.** Reported cases are shown in red. Model estimated infections are shown in blue (dark blue 50% interquartile range, light blue 95% quantile). The dashed line shows the current day.

By fitting to the time series of deaths, we are able to estimate a time-varying reproduction number, R_t. R_t is the the average number of secondary infections caused by a single infected person at a given time. If R_t is above 1, the rate of transmission is increasing and the number of new infections is increasing. R_t is assumed to change in relation to mobility fall in proportion. When fitting our model we assume that 100% of COVID-19 related deaths have been reported (please see our FAQ section for more information about this assumption). We also assume a fixed date at which the impact of mobility on transmission changes from pre-lockdown levels to post-lockdown levels, which may cause large changes in Rt. We are working to refine how this switch occurs and to formally calculate its shape.

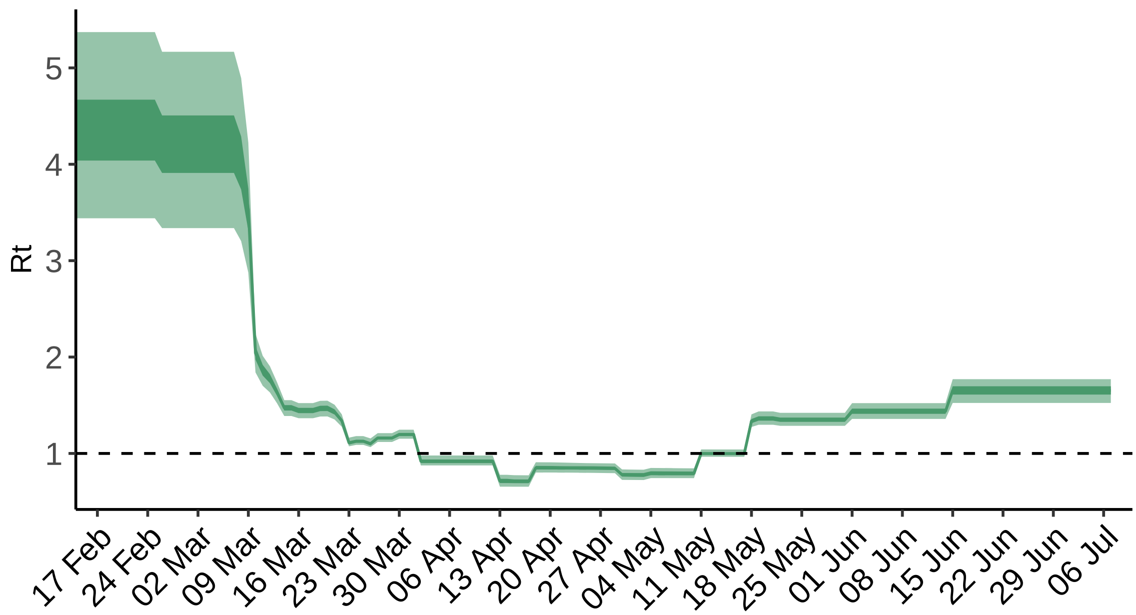

Figure 3: **Time-varying reproduction number, R_t.** R_t is the average number of secondary infections caused by a single infected person at time equal to t. $R_t < 1$ indicates a slowing epidemic in which new infections are not increasing. $R_t > 1$ indicates a growing epidemic in which new infections are increasing over time. Dark green shows the 50% CI and light green shows the 95% CI.

Using the model fit, we can forecast the expected trajectory for cumulative deaths, which is shown in the figure below. This assumes a severity pattern by age that is consistent with that observed in China, Europe and the U.S to date. This projection assumes that transmission is maintained at the current level of transmission as estimated by the final R_t value.

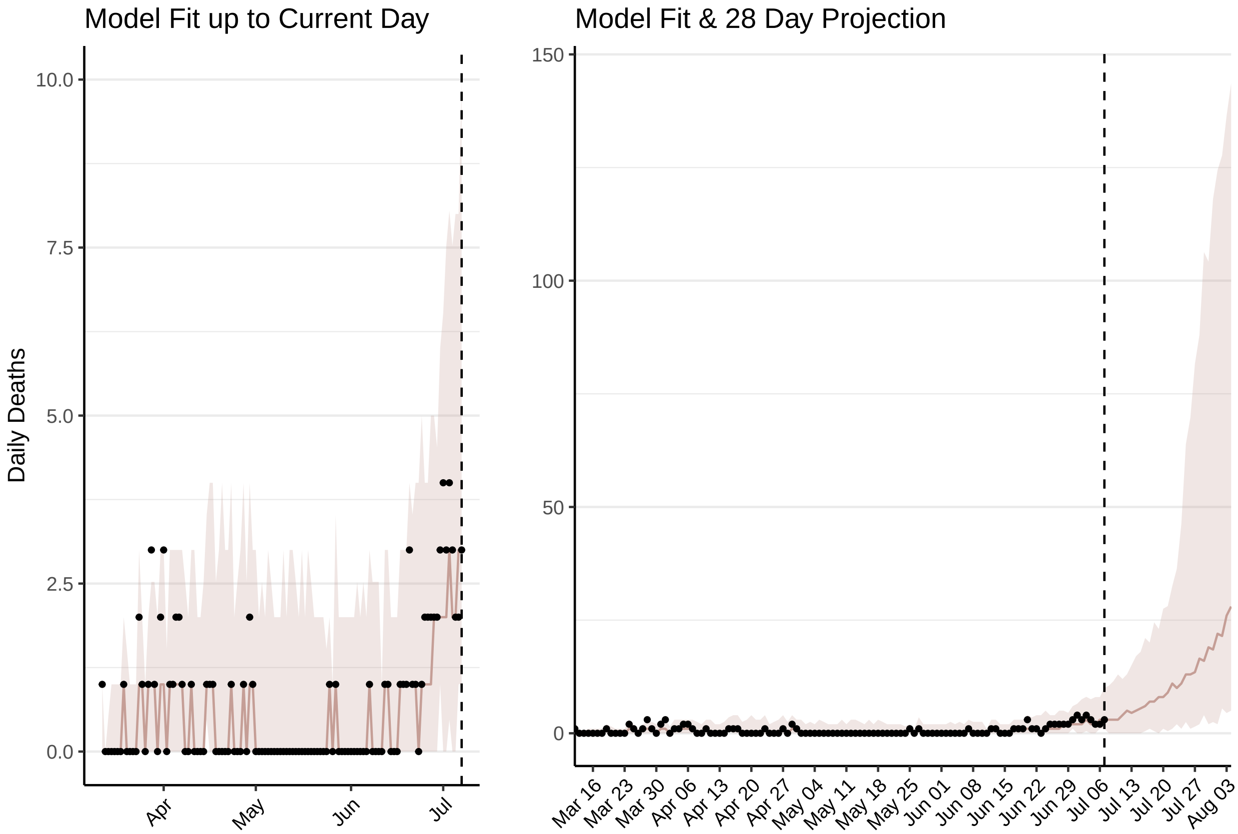

Figure 4: **Estimated daily deaths.** Projected deaths assuming the current level of interventions are maintained are shown in red (median and 95% quantile). Reported deaths are plotted in black. The plot on the left is focussed on the model fit prior to today, while the plot on the right forecasts the next 28 days.

Short-term Epidemic Scenarios

We make the following short-term projections of healthcare demand and new infections under the following three scenarios:

- **Scenario 1.** The epidemic continues to grow at the current rate.
- **Scenario 2.** Countries will further scale up interventions (either increasing current strategies or implementing new interventions) leading to a further 50% reduction in transmission.
- **Scenario 3.** Countries will relax current interventions by 50%

N.B. These scenarios currently assume that the impact of mobility on transmission will remain the same in the future as it has in the past. We are working to extend methods to estimate the impact of increases in mobility on transmission as lockdown and interventions are reversed. Consequently, projection are likely to represent an upper estimate of the healthcare demand and case load for each scenario

We estimate that over the next 4 weeks demand for hospital beds will change from 211 (95% CI: 185-238) patients requiring treatment with high-pressure oxygen at the current date to 1,695 (95% CI: 1,499-1,890) hospital beds being required on 2020-08-04 if no further interventions are introduced (Scenario 1). Similarly, we estimate that over the next 4 weeks demand for critical care (ICU) beds will change from 58 (95% CI: 50-66) patients requiring treatment with mechanical ventilation at the current date to 377 (95% CI: 347-407) by 2020-08-04. These projections assume that approximately 5% of all infections will require treatment with high-pressure oxygen and that approximately 30% of hospitalised cases will require treatment with mechanical ventilation (based on analysis of ongoing epidemics in Europe). **N.B. These scenarios are unlikely to show significant differences for the first week since there is a delay of approximately 10 days between infection and hospital admission. Consequently, the effectiveness of a change in policy is likely to be better captured by hospital admission data approximately 2 weeks after the policy change is implemented.**

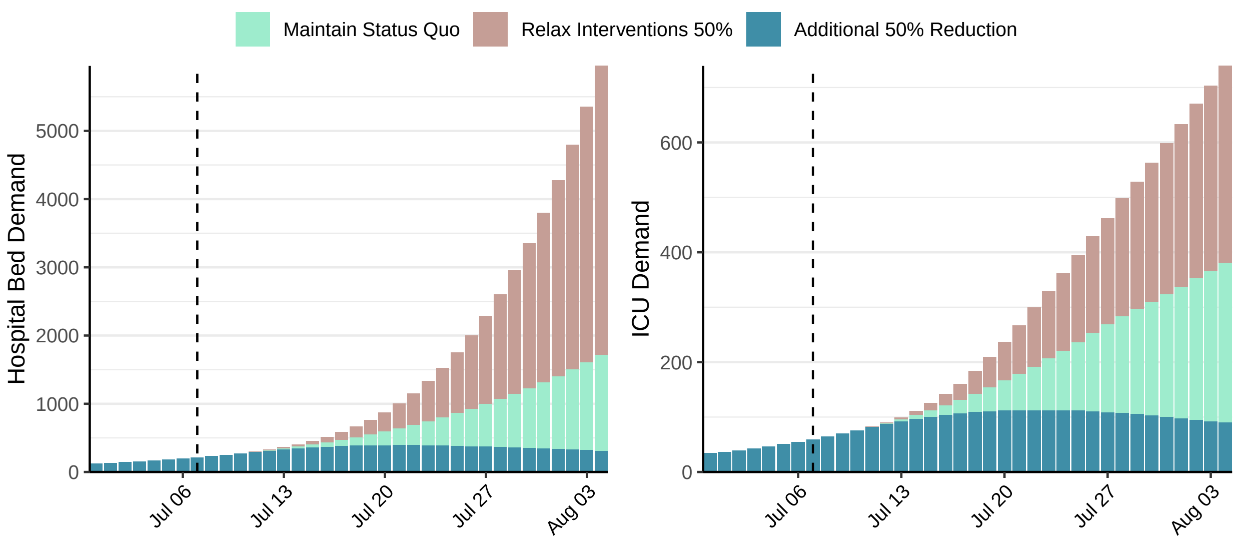

Figure 5: **Healthcare demands in the next 28 days.** Individuals needing an ICU bed are assumed to need mechanical ventilation. Projected demand for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

The impact of each scenario has a more immediate effect on the daily number of infections. The figure below shows the impact of each scenario on the estimated daily incidence of new infections. If interventions are scaled up (Scenario 2), the daily number of infections will change from 2,232 (95% CI: 1,960-2,503) at the current date to 1,006 (95% CI: 884-1,127) by 2020-08-04. If current interventions were relaxed by 50%, we estimate the daily number of infections will change from 2,232 (95% CI: 1,960-2,503) at the current date to 59,490 (95% CI: 55,928-63,052) by 2020-08-04.

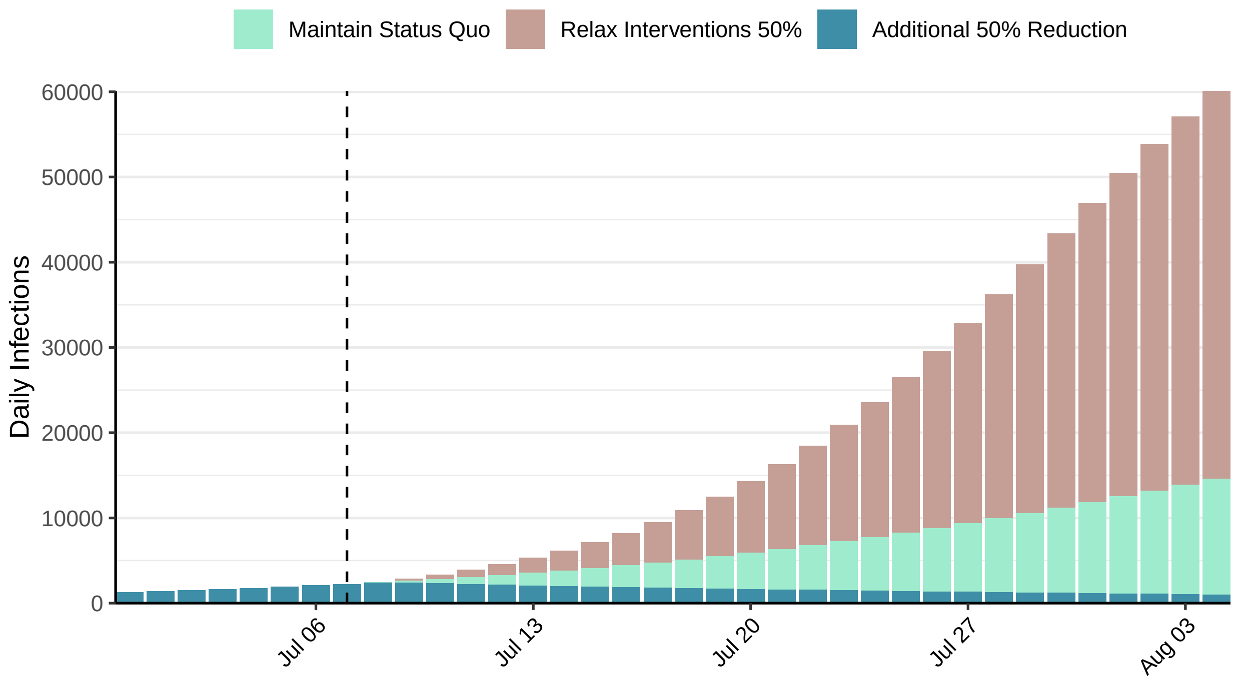

Figure 6: **Daily number of infections estimated by fitting to deaths.** Projected infections for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

To explore different scenarios, we recommend using our COVID-19 Scenario Analysis Tool - https://covidsim.org/, which can be used to simulate different intervention scenarios and explore the long term impact on healthcare demand.

Situation Report for COVID-19: Argentina, 2020-07-07

Download the report for Argentina, 2020-07-07 here. This report uses data from the European Centre for Disease Control. These data are updated daily and whilst there may be a short delay, they are generally consistent with Ministry reports. These data are then used to back-calculate an 'inferred number of COVID-19 infections' using mathematical modelling techniques (see Report 12 for further details) to estimate the number of people that have been infected and to make short-term projections for future healthcare needs.

Epidemiological Situation

Total Reported Cases	New Reported Cases	Total Reported Deaths	New Reported Deaths	Estimated R_t
77,802	2,439	1,523	33	1.25 (95% CI: 1.16-1.33)

The figure below shows the cumulative reported deaths as a function of the time since the 10th death was reported. Dashed lines show the expected trajectory for different doubling times of the epidemic. For example, with a doubling time of 3 days, if there are currently a total of 20 deaths reported, we would expect there to be 40 deaths in total reported in 3 days-time, 80 deaths in 6 days-time, 160 deaths in 9 days-time etc. For most epidemics, in the absence of interventions, we expect a doubling time of 3-4 days for this disease.

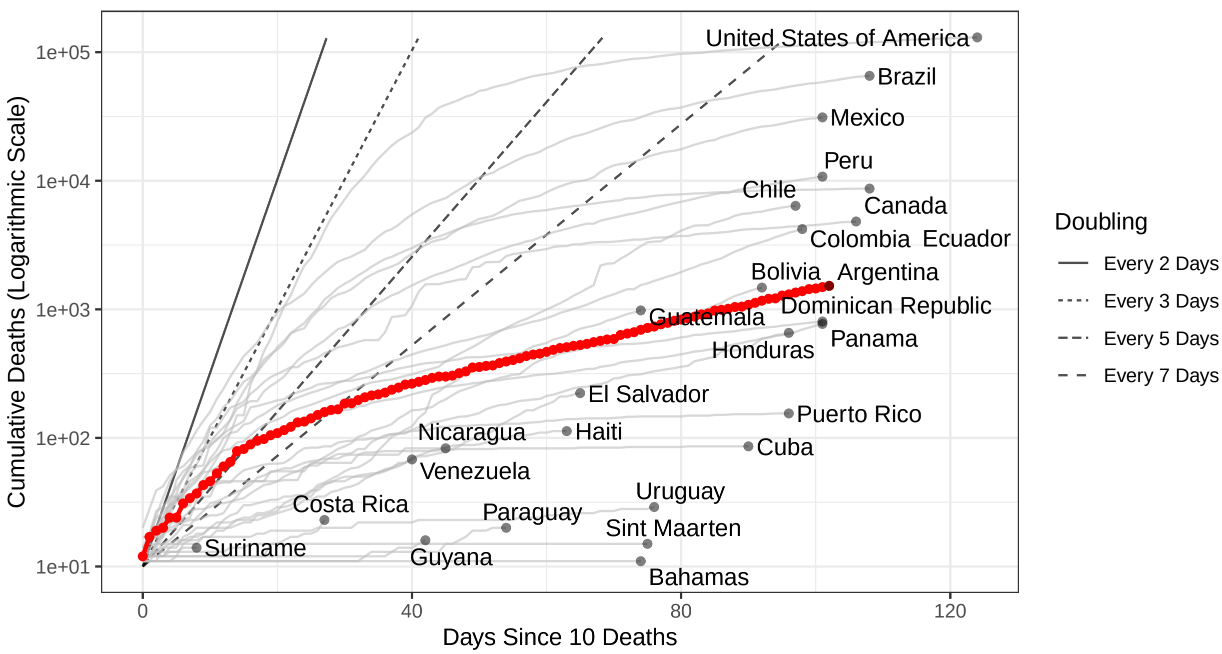

Figure 1: **Cumulative Deaths since 10 deaths.** Country not shown if fewer than 10 deaths.

COVID-19 Transmission Modelling

We assume that the deaths reported to date provide the best indication of the stage of the epidemic, as deaths are more consistently and accurately reported. Our current working estimate is that 1 death indicates that approximately 100 people will have been infected with the other 99 recovering (based on an infection fatality ratio of ~1%). These infections will have happened approximately 21 days previously – capturing a 5-day period from infection to onset of symptoms (the incubation period), 4 days from onset of symptoms to hospitalisation, and 12 days in hospital before death. With a 3-day doubling time, 100 infections that occurred 15 days ago will have generated 200 infections 12 days ago, 400 infections 9 days ago, 800 infections 6 days ago and 1,600 infections 3 days ago resulting in approximately 3,200 infections at the time the first death is observed.

To explore this, we fit our age-structured SEIR model (see Methods) to the time series of deaths in a country, in order to estimate the start date of the epidemic and the baseline R0. We assume that 100% of COVID-19 related deaths have been reported. We have also included the impact of interventions that have been put in place and their effect on human mobility and transmission based on the Google COVID-19 Community Mobility Reports. Using our mathematical model that formalises this approach, we estimate that there has been a total of 447,653 (95% CI: 395,750-499,556) infections over the past 4 weeks.

The figure below shows the estimated number of people infected over the past 4 weeks. The bar charts show, for comparison, the number of reported cases. The right-hand plot shows these data on a different scale as the estimated infections are likely to be much larger than the reported cases. **Importantly**, the estimated infections includes both asymptomatic and mild cases that would not necessarily be identified through surveillance. Consequently, the estimated infections are likely to be significantly higher than the reported cases (see our FAQ for further explanation of these differences and why the reported cases and estimated infections are unlikely to match).

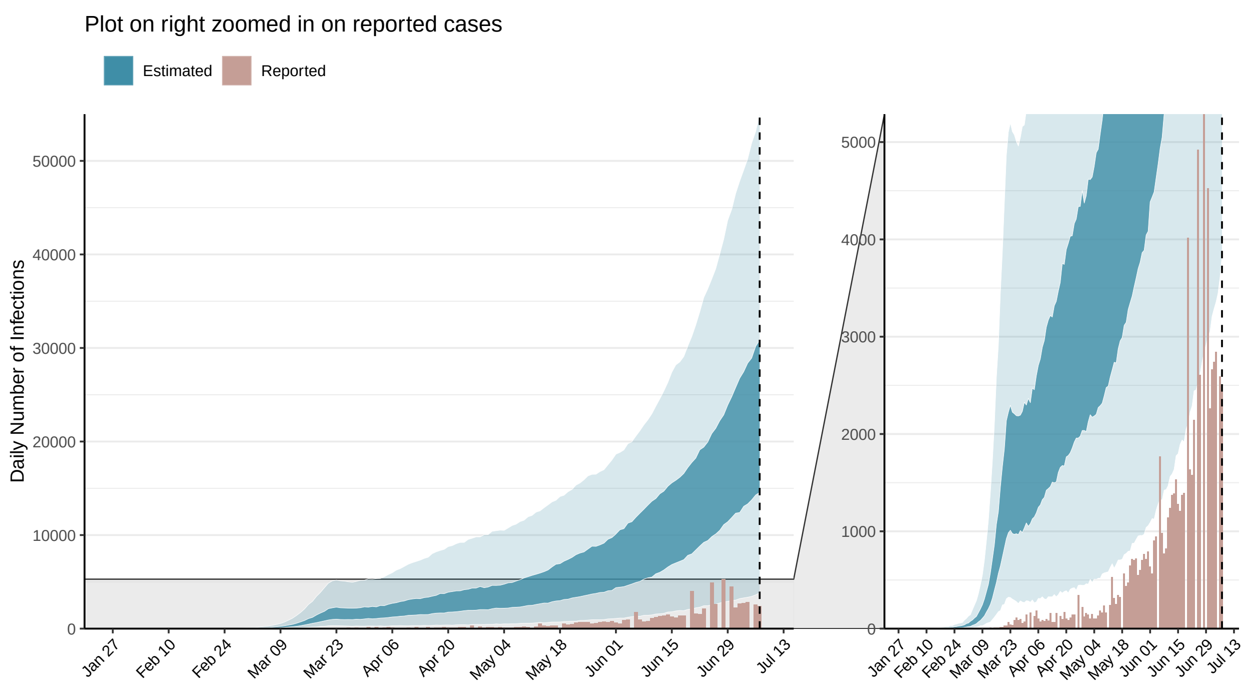

Figure 2: **Daily number of infections estimated by fitting to the current total of deaths.** Reported cases are shown in red. Model estimated infections are shown in blue (dark blue 50% interquartile range, light blue 95% quantile). The dashed line shows the current day.

By fitting to the time series of deaths, we are able to estimate a time-varying reproduction number, R_t. R_t is the the average number of secondary infections caused by a single infected person at a given time. If R_t is above 1, the rate of transmission is increasing and the number of new infections is increasing. R_t is assumed to change in relation to mobility fall in proportion. When fitting our model we assume that 100% of COVID-19 related deaths have been reported (please see our FAQ section for more information about this assumption). We also assume a fixed date at which the impact of mobility on transmission changes from pre-lockdown levels to post-lockdown levels, which may cause large changes in Rt. We are working to refine how this switch occurs and to formally calculate its shape.

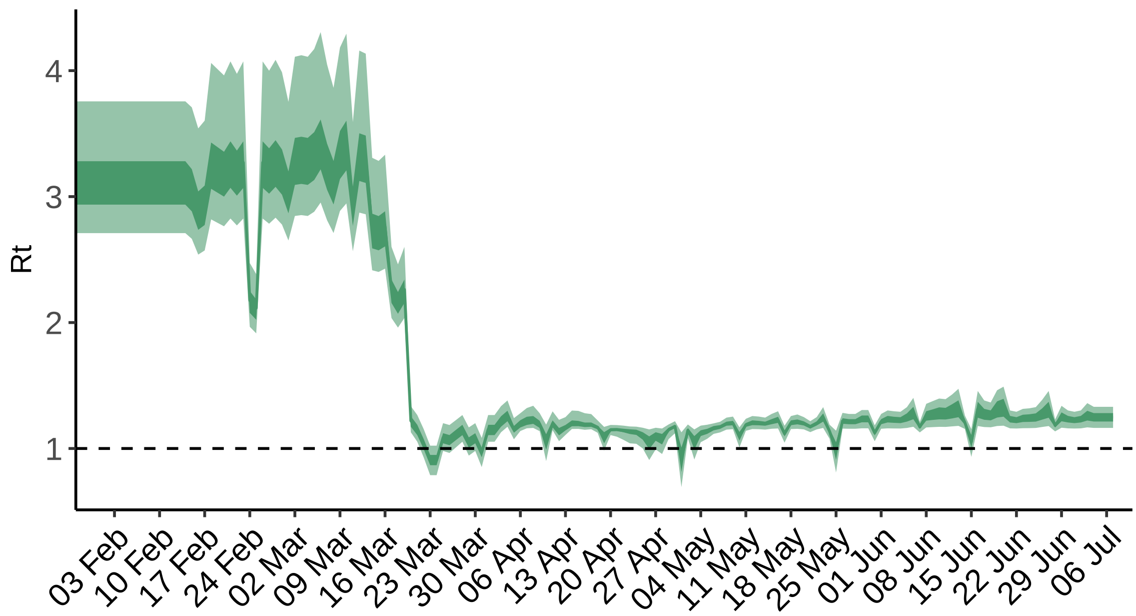

Figure 3: **Time-varying reproduction number, R_t.** R_t is the average number of secondary infections caused by a single infected person at time equal to t. $R_t < 1$ indicates a slowing epidemic in which new infections are not increasing. $R_t > 1$ indicates a growing epidemic in which new infections are increasing over time. Dark green shows the 50% CI and light green shows the 95% CI.

Using the model fit, we can forecast the expected trajectory for cumulative deaths, which is shown in the figure below. This assumes a severity pattern by age that is consistent with that observed in China, Europe and the U.S to date. This projection assumes that transmission is maintained at the current level of transmission as estimated by the final R_t value.

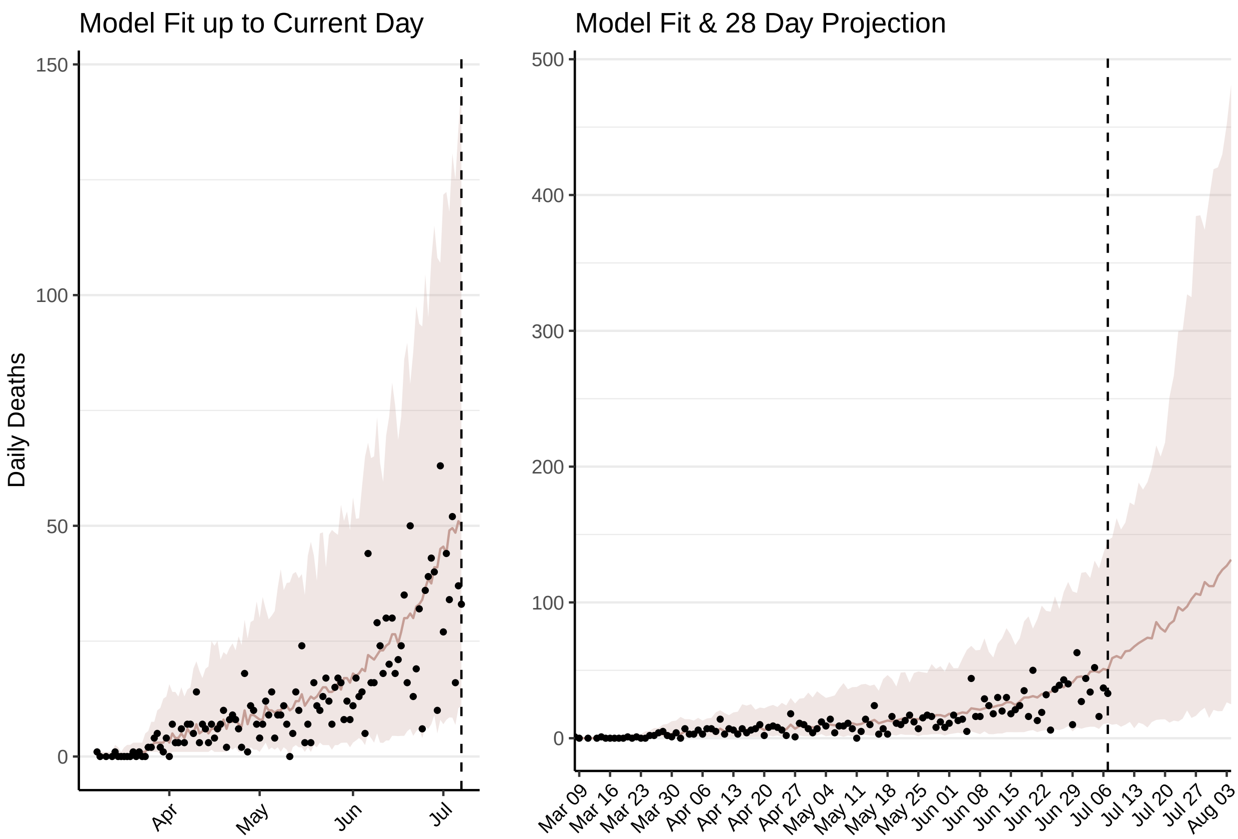

Figure 4: **Estimated daily deaths.** Projected deaths assuming the current level of interventions are maintained are shown in red (median and 95% quantile). Reported deaths are plotted in black. The plot on the left is focussed on the model fit prior to today, while the plot on the right forecasts the next 28 days.

Short-term Epidemic Scenarios

We make the following short-term projections of healthcare demand and new infections under the following three scenarios:

- **Scenario 1.** The epidemic continues to grow at the current rate.
- **Scenario 2.** Countries will further scale up interventions (either increasing current strategies or implementing new interventions) leading to a further 50% reduction in transmission.
- **Scenario 3.** Countries will relax current interventions by 50%

N.B. These scenarios currently assume that the impact of mobility on transmission will remain the same in the future as it has in the past. We are working to extend methods to estimate the impact of increases in mobility on transmission as lockdown and interventions are reversed. Consequently, projection are likely to represent an upper estimate of the healthcare demand and case load for each scenario

We estimate that over the next 4 weeks demand for hospital beds will change from 2,745 (95% CI: 2,421-3,069) patients requiring treatment with high-pressure oxygen at the current date to 6,267 (95% CI: 5,587-6,947) hospital beds being required on 2020-08-04 if no further interventions are introduced (Scenario 1). Similarly, we estimate that over the next 4 weeks demand for critical care (ICU) beds will change from 938 (95% CI: 826-1,050) patients requiring treatment with mechanical ventilation at the current date to 2,072 (95% CI: 1,870-2,273) by 2020-08-04. These projections assume that approximately 5% of all infections will require treatment with high-pressure oxygen and that approximately 30% of hospitalised cases will require treatment with mechanical ventilation (based on analysis of ongoing epidemics in Europe). **N.B. These scenarios are unlikely to show significant differences for the first week since there is a delay of approximately 10 days between infection and hospital admission. Consequently, the effectiveness of a change in policy is likely to be better captured by hospital admission data approximately 2 weeks after the policy change is implemented.**

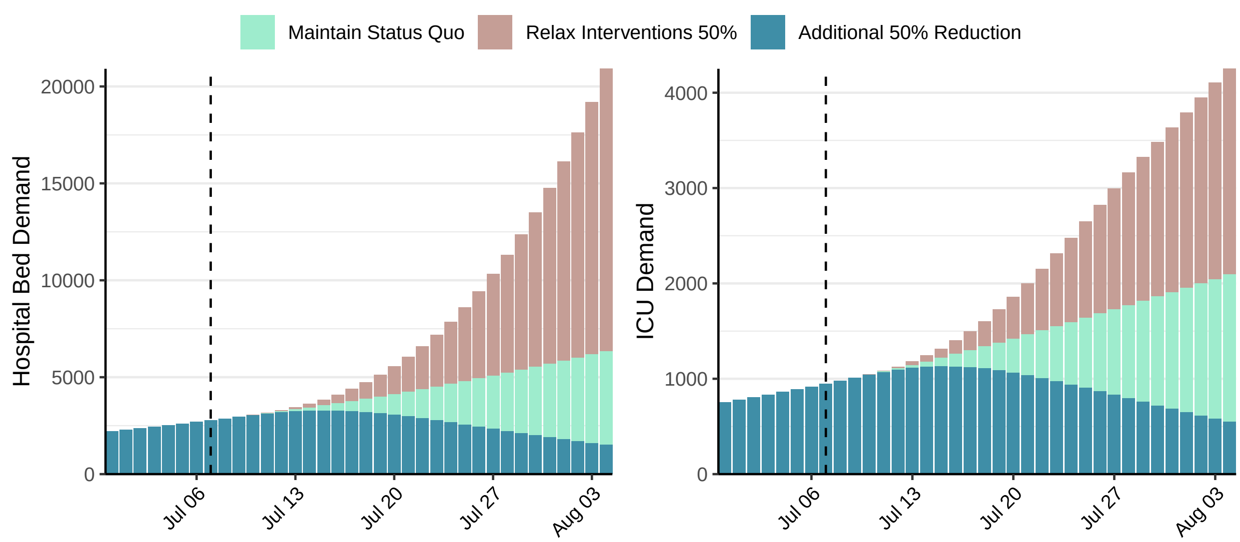

Figure 5: **Healthcare demands in the next 28 days.** Individuals needing an ICU bed are assumed to need mechanical ventilation. Projected demand for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

The impact of each scenario has a more immediate effect on the daily number of infections. The figure below shows the impact of each scenario on the estimated daily incidence of new infections. If interventions are scaled up (Scenario 2), the daily number of infections will change from 23,527 (95% CI: 20,884-26,170) at the current date to 3,832 (95% CI: 3,416-4,247) by 2020-08-04. If current interventions were relaxed by 50%, we estimate the daily number of infections will change from 23,527 (95% CI: 20,884-26,170) at the current date to 269,588 (95% CI: 245,475-293,701) by 2020-08-04.

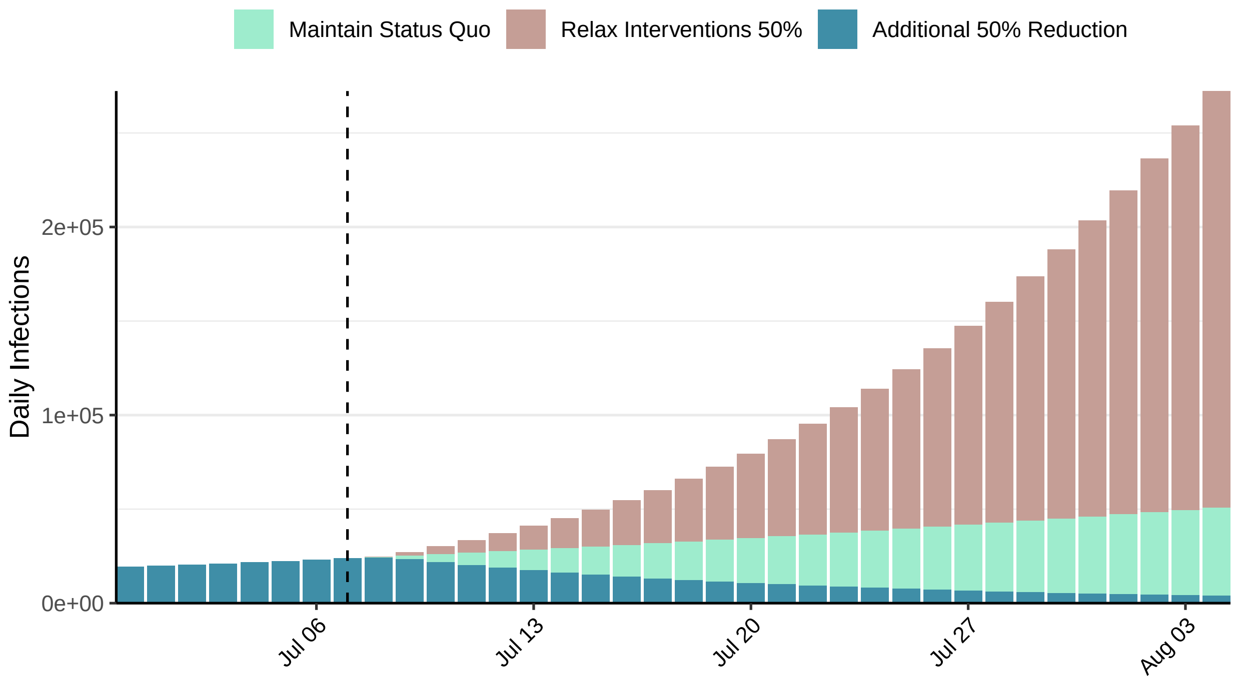

Figure 6: **Daily number of infections estimated by fitting to deaths.** Projected infections for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

To explore different scenarios, we recommend using our COVID-19 Scenario Analysis Tool - https://covidsim.org/, which can be used to simulate different intervention scenarios and explore the long term impact on healthcare demand.

Situation Report for COVID-19: Armenia, 2020-07-07

Download the report for Armenia, 2020-07-07 here. This report uses data from the European Centre for Disease Control. These data are updated daily and whilst there may be a short delay, they are generally consistent with Ministry reports. These data are then used to back-calculate an 'inferred number of COVID-19 infections' using mathematical modelling techniques (see Report 12 for further details) to estimate the number of people that have been infected and to make short-term projections for future healthcare needs.

Epidemiological Situation

Total Reported Cases	New Reported Cases	Total Reported Deaths	New Reported Deaths	Estimated R_t
28,936	330	491	7	1.21 (95% CI: 1.16-1.27)

The figure below shows the cumulative reported deaths as a function of the time since the 10th death was reported. Dashed lines show the expected trajectory for different doubling times of the epidemic. For example, with a doubling time of 3 days, if there are currently a total of 20 deaths reported, we would expect there to be 40 deaths in total reported in 3 days-time, 80 deaths in 6 days-time, 160 deaths in 9 days-time etc. For most epidemics, in the absence of interventions, we expect a doubling time of 3-4 days for this disease.

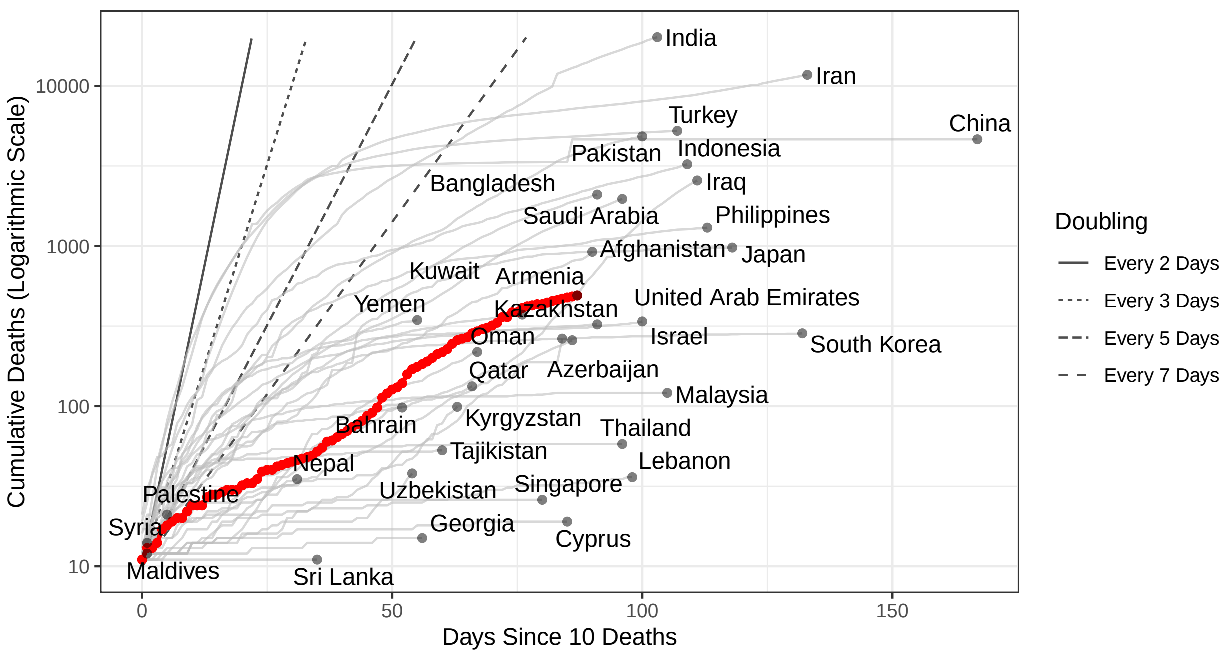

Figure 1: **Cumulative Deaths since 10 deaths.** Country not shown if fewer than 10 deaths.

COVID-19 Transmission Modelling

We assume that the deaths reported to date provide the best indication of the stage of the epidemic, as deaths are more consistently and accurately reported. Our current working estimate is that 1 death indicates that approximately 100 people will have been infected with the other 99 recovering (based on an infection fatality ratio of ~1%). These infections will have happened approximately 21 days previously – capturing a 5-day period from infection to onset of symptoms (the incubation period), 4 days from onset of symptoms to hospitalisation, and 12 days in hospital before death. With a 3-day doubling time, 100 infections that occurred 15 days ago will have generated 200 infections 12 days ago, 400 infections 9 days ago, 800 infections 6 days ago and 1,600 infections 3 days ago resulting in approximately 3,200 infections at the time the first death is observed.

To explore this, we fit our age-structured SEIR model (see Methods) to the time series of deaths in a country, in order to estimate the start date of the epidemic and the baseline R0. We assume that 100% of COVID-19 related deaths have been reported. We have also included the impact of interventions that have been put in place and their effect on human mobility and transmission based on the Google COVID-19 Community Mobility Reports. Using our mathematical model that formalises this approach, we estimate that there has been a total of 131,308 (95% CI: 122,710-139,906) infections over the past 4 weeks.

The figure below shows the estimated number of people infected over the past 4 weeks. The bar charts show, for comparison, the number of reported cases. The right-hand plot shows these data on a different scale as the estimated infections are likely to be much larger than the reported cases. **Importantly**, the estimated infections includes both asymptomatic and mild cases that would not necessarily be identified through surveillance. Consequently, the estimated infections are likely to be significantly higher than the reported cases (see our FAQ for further explanation of these differences and why the reported cases and estimated infections are unlikely to match).

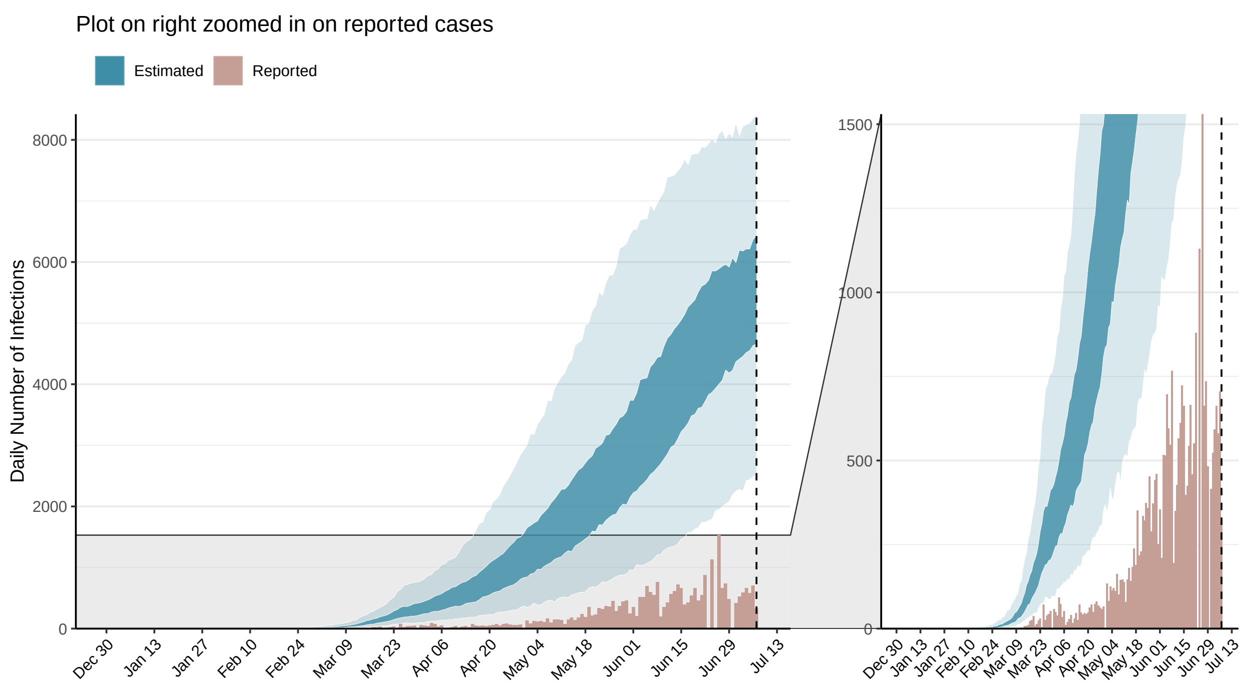

Figure 2: **Daily number of infections estimated by fitting to the current total of deaths.** Reported cases are shown in red. Model estimated infections are shown in blue (dark blue 50% interquartile range, light blue 95% quantile). The dashed line shows the current day.

By fitting to the time series of deaths, we are able to estimate a time-varying reproduction number, R_t. R_t is the the average number of secondary infections caused by a single infected person at a given time. If R_t is above 1, the rate of transmission is increasing and the number of new infections is increasing. R_t is assumed to change in relation to mobility fall in proportion. When fitting our model we assume that 100% of COVID-19 related deaths have been reported (please see our FAQ section for more information about this assumption). We also assume a fixed date at which the impact of mobility on transmission changes from pre-lockdown levels to post-lockdown levels, which may cause large changes in Rt. We are working to refine how this switch occurs and to formally calculate its shape.

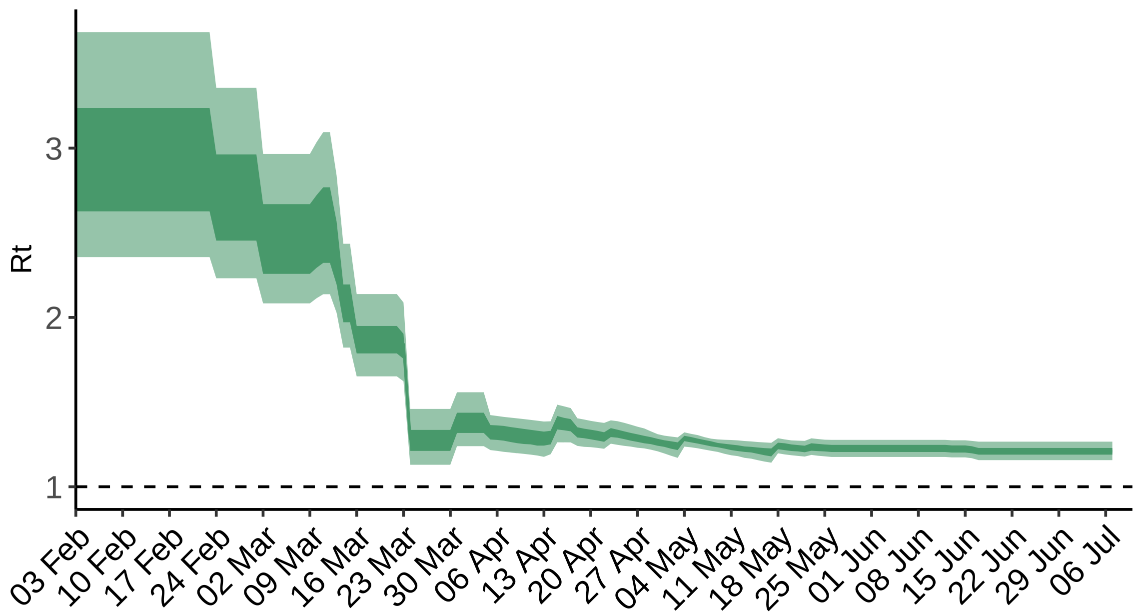

Figure 3: **Time-varying reproduction number, R_t.** R_t is the average number of secondary infections caused by a single infected person at time equal to t. $R_t < 1$ indicates a slowing epidemic in which new infections are not increasing. $R_t > 1$ indicates a growing epidemic in which new infections are increasing over time. Dark green shows the 50% CI and light green shows the 95% CI.

Using the model fit, we can forecast the expected trajectory for cumulative deaths, which is shown in the figure below. This assumes a severity pattern by age that is consistent with that observed in China, Europe and the U.S to date. This projection assumes that transmission is maintained at the current level of transmission as estimated by the final R_t value. **N.B. Armenia is forecast to be close to or surpassing our best estimates for healthcare capacity in the next 28 days.** Estimates of deaths in the next 28 days may be inaccurate due to our working assumptions for mortality in individuals who do not receive appropriate treatment. See our methods for more information.

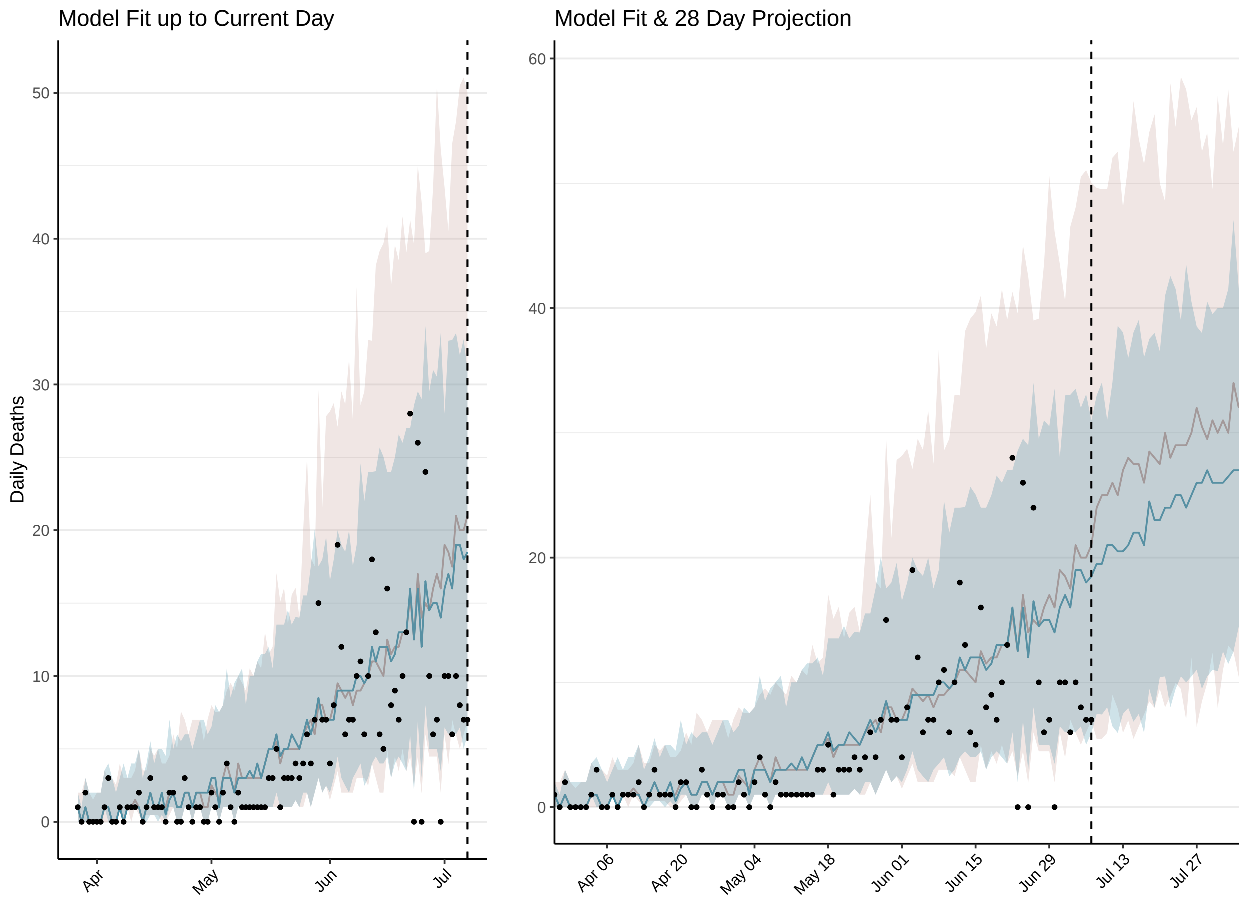

Figure 4: **Estimated daily deaths.** Projected deaths assuming the current level of interventions are maintained are shown in red (median and 95% quantile). Reported deaths are plotted in black. The plot on the left is focussed on the model fit prior to today, while the plot on the right forecasts the next 28 days. The forecasted deaths in blue assumes healthcare capacity has been surged to ensure sufficient supply of ICU and hospital beds. The red curve assumes no surging in healthcare capacity and subsequently projects increased deaths.

Short-term Epidemic Scenarios

We make the following short-term projections of healthcare demand and new infections under the following three scenarios:

- **Scenario 1.** The epidemic continues to grow at the current rate.
- **Scenario 2.** Countries will further scale up interventions (either increasing current strategies or implementing new interventions) leading to a further 50% reduction in transmission.
- **Scenario 3.** Countries will relax current interventions by 50%

N.B. These scenarios currently assume that the impact of mobility on transmission will remain the same in the future as it has in the past. We are working to extend methods to estimate the impact of increases in mobility on transmission as lockdown and interventions are reversed. Consequently, projection are likely to represent an upper estimate of the healthcare demand and case load for each scenario

We estimate that over the next 4 weeks demand for hospital beds will change from 983 (95% CI: 917-1,048) patients requiring treatment with high-pressure oxygen at the current date to 1,242 (95% CI: 1,183-1,300) hospital beds being required on 2020-08-04 if no further interventions are introduced (Scenario 1). Similarly, we estimate that over the next 4 weeks demand for critical care (ICU) beds will change from 217 (95% CI: 209-226) patients requiring treatment with mechanical ventilation at the current date to 238 (95% CI: 232-244) by 2020-08-04. These projections assume that approximately 5% of all infections will require treatment with high-pressure oxygen and that approximately 30% of hospitalised cases will require treatment with mechanical ventilation (based on analysis of ongoing epidemics in Europe). **N.B. These scenarios are unlikely to show significant differences for the first week since there is a delay of approximately 10 days between infection and hospital admission. Consequently, the effectiveness of a change in policy is likely to be better captured by hospital admission data approximately 2 weeks after the policy change is implemented.**

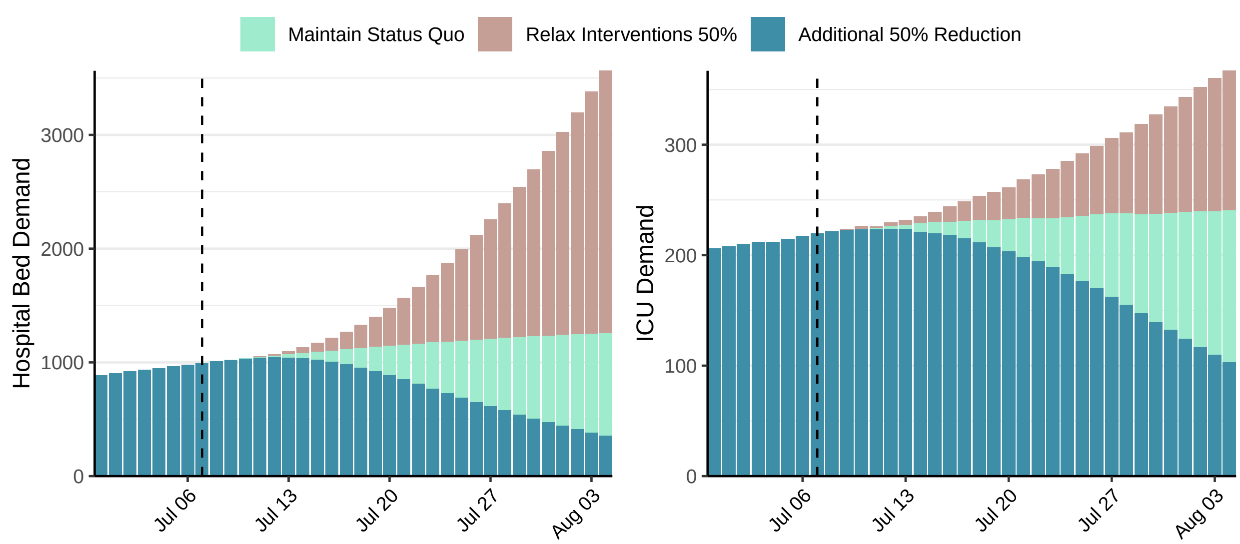

Figure 5: **Healthcare demands in the next 28 days.** Individuals needing an ICU bed are assumed to need mechanical ventilation. Projected demand for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

The impact of each scenario has a more immediate effect on the daily number of infections. The figure below shows the impact of each scenario on the estimated daily incidence of new infections. If interventions are scaled up (Scenario 2), the daily number of infections will change from 5,496 (95% CI: 5,192-5,799) at the current date to 540 (95% CI: 515-565) by 2020-08-04. If current interventions were relaxed by 50%, we estimate the daily number of infections will change from 5,496 (95% CI: 5,192-5,799) at the current date to 26,173 (95% CI: 25,189-27,157) by 2020-08-04.

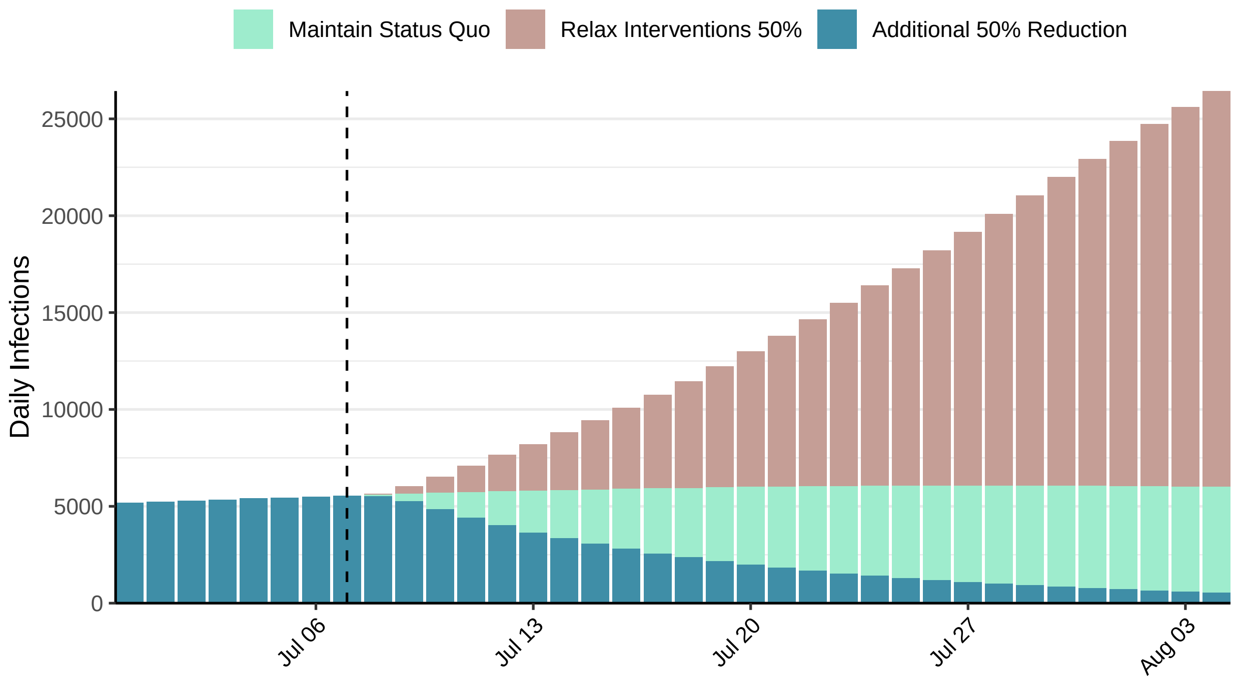

Figure 6: **Daily number of infections estimated by fitting to deaths.** Projected infections for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

To explore different scenarios, we recommend using our COVID-19 Scenario Analysis Tool - https://covidsim.org/, which can be used to simulate different intervention scenarios and explore the long term impact on healthcare demand.

Situation Report for COVID-19: Azerbaijan, 2020-07-07

Download the report for Azerbaijan, 2020-07-07 here. This report uses data from the European Centre for Disease Control. These data are updated daily and whilst there may be a short delay, they are generally consistent with Ministry reports. These data are then used to back-calculate an 'inferred number of COVID-19 infections' using mathematical modelling techniques (see Report 12 for further details) to estimate the number of people that have been infected and to make short-term projections for future healthcare needs.

Epidemiological Situation

Total Reported Cases	New Reported Cases	Total Reported Deaths	New Reported Deaths	Estimated R_t
20,837	513	258	8	1.33 (95% CI: 1.24-1.42)

The figure below shows the cumulative reported deaths as a function of the time since the 10th death was reported. Dashed lines show the expected trajectory for different doubling times of the epidemic. For example, with a doubling time of 3 days, if there are currently a total of 20 deaths reported, we would expect there to be 40 deaths in total reported in 3 days-time, 80 deaths in 6 days-time, 160 deaths in 9 days-time etc. For most epidemics, in the absence of interventions, we expect a doubling time of 3-4 days for this disease.

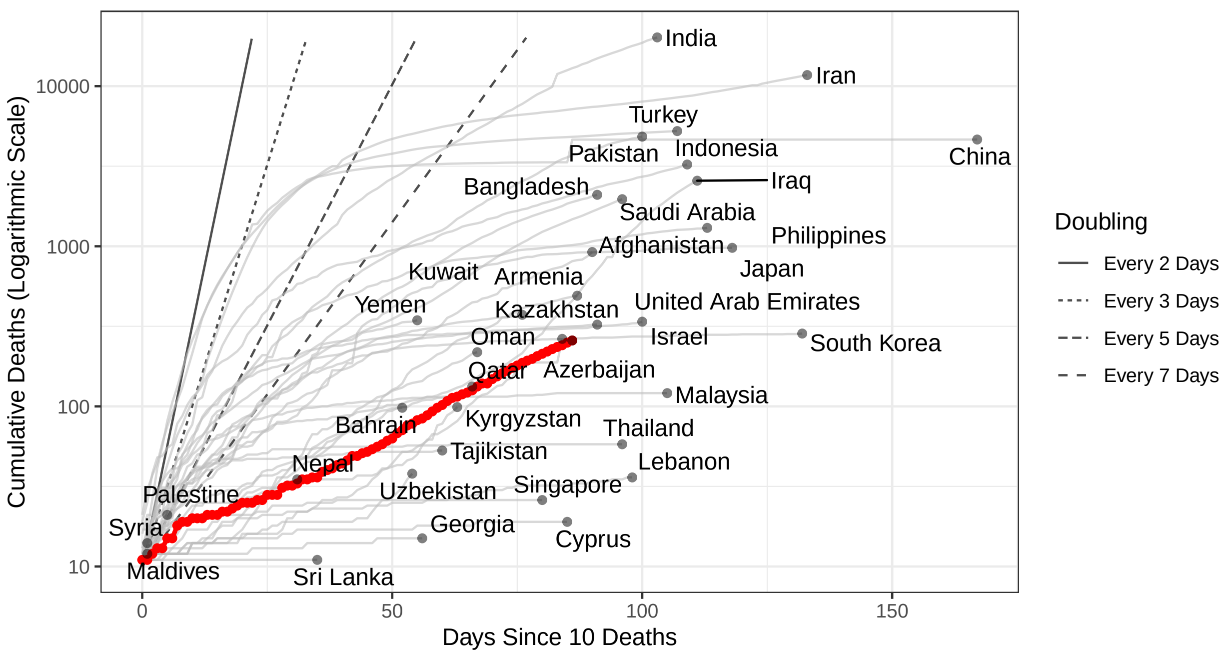

Figure 1: **Cumulative Deaths since 10 deaths.** Country not shown if fewer than 10 deaths.

COVID-19 Transmission Modelling

We assume that the deaths reported to date provide the best indication of the stage of the epidemic, as deaths are more consistently and accurately reported. Our current working estimate is that 1 death indicates that approximately 100 people will have been infected with the other 99 recovering (based on an infection fatality ratio of ~1%). These infections will have happened approximately 21 days previously – capturing a 5-day period from infection to onset of symptoms (the incubation period), 4 days from onset of symptoms to hospitalisation, and 12 days in hospital before death. With a 3-day doubling time, 100 infections that occurred 15 days ago will have generated 200 infections 12 days ago, 400 infections 9 days ago, 800 infections 6 days ago and 1,600 infections 3 days ago resulting in approximately 3,200 infections at the time the first death is observed.

To explore this, we fit our age-structured SEIR model (see Methods) to the time series of deaths in a country, in order to estimate the start date of the epidemic and the baseline R0. We assume that 100% of COVID-19 related deaths have been reported. We have also included the impact of interventions that have been put in place and their effect on human mobility and transmission based on the Google COVID-19 Community Mobility Reports. Using our mathematical model that formalises this approach, we estimate that there has been a total of 150,890 (95% CI: 136,368-165,413) infections over the past 4 weeks.

The figure below shows the estimated number of people infected over the past 4 weeks. The bar charts show, for comparison, the number of reported cases. The right-hand plot shows these data on a different scale as the estimated infections are likely to be much larger than the reported cases. **Importantly**, the estimated infections includes both asymptomatic and mild cases that would not necessarily be identified through surveillance. Consequently, the estimated infections are likely to be significantly higher than the reported cases (see our FAQ for further explanation of these differences and why the reported cases and estimated infections are unlikely to match).

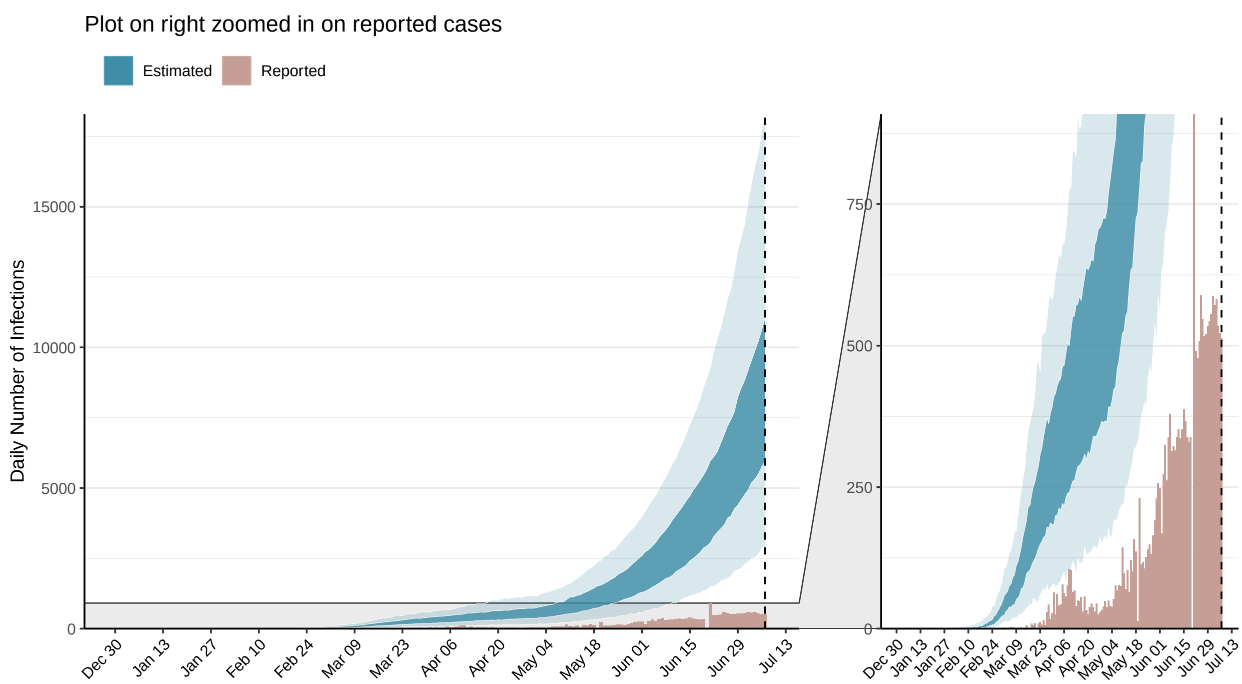

Figure 2: **Daily number of infections estimated by fitting to the current total of deaths.** Reported cases are shown in red. Model estimated infections are shown in blue (dark blue 50% interquartile range, light blue 95% quantile). The dashed line shows the current day.

By fitting to the time series of deaths, we are able to estimate a time-varying reproduction number, R_t. R_t is the the average number of secondary infections caused by a single infected person at a given time. If R_t is above 1, the rate of transmission is increasing and the number of new infections is increasing. R_t is assumed to change in relation to mobility fall in proportion. When fitting our model we assume that 100% of COVID-19 related deaths have been reported (please see our FAQ section for more information about this assumption). We also assume a fixed date at which the impact of mobility on transmission changes from pre-lockdown levels to post-lockdown levels, which may cause large changes in Rt. We are working to refine how this switch occurs and to formally calculate its shape.

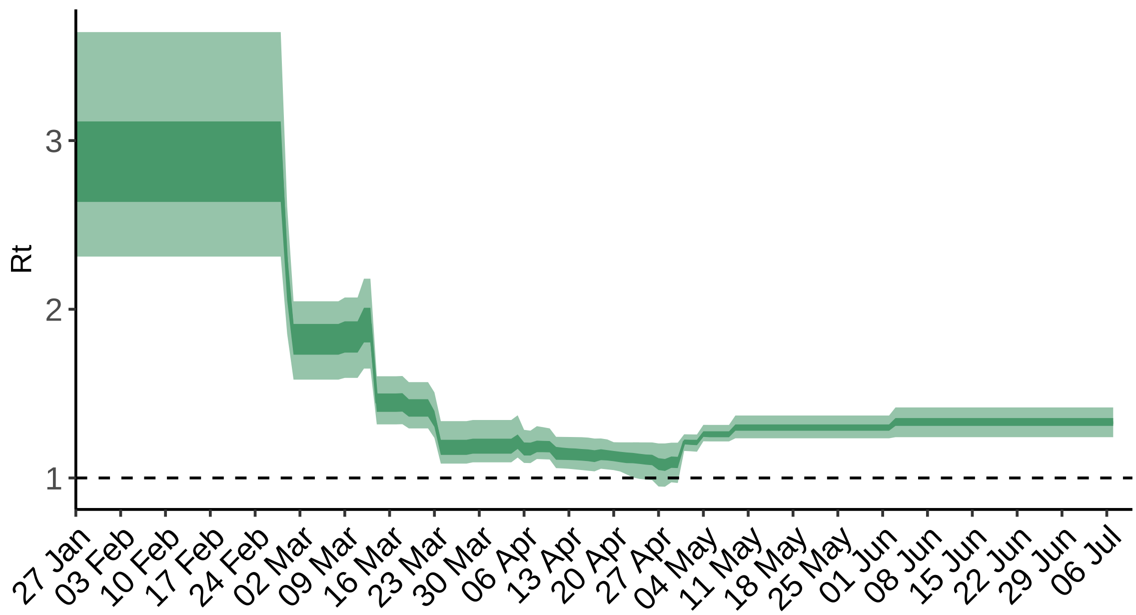

Figure 3: **Time-varying reproduction number, R_t.** R_t is the average number of secondary infections caused by a single infected person at time equal to t. $R_t < 1$ indicates a slowing epidemic in which new infections are not increasing. $R_t > 1$ indicates a growing epidemic in which new infections are increasing over time. Dark green shows the 50% CI and light green shows the 95% CI.

Using the model fit, we can forecast the expected trajectory for cumulative deaths, which is shown in the figure below. This assumes a severity pattern by age that is consistent with that observed in China, Europe and the U.S to date. This projection assumes that transmission is maintained at the current level of transmission as estimated by the final R_t value.

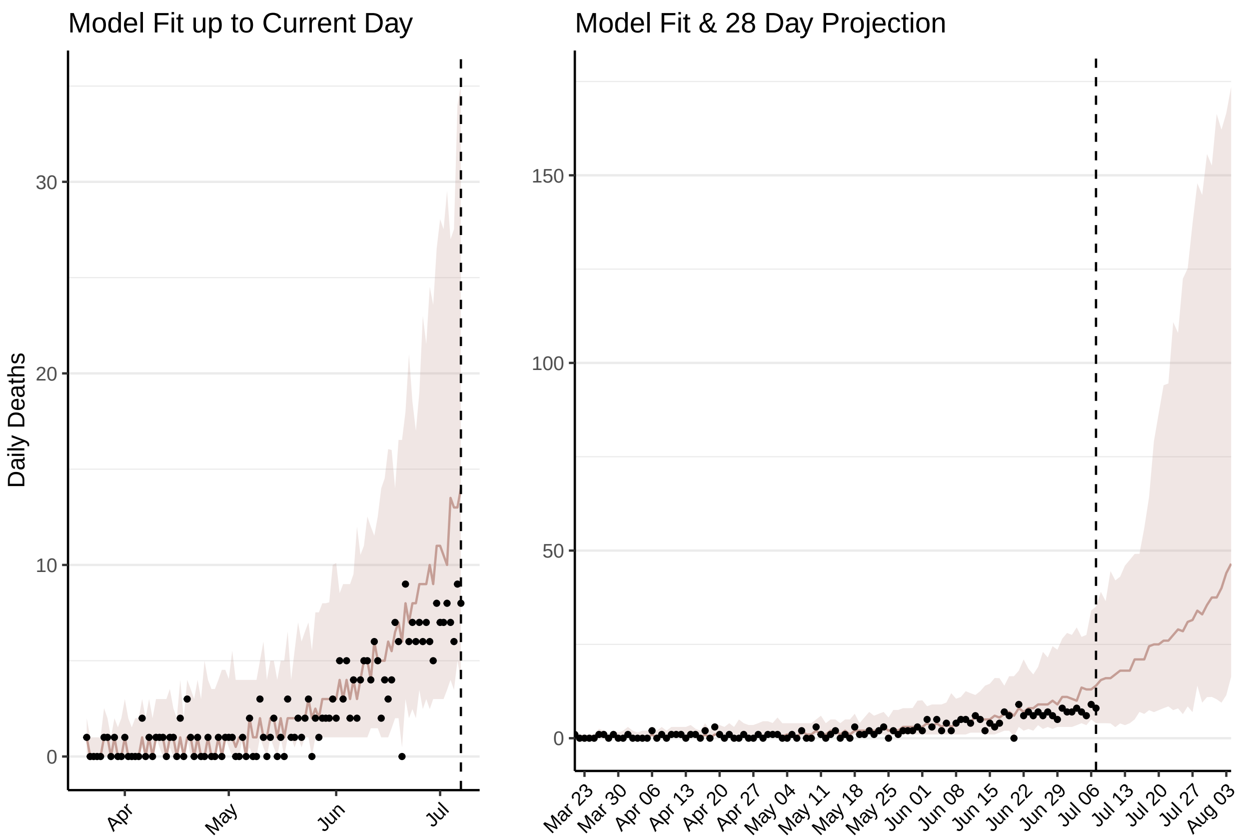

Figure 4: **Estimated daily deaths.** Projected deaths assuming the current level of interventions are maintained are shown in red (median and 95% quantile). Reported deaths are plotted in black. The plot on the left is focussed on the model fit prior to today, while the plot on the right forecasts the next 28 days.

Short-term Epidemic Scenarios

We make the following short-term projections of healthcare demand and new infections under the following three scenarios:

- **Scenario 1.** The epidemic continues to grow at the current rate.
- **Scenario 2.** Countries will further scale up interventions (either increasing current strategies or implementing new interventions) leading to a further 50% reduction in transmission.
- **Scenario 3.** Countries will relax current interventions by 50%

N.B. These scenarios currently assume that the impact of mobility on transmission will remain the same in the future as it has in the past. We are working to extend methods to estimate the impact of increases in mobility on transmission as lockdown and interventions are reversed. Consequently, projection are likely to represent an upper estimate of the healthcare demand and case load for each scenario

We estimate that over the next 4 weeks demand for hospital beds will change from 1,068 (95% CI: 963-1,172) patients requiring treatment with high-pressure oxygen at the current date to 3,120 (95% CI: 2,826-3,414) hospital beds being required on 2020-08-04 if no further interventions are introduced (Scenario 1). Similarly, we estimate that over the next 4 weeks demand for critical care (ICU) beds will change from 251 (95% CI: 226-275) patients requiring treatment with mechanical ventilation at the current date to 641 (95% CI: 600-681) by 2020-08-04. These projections assume that approximately 5% of all infections will require treatment with high-pressure oxygen and that approximately 30% of hospitalised cases will require treatment with mechanical ventilation (based on analysis of ongoing epidemics in Europe). **N.B. These scenarios are unlikely to show significant differences for the first week since there is a delay of approximately 10 days between infection and hospital admission. Consequently, the effectiveness of a change in policy is likely to be better captured by hospital admission data approximately 2 weeks after the policy change is implemented.**

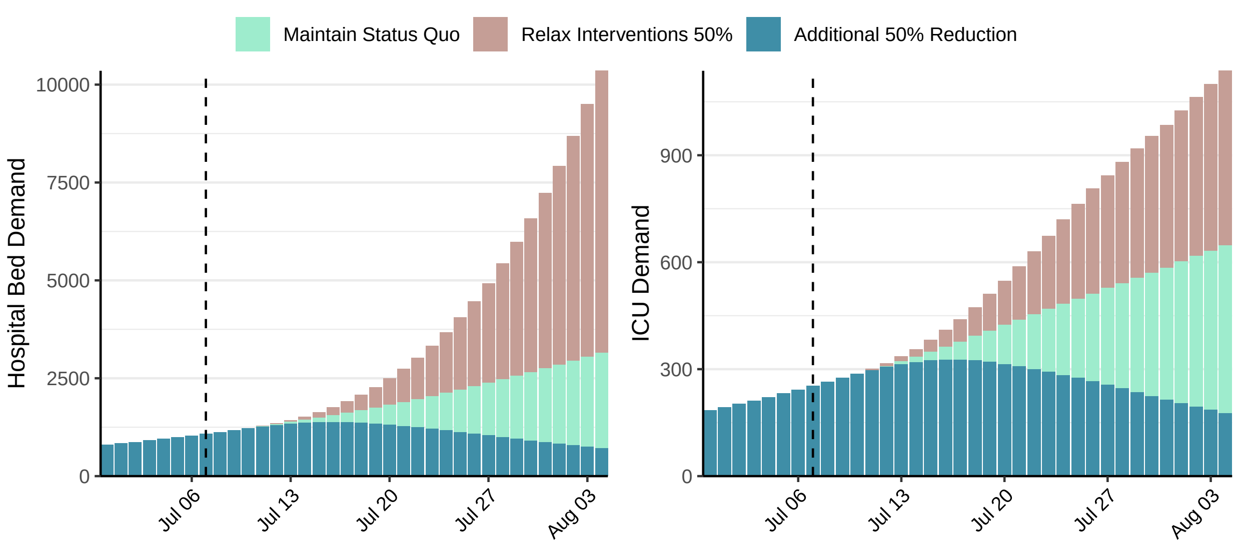

Figure 5: **Healthcare demands in the next 28 days.** Individuals needing an ICU bed are assumed to need mechanical ventilation. Projected demand for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

The impact of each scenario has a more immediate effect on the daily number of infections. The figure below shows the impact of each scenario on the estimated daily incidence of new infections. If interventions are scaled up (Scenario 2), the daily number of infections will change from 8,883 (95% CI: 8,017-9,748) at the current date to 1,762 (95% CI: 1,592-1,933) by 2020-08-04. If current interventions were relaxed by 50%, we estimate the daily number of infections will change from 8,883 (95% CI: 8,017-9,748) at the current date to 115,092 (95% CI: 107,623-122,560) by 2020-08-04.

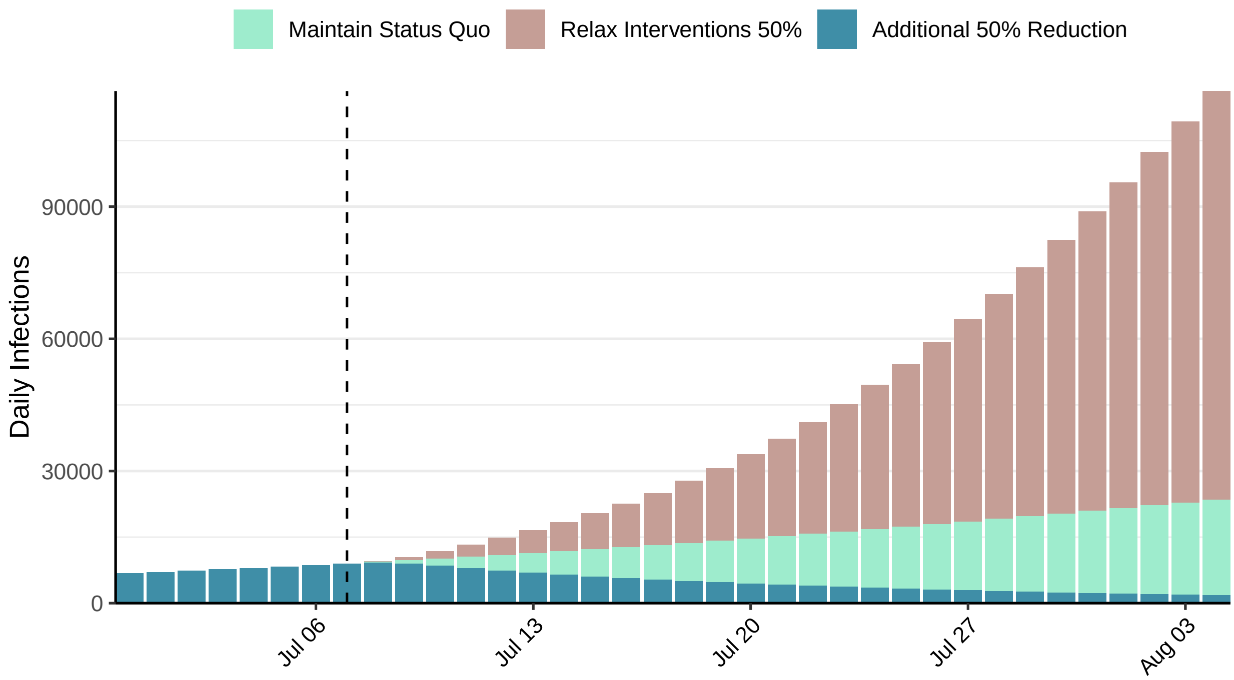

Figure 6: **Daily number of infections estimated by fitting to deaths.** Projected infections for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

To explore different scenarios, we recommend using our COVID-19 Scenario Analysis Tool - https://covidsim.org/, which can be used to simulate different intervention scenarios and explore the long term impact on healthcare demand.

Situation Report for COVID-19: Burundi, 2020-07-07

Download the report for Burundi, 2020-07-07 here. This report uses data from the European Centre for Disease Control. These data are updated daily and whilst there may be a short delay, they are generally consistent with Ministry reports. These data are then used to back-calculate an 'inferred number of COVID-19 infections' using mathematical modelling techniques (see Report 12 for further details) to estimate the number of people that have been infected and to make short-term projections for future healthcare needs.

Epidemiological Situation

Total Reported Cases	New Reported Cases	Total Reported Deaths	New Reported Deaths	Estimated R_t
191	0	1	0	0.62 (95% CI: 0.27-1.05)

The figure below shows the cumulative reported deaths as a function of the time since the 10th death was reported. Dashed lines show the expected trajectory for different doubling times of the epidemic. For example, with a doubling time of 3 days, if there are currently a total of 20 deaths reported, we would expect there to be 40 deaths in total reported in 3 days-time, 80 deaths in 6 days-time, 160 deaths in 9 days-time etc. For most epidemics, in the absence of interventions, we expect a doubling time of 3-4 days for this disease. **N.B. Burundi is not shown in the following plot as only 1 deaths have been reported to date**

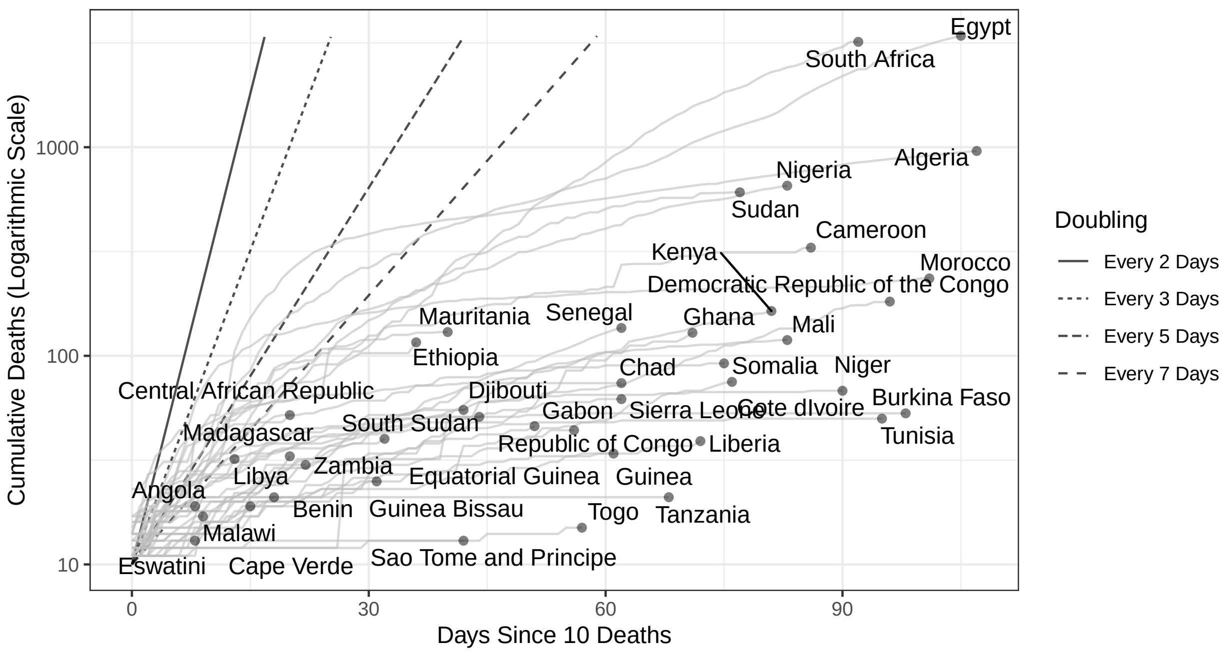

Figure 1: **Cumulative Deaths since 10 deaths.** Country not shown if fewer than 10 deaths.

COVID-19 Transmission Modelling

We assume that the deaths reported to date provide the best indication of the stage of the epidemic, as deaths are more consistently and accurately reported. Our current working estimate is that 1 death indicates that approximately 100 people will have been infected with the other 99 recovering (based on an infection fatality ratio of ~1%). These infections will have happened approximately 21 days previously – capturing a 5-day period from infection to onset of symptoms (the incubation period), 4 days from onset of symptoms to hospitalisation, and 12 days in hospital before death. With a 3-day doubling time, 100 infections that occurred 15 days ago will have generated 200 infections 12 days ago, 400 infections 9 days ago, 800 infections 6 days ago and 1,600 infections 3 days ago resulting in approximately 3,200 infections at the time the first death is observed.

To explore this, we fit our age-structured SEIR model (see Methods) to the time series of deaths in a country, in order to estimate the start date of the epidemic and the baseline R0. We assume that 100% of COVID-19 related deaths have been reported. We have also included the impact of interventions that have been put in place and their effect on human mobility and transmission based on the Google COVID-19 Community Mobility Reports. Using our mathematical model that formalises this approach, we estimate that there has been a total of 23 (95% CI: 9-38) infections over the past 4 weeks.

The figure below shows the estimated number of people infected over the past 4 weeks. The bar charts show, for comparison, the number of reported cases. The right-hand plot shows these data on a different scale as the estimated infections are likely to be much larger than the reported cases. **Importantly**, the estimated infections includes both asymptomatic and mild cases that would not necessarily be identified through surveillance. Consequently, the estimated infections are likely to be significantly higher than the reported cases (see our FAQ for further explanation of these differences and why the reported cases and estimated infections are unlikely to match).

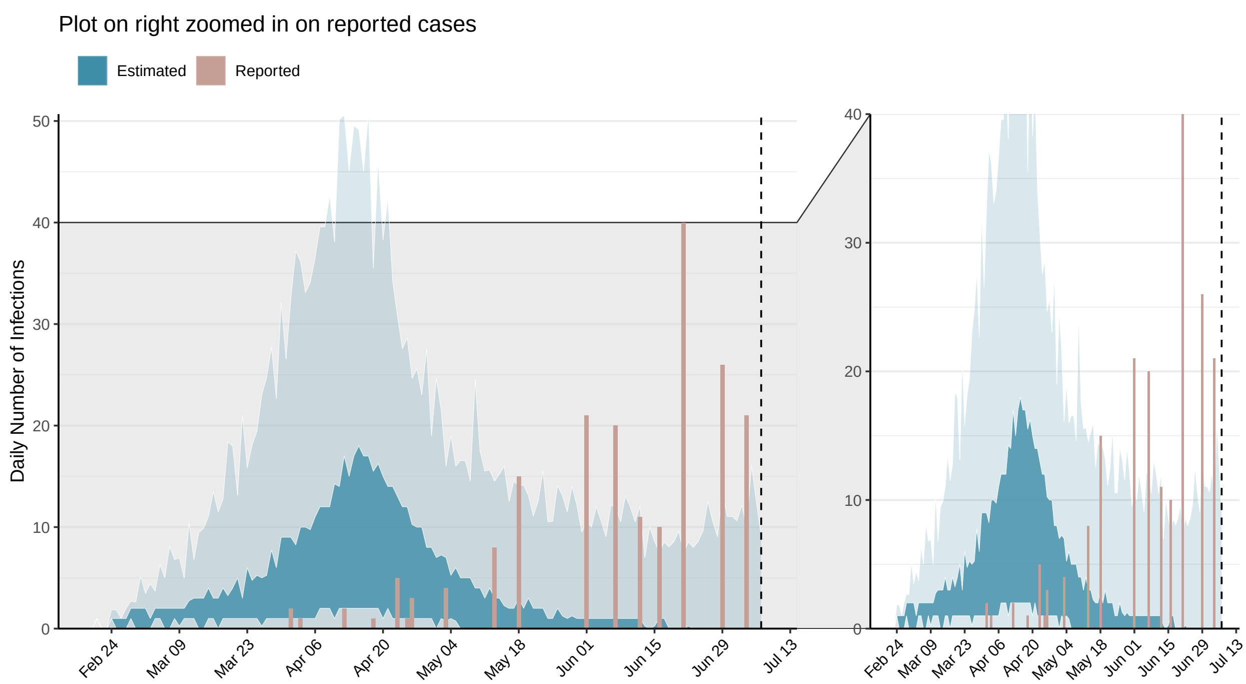

Figure 2: **Daily number of infections estimated by fitting to the current total of deaths.** Reported cases are shown in red. Model estimated infections are shown in blue (dark blue 50% interquartile range, light blue 95% quantile). The dashed line shows the current day.

By fitting to the time series of deaths, we are able to estimate a time-varying reproduction number, R_t. R_t is the the average number of secondary infections caused by a single infected person at a given time. If R_t is above 1, the rate of transmission is increasing and the number of new infections is increasing. R_t is assumed to change in relation to mobility fall in proportion. When fitting our model we assume that 100% of COVID-19 related deaths have been reported (please see our FAQ section for more information about this assumption). We also assume a fixed date at which the impact of mobility on transmission changes from pre-lockdown levels to post-lockdown levels, which may cause large changes in Rt. We are working to refine how this switch occurs and to formally calculate its shape.

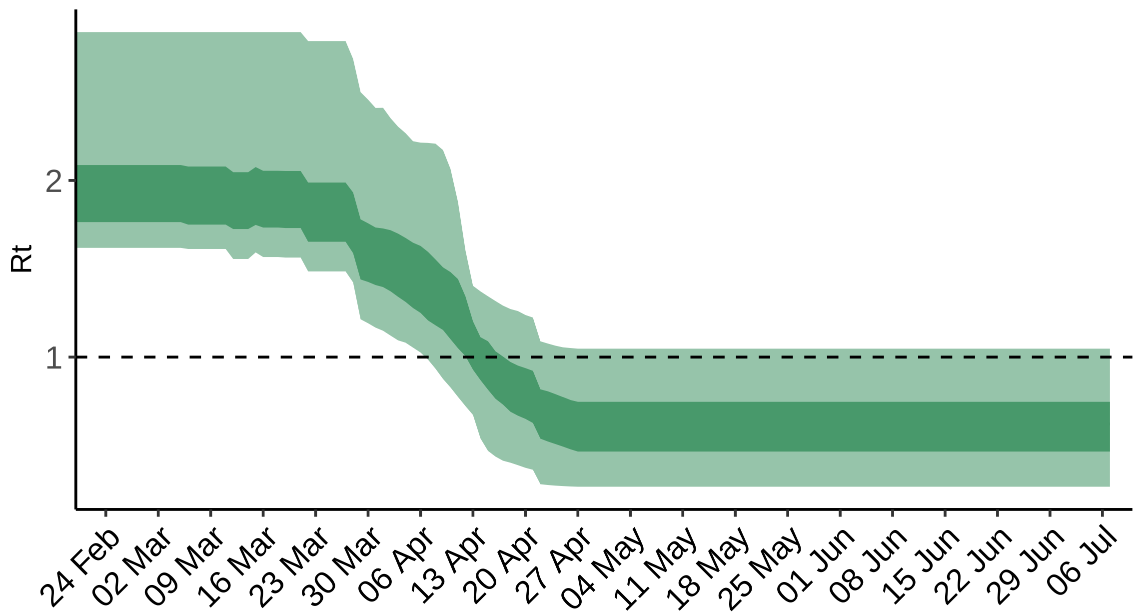

Figure 3: **Time-varying reproduction number, R_t.** R_t is the average number of secondary infections caused by a single infected person at time equal to t. $R_t < 1$ indicates a slowing epidemic in which new infections are not increasing. $R_t > 1$ indicates a growing epidemic in which new infections are increasing over time. Dark green shows the 50% CI and light green shows the 95% CI.

Using the model fit, we can forecast the expected trajectory for cumulative deaths, which is shown in the figure below. This assumes a severity pattern by age that is consistent with that observed in China, Europe and the U.S to date. This projection assumes that transmission is maintained at the current level of transmission as estimated by the final R_t value.

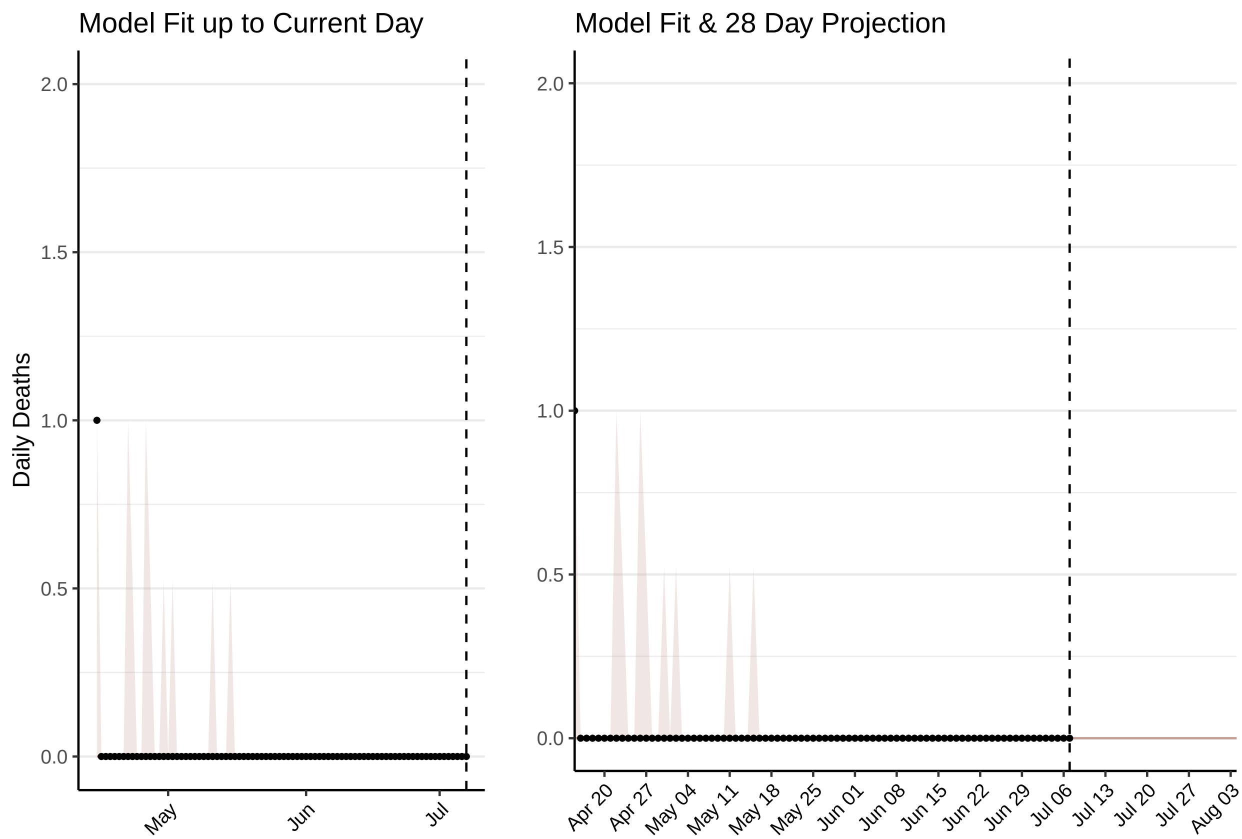

Figure 4: **Estimated daily deaths.** Projected deaths assuming the current level of interventions are maintained are shown in red (median and 95% quantile). Reported deaths are plotted in black. The plot on the left is focussed on the model fit prior to today, while the plot on the right forecasts the next 28 days.

Short-term Epidemic Scenarios

We make the following short-term projections of healthcare demand and new infections under the following three scenarios:

- **Scenario 1.** The epidemic continues to grow at the current rate.
- **Scenario 2.** Countries will further scale up interventions (either increasing current strategies or implementing new interventions) leading to a further 50% reduction in transmission.
- **Scenario 3.** Countries will relax current interventions by 50%

N.B. These scenarios currently assume that the impact of mobility on transmission will remain the same in the future as it has in the past. We are working to extend methods to estimate the impact of increases in mobility on transmission as lockdown and interventions are reversed. Consequently, projection are likely to represent an upper estimate of the healthcare demand and case load for each scenario

We estimate that over the next 4 weeks demand for hospital beds will change from 0 (95% CI: 0-0) patients requiring treatment with high-pressure oxygen at the current date to 0 (95% CI: 0-0) hospital beds being required on 2020-08-04 if no further interventions are introduced (Scenario 1). Similarly, we estimate that over the next 4 weeks demand for critical care (ICU) beds will change from 0 (95% CI: 0-0) patients requiring treatment with mechanical ventilation at the current date to 0 (95% CI: 0-0) by 2020-08-04. These projections assume that approximately 5% of all infections will require treatment with high-pressure oxygen and that approximately 30% of hospitalised cases will require treatment with mechanical ventilation (based on analysis of ongoing epidemics in Europe). **N.B. These scenarios are unlikely to show significant differences for the first week since there is a delay of approximately 10 days between infection and hospital admission. Consequently, the effectiveness of a change in policy is likely to be better captured by hospital admission data approximately 2 weeks after the policy change is implemented.**

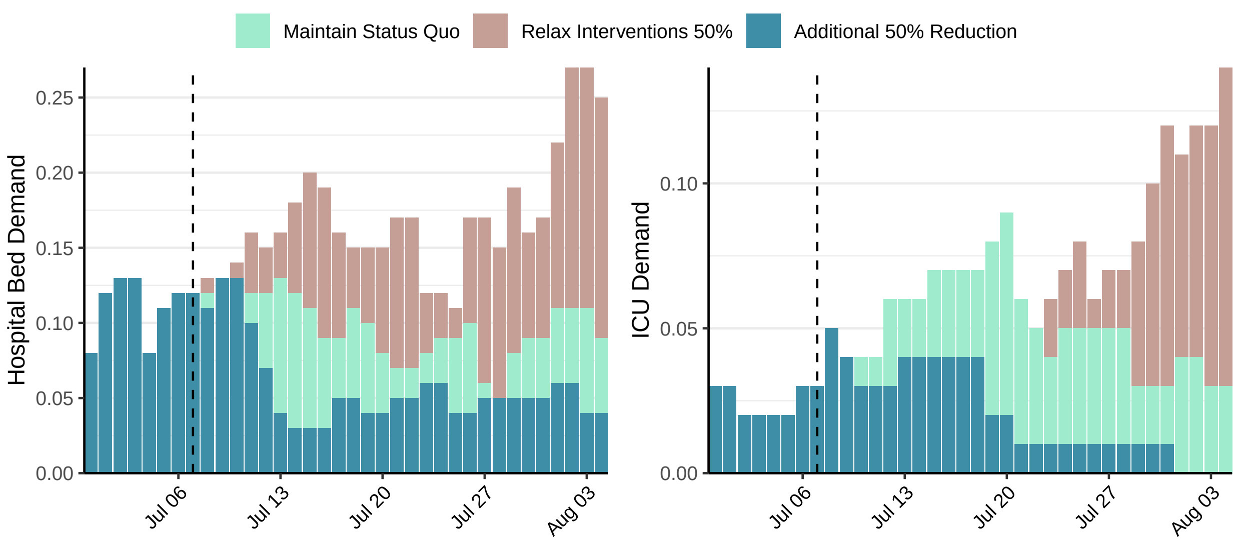

Figure 5: **Healthcare demands in the next 28 days.** Individuals needing an ICU bed are assumed to need mechanical ventilation. Projected demand for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

The impact of each scenario has a more immediate effect on the daily number of infections. The figure below shows the impact of each scenario on the estimated daily incidence of new infections. If interventions are scaled up (Scenario 2), the daily number of infections will change from 1 (95% CI: 0-1) at the current date to 0 (95% CI: 0-0) by 2020-08-04. If current interventions were relaxed by 50%, we estimate the daily number of infections will change from 1 (95% CI: 0-1) at the current date to 4 (95% CI: 0-8) by 2020-08-04.

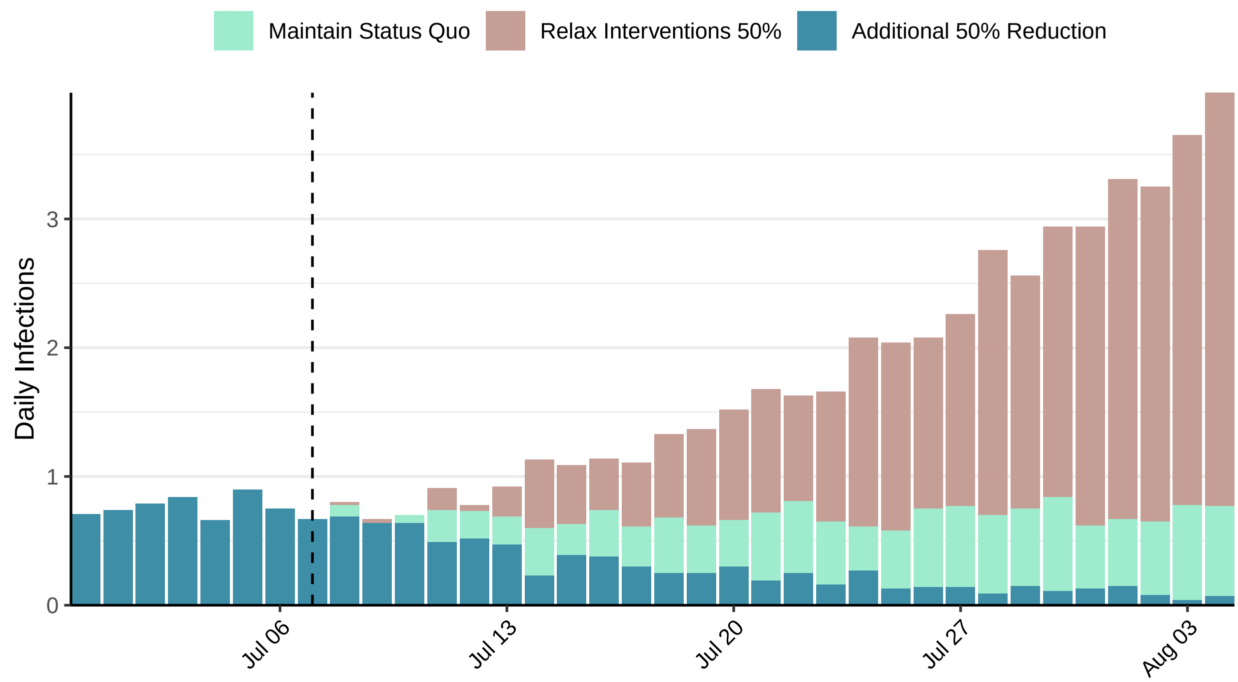

Figure 6: **Daily number of infections estimated by fitting to deaths.** Projected infections for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

To explore different scenarios, we recommend using our COVID-19 Scenario Analysis Tool - https://covidsim.org/, which can be used to simulate different intervention scenarios and explore the long term impact on healthcare demand.

Situation Report for COVID-19: Benin, 2020-07-07

Download the report for Benin, 2020-07-07 here. This report uses data from the European Centre for Disease Control. These data are updated daily and whilst there may be a short delay, they are generally consistent with Ministry reports. These data are then used to back-calculate an 'inferred number of COVID-19 infections' using mathematical modelling techniques (see Report 12 for further details) to estimate the number of people that have been infected and to make short-term projections for future healthcare needs.

Epidemiological Situation

Total Reported Cases	New Reported Cases	Total Reported Deaths	New Reported Deaths	Estimated R_t
1,199	0	21	0	1.34 (95% CI: 1.13-1.57)

The figure below shows the cumulative reported deaths as a function of the time since the 10th death was reported. Dashed lines show the expected trajectory for different doubling times of the epidemic. For example, with a doubling time of 3 days, if there are currently a total of 20 deaths reported, we would expect there to be 40 deaths in total reported in 3 days-time, 80 deaths in 6 days-time, 160 deaths in 9 days-time etc. For most epidemics, in the absence of interventions, we expect a doubling time of 3-4 days for this disease.

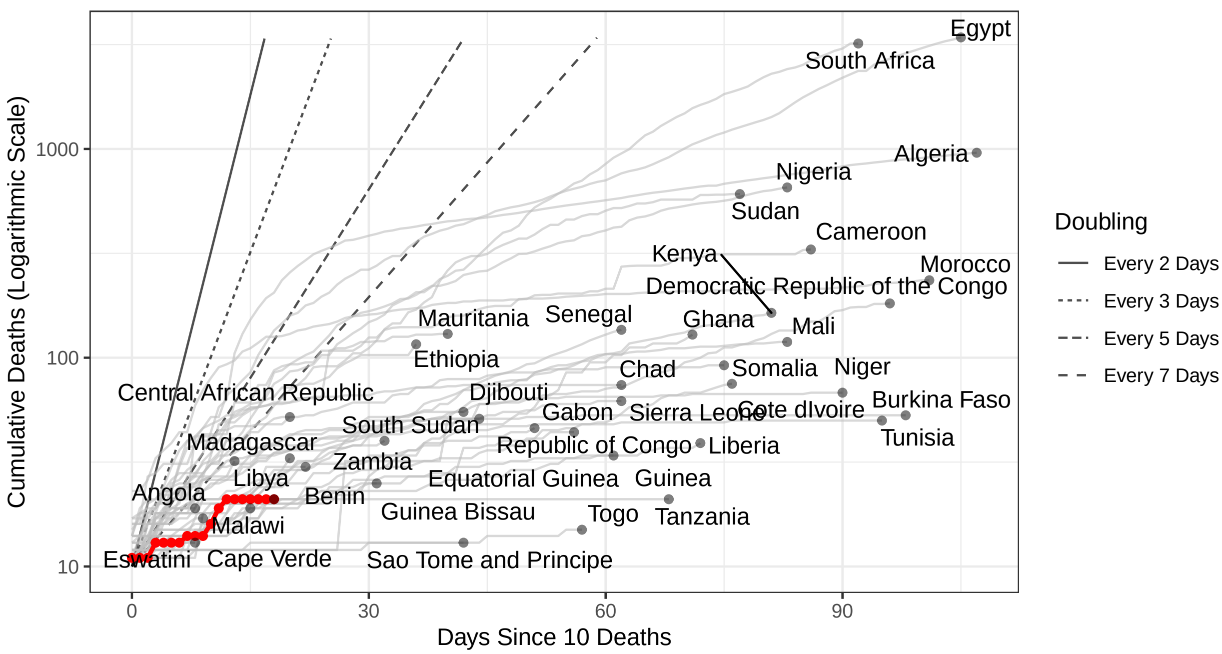

Figure 1: **Cumulative Deaths since 10 deaths.** Country not shown if fewer than 10 deaths.

COVID-19 Transmission Modelling

We assume that the deaths reported to date provide the best indication of the stage of the epidemic, as deaths are more consistently and accurately reported. Our current working estimate is that 1 death indicates that approximately 100 people will have been infected with the other 99 recovering (based on an infection fatality ratio of ~1%). These infections will have happened approximately 21 days previously – capturing a 5-day period from infection to onset of symptoms (the incubation period), 4 days from onset of symptoms to hospitalisation, and 12 days in hospital before death. With a 3-day doubling time, 100 infections that occurred 15 days ago will have generated 200 infections 12 days ago, 400 infections 9 days ago, 800 infections 6 days ago and 1,600 infections 3 days ago resulting in approximately 3,200 infections at the time the first death is observed.

To explore this, we fit our age-structured SEIR model (see Methods) to the time series of deaths in a country, in order to estimate the start date of the epidemic and the baseline R0. We assume that 100% of COVID-19 related deaths have been reported. We have also included the impact of interventions that have been put in place and their effect on human mobility and transmission based on the Google COVID-19 Community Mobility Reports. Using our mathematical model that formalises this approach, we estimate that there has been a total of 11,206 (95% CI: 9,155-13,256) infections over the past 4 weeks.

The figure below shows the estimated number of people infected over the past 4 weeks. The bar charts show, for comparison, the number of reported cases. The right-hand plot shows these data on a different scale as the estimated infections are likely to be much larger than the reported cases. **Importantly**, the estimated infections includes both asymptomatic and mild cases that would not necessarily be identified through surveillance. Consequently, the estimated infections are likely to be significantly higher than the reported cases (see our FAQ for further explanation of these differences and why the reported cases and estimated infections are unlikely to match). **N.B. Benin has revised their historic reported cases and thus have reported negative cases.**

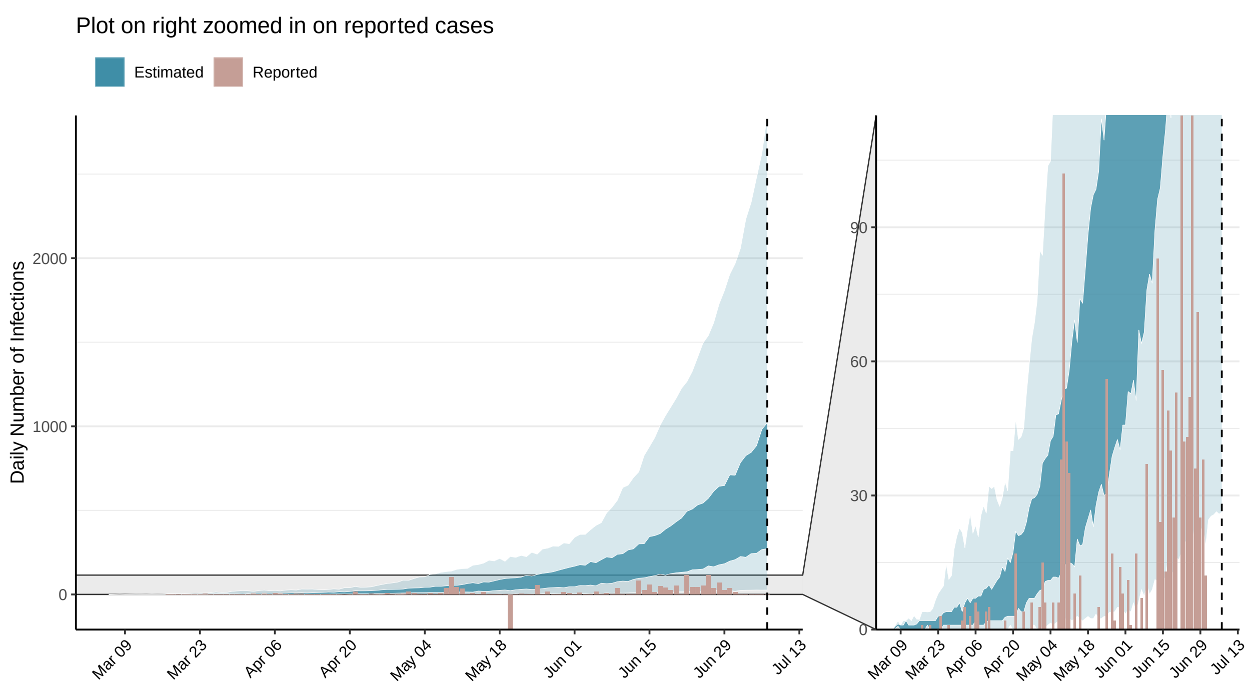

Figure 2: **Daily number of infections estimated by fitting to the current total of deaths.** Reported cases are shown in red. Model estimated infections are shown in blue (dark blue 50% interquartile range, light blue 95% quantile). The dashed line shows the current day.

By fitting to the time series of deaths, we are able to estimate a time-varying reproduction number, R_t. R_t is the the average number of secondary infections caused by a single infected person at a given time. If R_t is above 1, the rate of transmission is increasing and the number of new infections is increasing. R_t is assumed to change in relation to mobility fall in proportion. When fitting our model we assume that 100% of COVID-19 related deaths have been reported (please see our FAQ section for more information about this assumption). We also assume a fixed date at which the impact of mobility on transmission changes from pre-lockdown levels to post-lockdown levels, which may cause large changes in Rt. We are working to refine how this switch occurs and to formally calculate its shape.

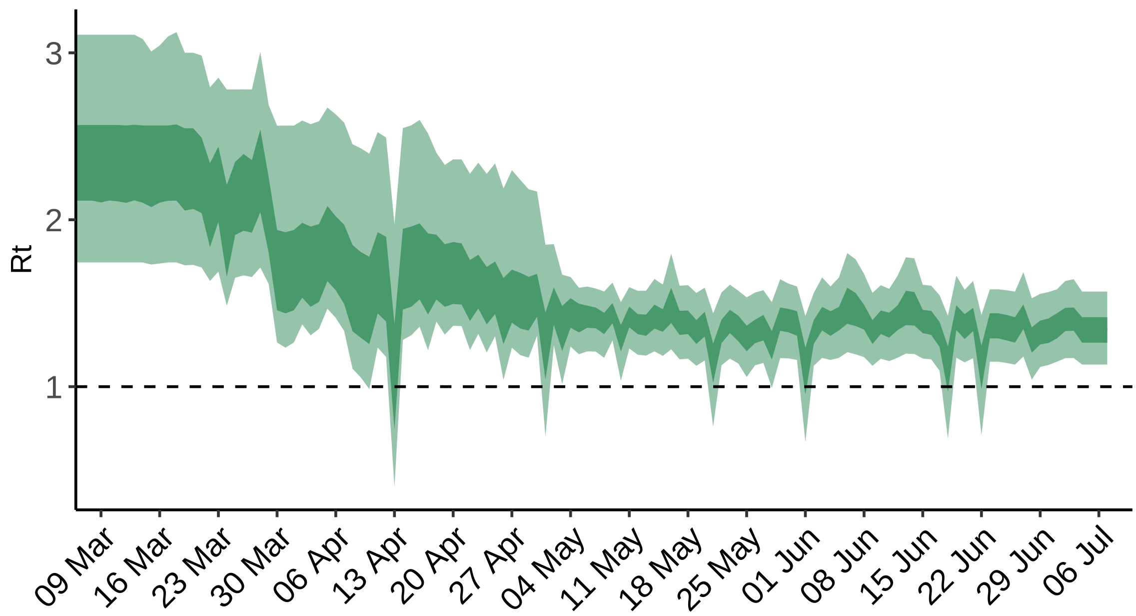

Figure 3: **Time-varying reproduction number, R_t.** R_t is the average number of secondary infections caused by a single infected person at time equal to t. $R_t < 1$ indicates a slowing epidemic in which new infections are not increasing. $R_t > 1$ indicates a growing epidemic in which new infections are increasing over time. Dark green shows the 50% CI and light green shows the 95% CI.

Using the model fit, we can forecast the expected trajectory for cumulative deaths, which is shown in the figure below. This assumes a severity pattern by age that is consistent with that observed in China, Europe and the U.S to date. This projection assumes that transmission is maintained at the current level of transmission as estimated by the final R_t value.

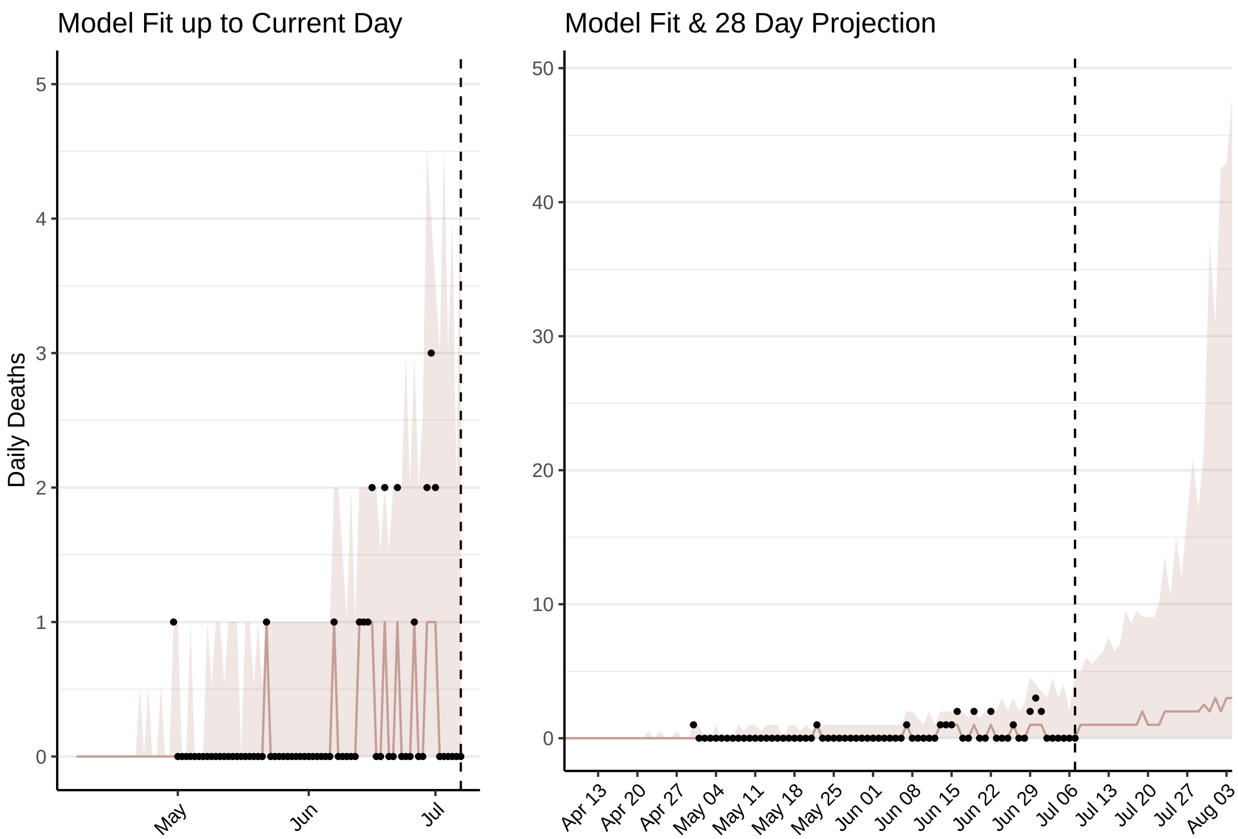

Figure 4: **Estimated daily deaths.** Projected deaths assuming the current level of interventions are maintained are shown in red (median and 95% quantile). Reported deaths are plotted in black. The plot on the left is focussed on the model fit prior to today, while the plot on the right forecasts the next 28 days.

Short-term Epidemic Scenarios

We make the following short-term projections of healthcare demand and new infections under the following three scenarios:

- **Scenario 1.** The epidemic continues to grow at the current rate.
- **Scenario 2.** Countries will further scale up interventions (either increasing current strategies or implementing new interventions) leading to a further 50% reduction in transmission.
- **Scenario 3.** Countries will relax current interventions by 50%

N.B. These scenarios currently assume that the impact of mobility on transmission will remain the same in the future as it has in the past. We are working to extend methods to estimate the impact of increases in mobility on transmission as lockdown and interventions are reversed. Consequently, projection are likely to represent an upper estimate of the healthcare demand and case load for each scenario

We estimate that over the next 4 weeks demand for hospital beds will change from 63 (95% CI: 51-75) patients requiring treatment with high-pressure oxygen at the current date to 291 (95% CI: 219-362) hospital beds being required on 2020-08-04 if no further interventions are introduced (Scenario 1). Similarly, we estimate that over the next 4 weeks demand for critical care (ICU) beds will change from 18 (95% CI: 14-21) patients requiring treatment with mechanical ventilation at the current date to 72 (95% CI: 57-87) by 2020-08-04. These projections assume that approximately 5% of all infections will require treatment with high-pressure oxygen and that approximately 30% of hospitalised cases will require treatment with mechanical ventilation (based on analysis of ongoing epidemics in Europe). **N.B. These scenarios are unlikely to show significant differences for the first week since there is a delay of approximately 10 days between infection and hospital admission. Consequently, the effectiveness of a change in policy is likely to be better captured by hospital admission data approximately 2 weeks after the policy change is implemented.**

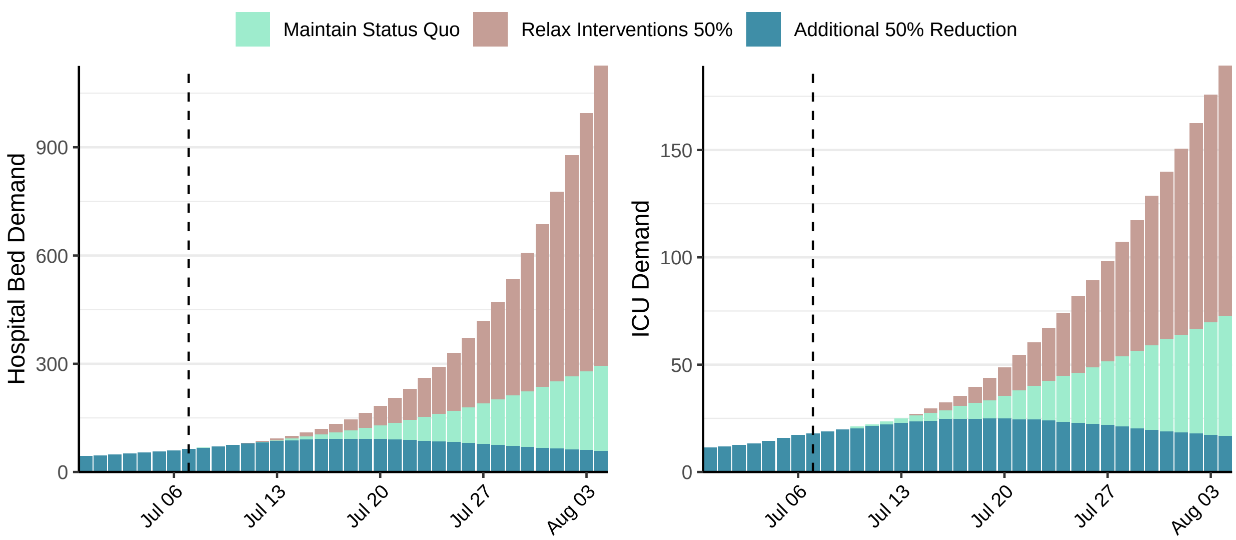

Figure 5: **Healthcare demands in the next 28 days.** Individuals needing an ICU bed are assumed to need mechanical ventilation. Projected demand for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

The impact of each scenario has a more immediate effect on the daily number of infections. The figure below shows the impact of each scenario on the estimated daily incidence of new infections. If interventions are scaled up (Scenario 2), the daily number of infections will change from 745 (95% CI: 594-896) at the current date to 214 (95% CI: 158-271) by 2020-08-04. If current interventions were relaxed by 50%, we estimate the daily number of infections will change from 745 (95% CI: 594-896) at the current date to 22,651 (95% CI: 16,568-28,734) by 2020-08-04.

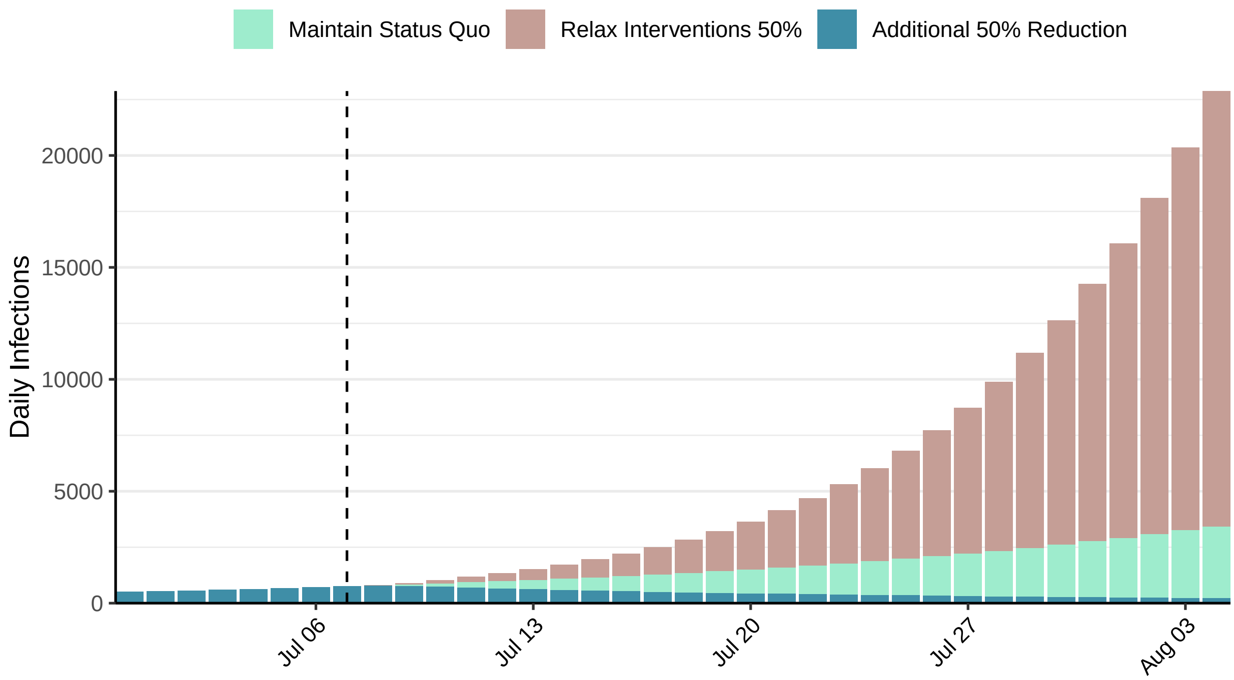

Figure 6: **Daily number of infections estimated by fitting to deaths.** Projected infections for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

To explore different scenarios, we recommend using our COVID-19 Scenario Analysis Tool - https://covidsim.org/, which can be used to simulate different intervention scenarios and explore the long term impact on healthcare demand.

Situation Report for COVID-19: Burkina Faso, 2020-07-07

Download the report for Burkina Faso, 2020-07-07 here. This report uses data from the European Centre for Disease Control. These data are updated daily and whilst there may be a short delay, they are generally consistent with Ministry reports. These data are then used to back-calculate an 'inferred number of COVID-19 infections' using mathematical modelling techniques (see Report 12 for further details) to estimate the number of people that have been infected and to make short-term projections for future healthcare needs.

Epidemiological Situation

Total Reported Cases	New Reported Cases	Total Reported Deaths	New Reported Deaths	Estimated R_t
1,000	13	53	0	0.62 (95% CI: 0.31-1)

The figure below shows the cumulative reported deaths as a function of the time since the 10th death was reported. Dashed lines show the expected trajectory for different doubling times of the epidemic. For example, with a doubling time of 3 days, if there are currently a total of 20 deaths reported, we would expect there to be 40 deaths in total reported in 3 days-time, 80 deaths in 6 days-time, 160 deaths in 9 days-time etc. For most epidemics, in the absence of interventions, we expect a doubling time of 3-4 days for this disease.

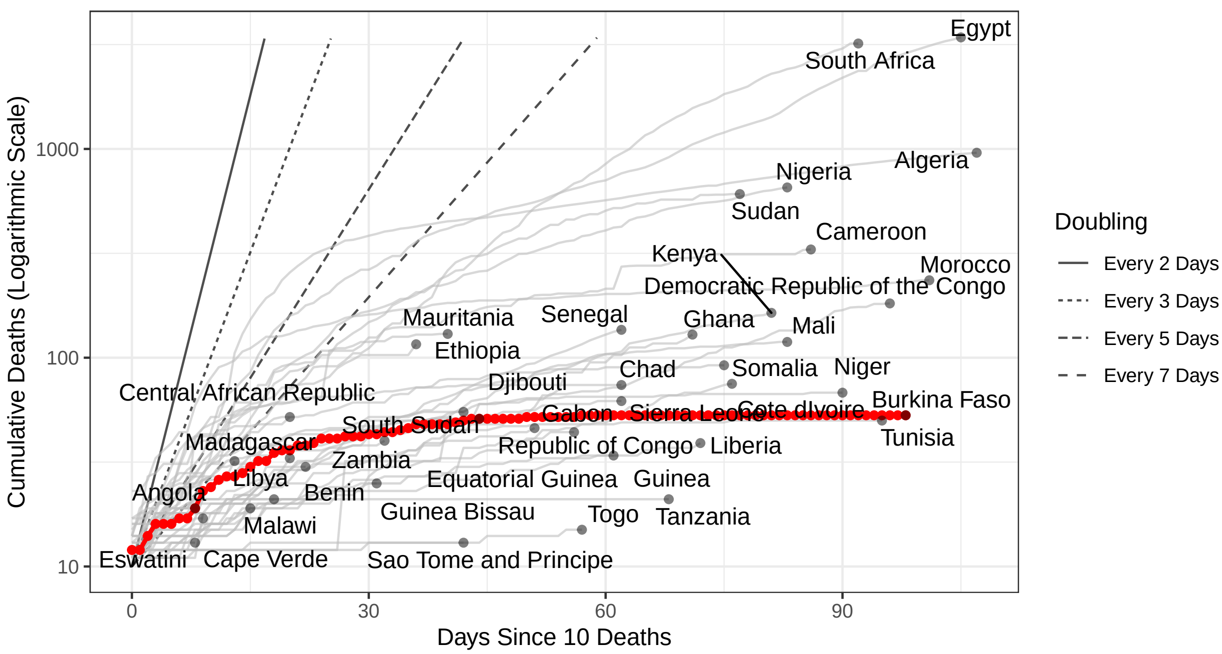

Figure 1: **Cumulative Deaths since 10 deaths.** Country not shown if fewer than 10 deaths.

COVID-19 Transmission Modelling

We assume that the deaths reported to date provide the best indication of the stage of the epidemic, as deaths are more consistently and accurately reported. Our current working estimate is that 1 death indicates that approximately 100 people will have been infected with the other 99 recovering (based on an infection fatality ratio of ~1%). These infections will have happened approximately 21 days previously – capturing a 5-day period from infection to onset of symptoms (the incubation period), 4 days from onset of symptoms to hospitalisation, and 12 days in hospital before death. With a 3-day doubling time, 100 infections that occurred 15 days ago will have generated 200 infections 12 days ago, 400 infections 9 days ago, 800 infections 6 days ago and 1,600 infections 3 days ago resulting in approximately 3,200 infections at the time the first death is observed.

To explore this, we fit our age-structured SEIR model (see Methods) to the time series of deaths in a country, in order to estimate the start date of the epidemic and the baseline R0. We assume that 100% of COVID-19 related deaths have been reported. We have also included the impact of interventions that have been put in place and their effect on human mobility and transmission based on the Google COVID-19 Community Mobility Reports. Using our mathematical model that formalises this approach, we estimate that there has been a total of 82 (95% CI: 54-110) infections over the past 4 weeks.

The figure below shows the estimated number of people infected over the past 4 weeks. The bar charts show, for comparison, the number of reported cases. The right-hand plot shows these data on a different scale as the estimated infections are likely to be much larger than the reported cases. **Importantly**, the estimated infections includes both asymptomatic and mild cases that would not necessarily be identified through surveillance. Consequently, the estimated infections are likely to be significantly higher than the reported cases (see our FAQ for further explanation of these differences and why the reported cases and estimated infections are unlikely to match).

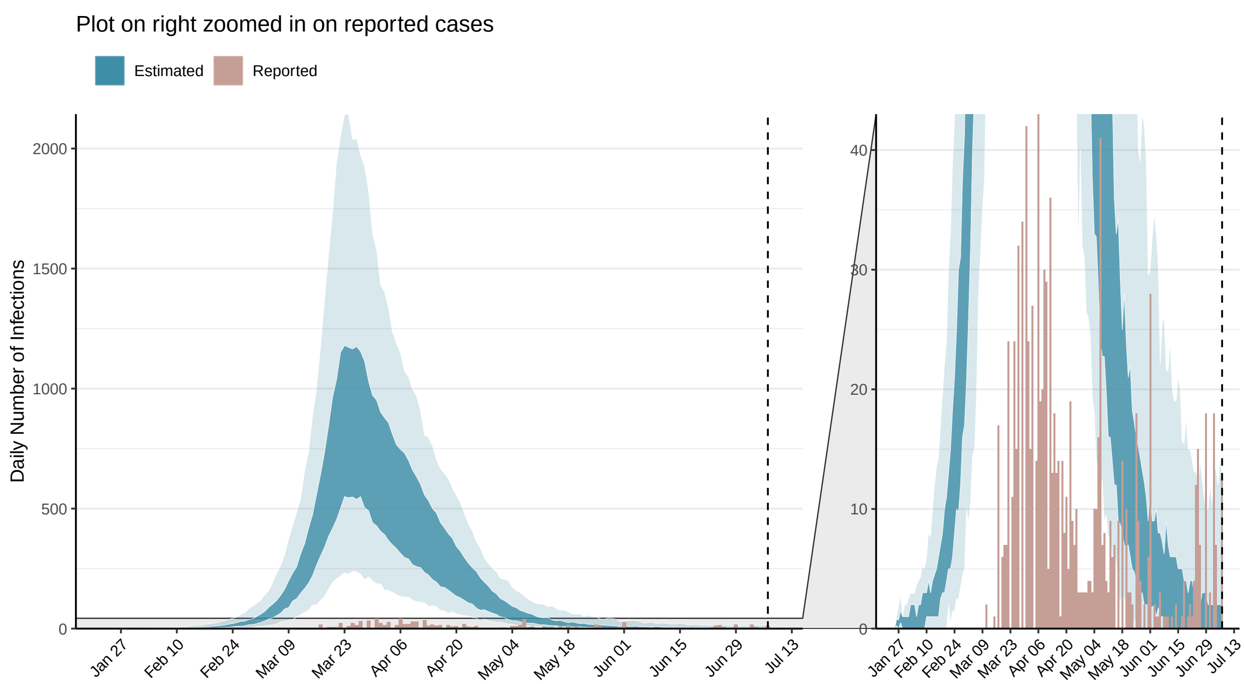

Figure 2: **Daily number of infections estimated by fitting to the current total of deaths.** Reported cases are shown in red. Model estimated infections are shown in blue (dark blue 50% interquartile range, light blue 95% quantile). The dashed line shows the current day.

By fitting to the time series of deaths, we are able to estimate a time-varying reproduction number, R_t. R_t is the the average number of secondary infections caused by a single infected person at a given time. If R_t is above 1, the rate of transmission is increasing and the number of new infections is increasing. R_t is assumed to change in relation to mobility fall in proportion. When fitting our model we assume that 100% of COVID-19 related deaths have been reported (please see our FAQ section for more information about this assumption). We also assume a fixed date at which the impact of mobility on transmission changes from pre-lockdown levels to post-lockdown levels, which may cause large changes in Rt. We are working to refine how this switch occurs and to formally calculate its shape.

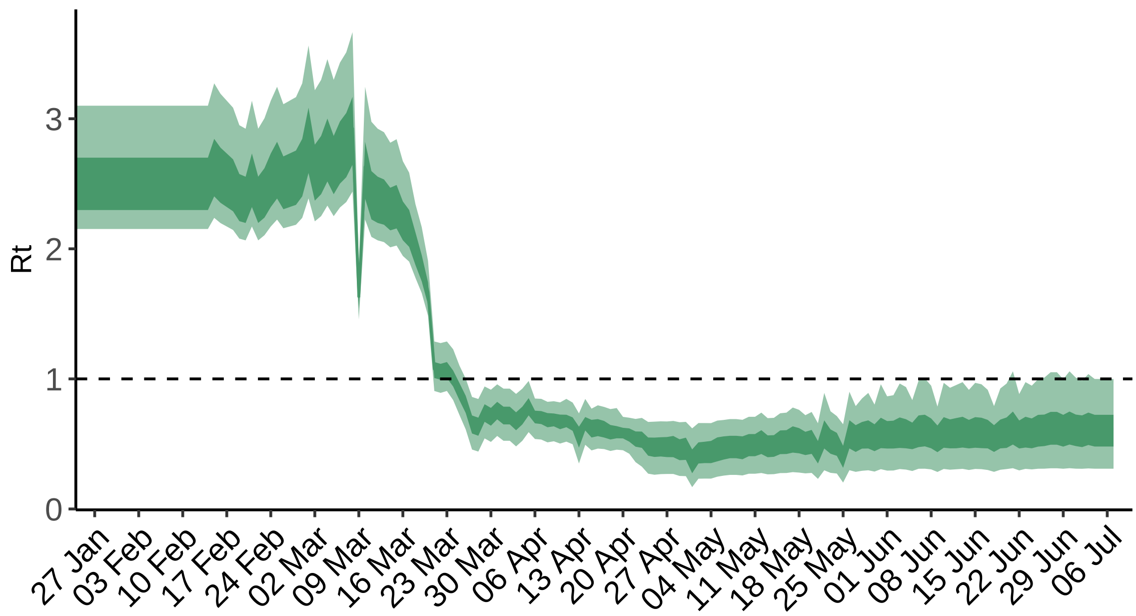

Figure 3: **Time-varying reproduction number, R_t.** R_t is the average number of secondary infections caused by a single infected person at time equal to t. $R_t < 1$ indicates a slowing epidemic in which new infections are not increasing. $R_t > 1$ indicates a growing epidemic in which new infections are increasing over time. Dark green shows the 50% CI and light green shows the 95% CI.

Using the model fit, we can forecast the expected trajectory for cumulative deaths, which is shown in the figure below. This assumes a severity pattern by age that is consistent with that observed in China, Europe and the U.S to date. This projection assumes that transmission is maintained at the current level of transmission as estimated by the final R_t value.

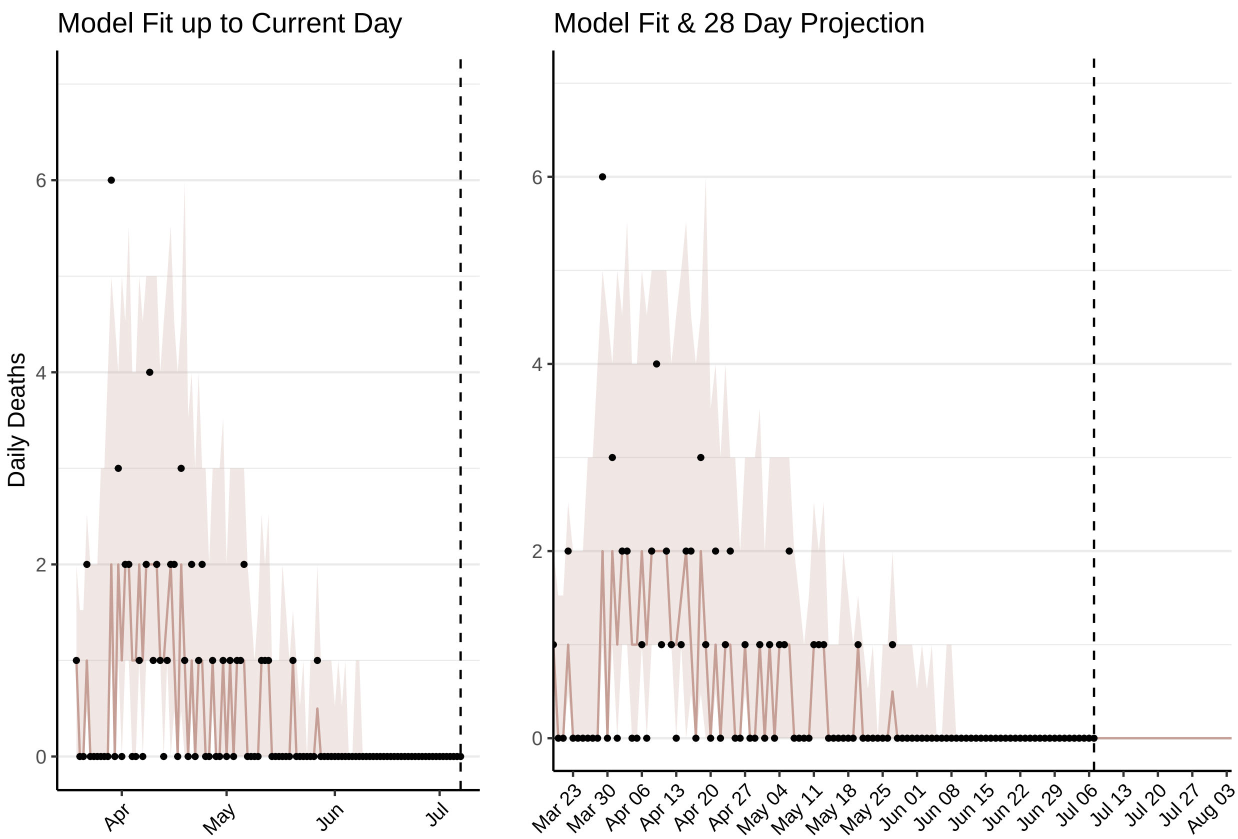

Figure 4: **Estimated daily deaths.** Projected deaths assuming the current level of interventions are maintained are shown in red (median and 95% quantile). Reported deaths are plotted in black. The plot on the left is focussed on the model fit prior to today, while the plot on the right forecasts the next 28 days.

Short-term Epidemic Scenarios

We make the following short-term projections of healthcare demand and new infections under the following three scenarios:

- **Scenario 1.** The epidemic continues to grow at the current rate.
- **Scenario 2.** Countries will further scale up interventions (either increasing current strategies or implementing new interventions) leading to a further 50% reduction in transmission.
- **Scenario 3.** Countries will relax current interventions by 50%

N.B. These scenarios currently assume that the impact of mobility on transmission will remain the same in the future as it has in the past. We are working to extend methods to estimate the impact of increases in mobility on transmission as lockdown and interventions are reversed. Consequently, projection are likely to represent an upper estimate of the healthcare demand and case load for each scenario

We estimate that over the next 4 weeks demand for hospital beds will change from 0 (95% CI: 0-0) patients requiring treatment with high-pressure oxygen at the current date to 0 (95% CI: 0-0) hospital beds being required on 2020-08-04 if no further interventions are introduced (Scenario 1). Similarly, we estimate that over the next 4 weeks demand for critical care (ICU) beds will change from 0 (95% CI: 0-0) patients requiring treatment with mechanical ventilation at the current date to 0 (95% CI: 0-0) by 2020-08-04. These projections assume that approximately 5% of all infections will require treatment with high-pressure oxygen and that approximately 30% of hospitalised cases will require treatment with mechanical ventilation (based on analysis of ongoing epidemics in Europe). **N.B. These scenarios are unlikely to show significant differences for the first week since there is a delay of approximately 10 days between infection and hospital admission. Consequently, the effectiveness of a change in policy is likely to be better captured by hospital admission data approximately 2 weeks after the policy change is implemented.**

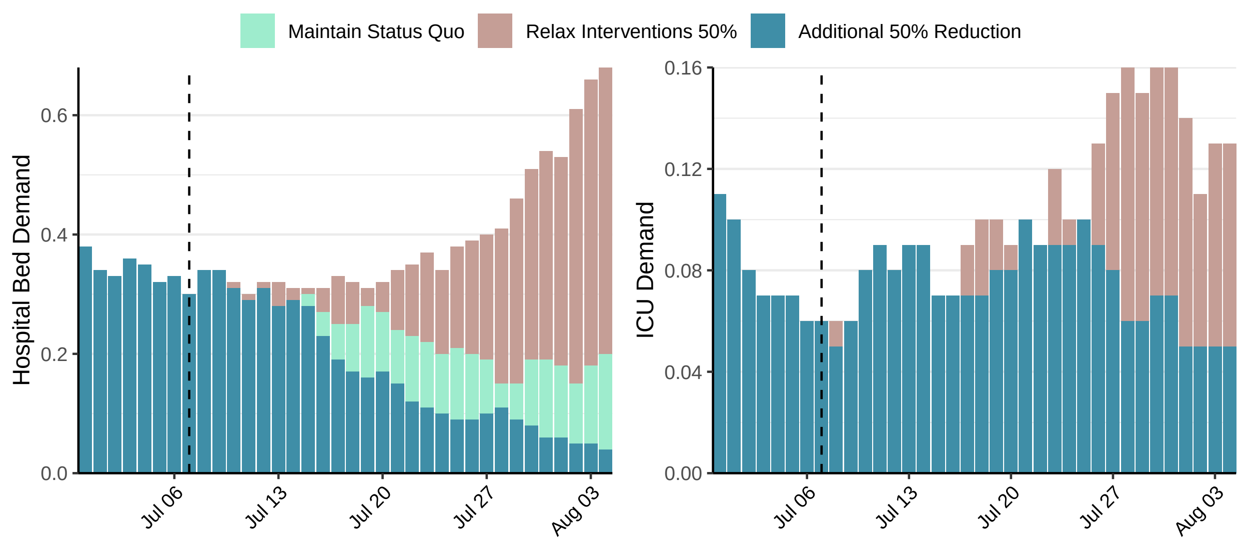

Figure 5: **Healthcare demands in the next 28 days.** Individuals needing an ICU bed are assumed to need mechanical ventilation. Projected demand for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

The impact of each scenario has a more immediate effect on the daily number of infections. The figure below shows the impact of each scenario on the estimated daily incidence of new infections. If interventions are scaled up (Scenario 2), the daily number of infections will change from 2 (95% CI: 1-3) at the current date to 0 (95% CI: 0-0) by 2020-08-04. If current interventions were relaxed by 50%, we estimate the daily number of infections will change from 2 (95% CI: 1-3) at the current date to 7 (95% CI: 3-11) by 2020-08-04.

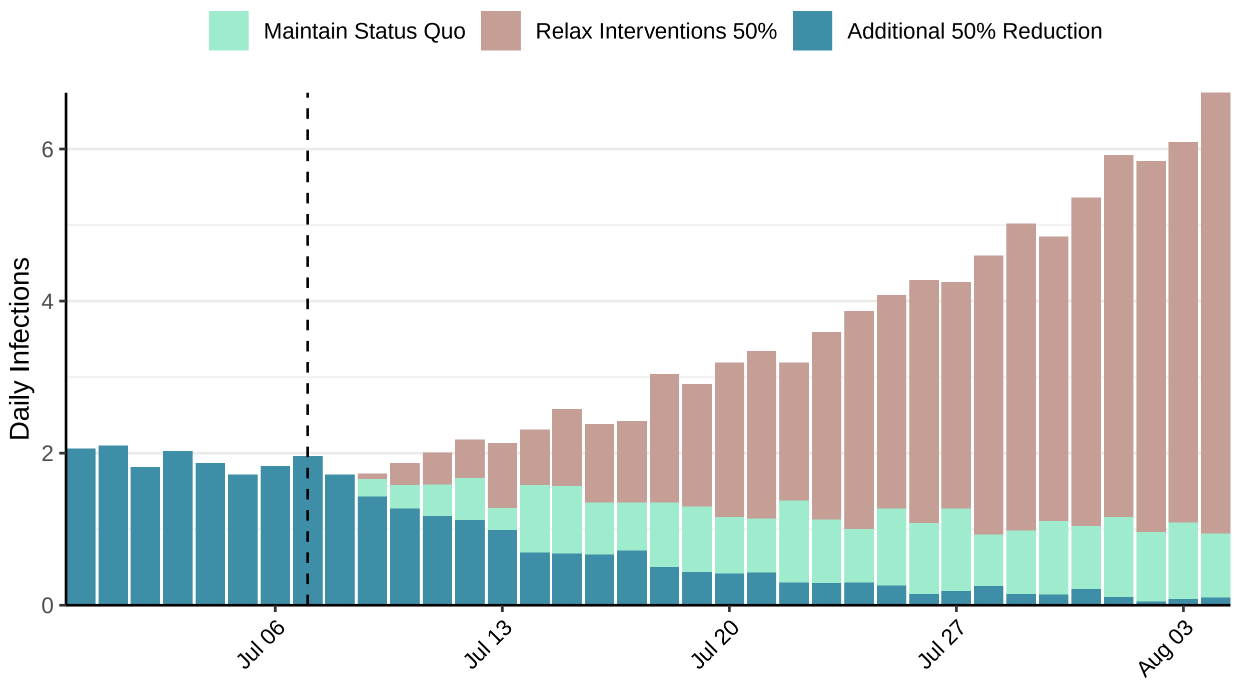

Figure 6: **Daily number of infections estimated by fitting to deaths.** Projected infections for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

To explore different scenarios, we recommend using our COVID-19 Scenario Analysis Tool - https://covidsim.org/, which can be used to simulate different intervention scenarios and explore the long term impact on healthcare demand.

Situation Report for COVID-19: Bangladesh, 2020-07-07

Download the report for Bangladesh, 2020-07-07 here. This report uses data from the European Centre for Disease Control. These data are updated daily and whilst there may be a short delay, they are generally consistent with Ministry reports. These data are then used to back-calculate an 'inferred number of COVID-19 infections' using mathematical modelling techniques (see Report 12 for further details) to estimate the number of people that have been infected and to make short-term projections for future healthcare needs.

Epidemiological Situation

Total Reported Cases	New Reported Cases	Total Reported Deaths	New Reported Deaths	Estimated R_t
165,618	3,201	2,096	44	1.04 (95% CI: 0.95-1.16)

The figure below shows the cumulative reported deaths as a function of the time since the 10th death was reported. Dashed lines show the expected trajectory for different doubling times of the epidemic. For example, with a doubling time of 3 days, if there are currently a total of 20 deaths reported, we would expect there to be 40 deaths in total reported in 3 days-time, 80 deaths in 6 days-time, 160 deaths in 9 days-time etc. For most epidemics, in the absence of interventions, we expect a doubling time of 3-4 days for this disease.

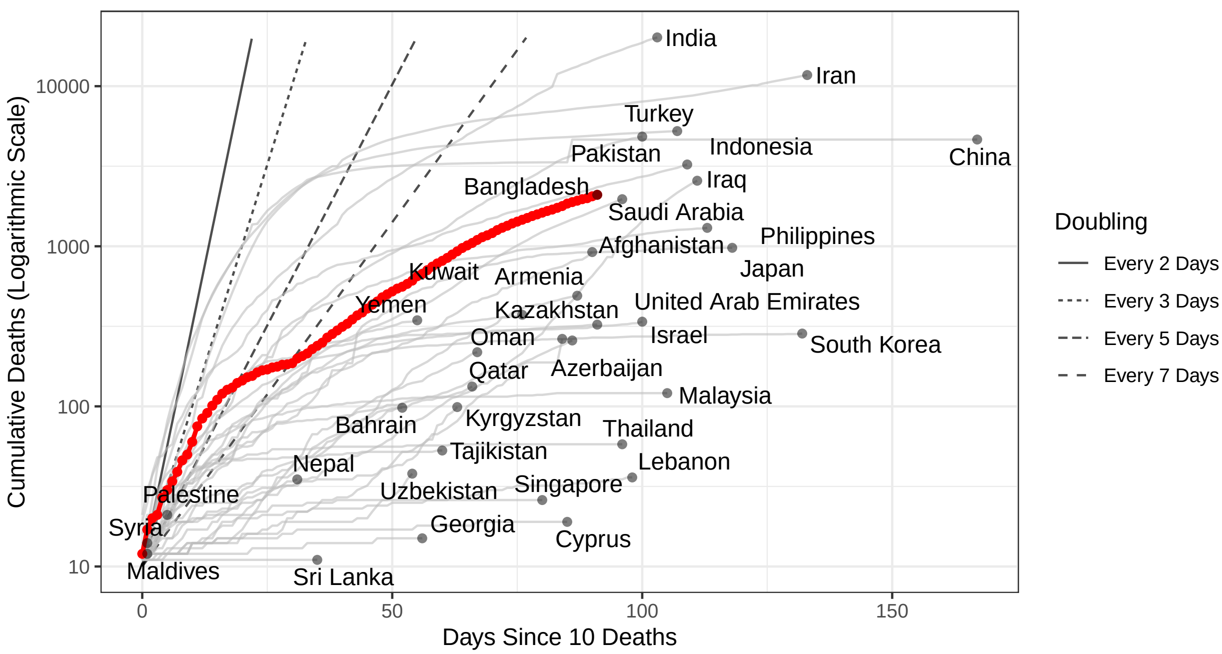

Figure 1: **Cumulative Deaths since 10 deaths.** Country not shown if fewer than 10 deaths.

COVID-19 Transmission Modelling

We assume that the deaths reported to date provide the best indication of the stage of the epidemic, as deaths are more consistently and accurately reported. Our current working estimate is that 1 death indicates that approximately 100 people will have been infected with the other 99 recovering (based on an infection fatality ratio of ~1%). These infections will have happened approximately 21 days previously – capturing a 5-day period from infection to onset of symptoms (the incubation period), 4 days from onset of symptoms to hospitalisation, and 12 days in hospital before death. With a 3-day doubling time, 100 infections that occurred 15 days ago will have generated 200 infections 12 days ago, 400 infections 9 days ago, 800 infections 6 days ago and 1,600 infections 3 days ago resulting in approximately 3,200 infections at the time the first death is observed.

To explore this, we fit our age-structured SEIR model (see Methods) to the time series of deaths in a country, in order to estimate the start date of the epidemic and the baseline R0. We assume that 100% of COVID-19 related deaths have been reported. We have also included the impact of interventions that have been put in place and their effect on human mobility and transmission based on the Google COVID-19 Community Mobility Reports. Using our mathematical model that formalises this approach, we estimate that there has been a total of 477,514 (95% CI: 421,805-533,224) infections over the past 4 weeks.

The figure below shows the estimated number of people infected over the past 4 weeks. The bar charts show, for comparison, the number of reported cases. The right-hand plot shows these data on a different scale as the estimated infections are likely to be much larger than the reported cases. **Importantly**, the estimated infections includes both asymptomatic and mild cases that would not necessarily be identified through surveillance. Consequently, the estimated infections are likely to be significantly higher than the reported cases (see our FAQ for further explanation of these differences and why the reported cases and estimated infections are unlikely to match).

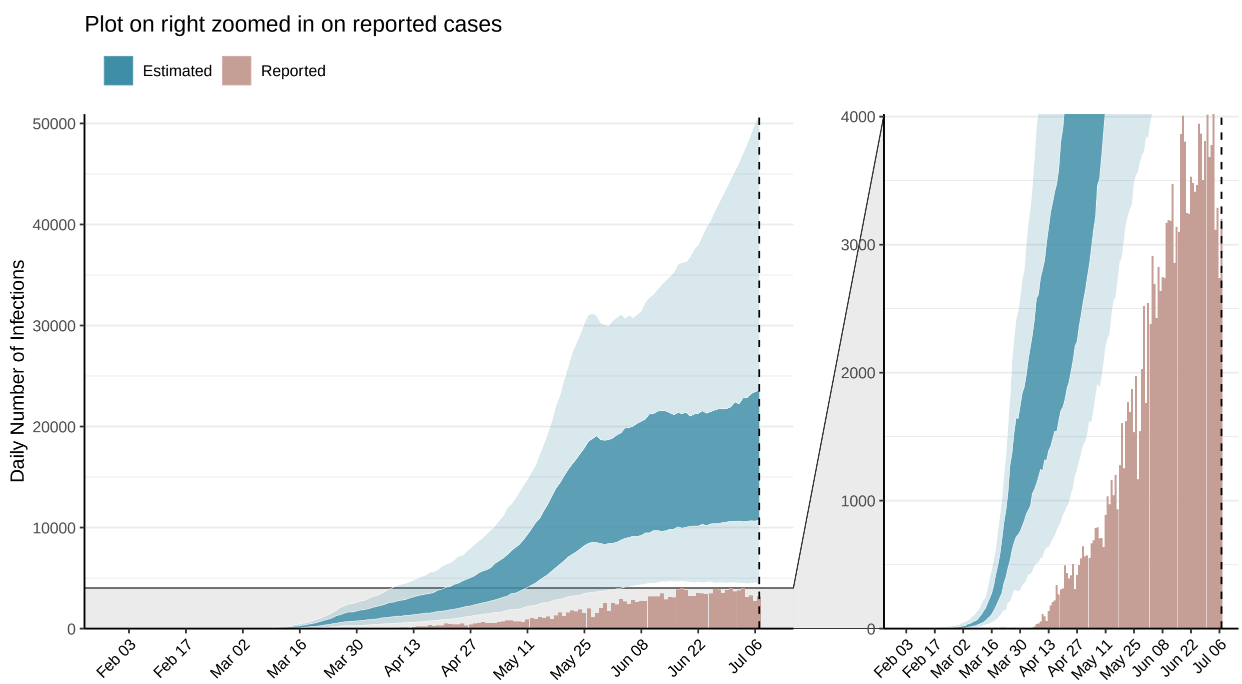

Figure 2: **Daily number of infections estimated by fitting to the current total of deaths.** Reported cases are shown in red. Model estimated infections are shown in blue (dark blue 50% interquartile range, light blue 95% quantile). The dashed line shows the current day.

By fitting to the time series of deaths, we are able to estimate a time-varying reproduction number, R_t. R_t is the the average number of secondary infections caused by a single infected person at a given time. If R_t is above 1, the rate of transmission is increasing and the number of new infections is increasing. R_t is assumed to change in relation to mobility fall in proportion. When fitting our model we assume that 100% of COVID-19 related deaths have been reported (please see our FAQ section for more information about this assumption). We also assume a fixed date at which the impact of mobility on transmission changes from pre-lockdown levels to post-lockdown levels, which may cause large changes in Rt. We are working to refine how this switch occurs and to formally calculate its shape.

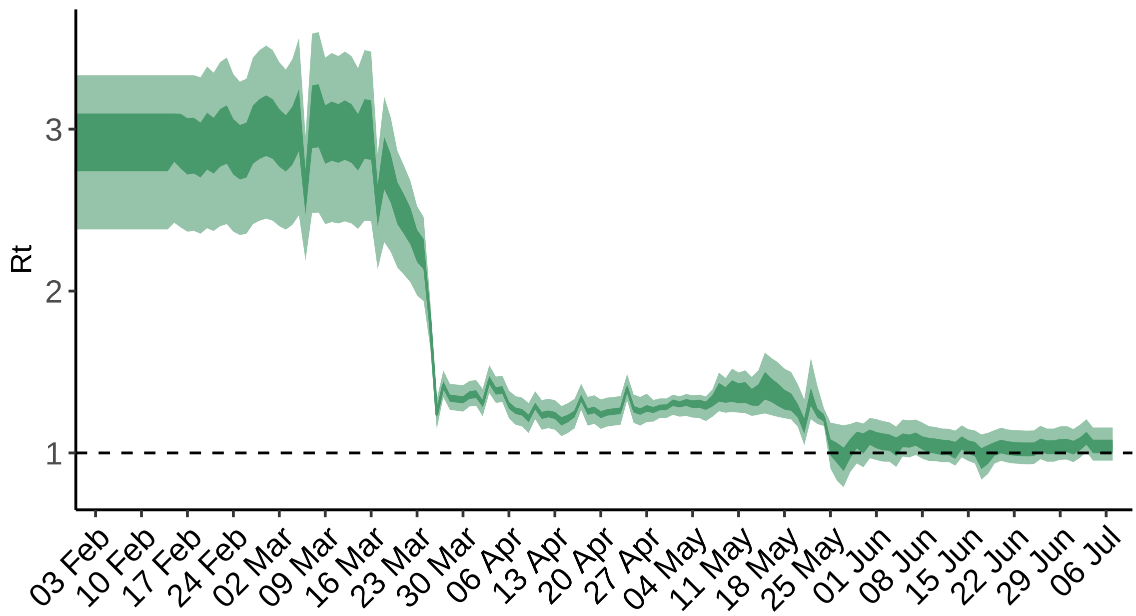

Figure 3: **Time-varying reproduction number, R_t.** R_t is the average number of secondary infections caused by a single infected person at time equal to t. $R_t < 1$ indicates a slowing epidemic in which new infections are not increasing. $R_t > 1$ indicates a growing epidemic in which new infections are increasing over time. Dark green shows the 50% CI and light green shows the 95% CI.

Using the model fit, we can forecast the expected trajectory for cumulative deaths, which is shown in the figure below. This assumes a severity pattern by age that is consistent with that observed in China, Europe and the U.S to date. This projection assumes that transmission is maintained at the current level of transmission as estimated by the final R_t value.

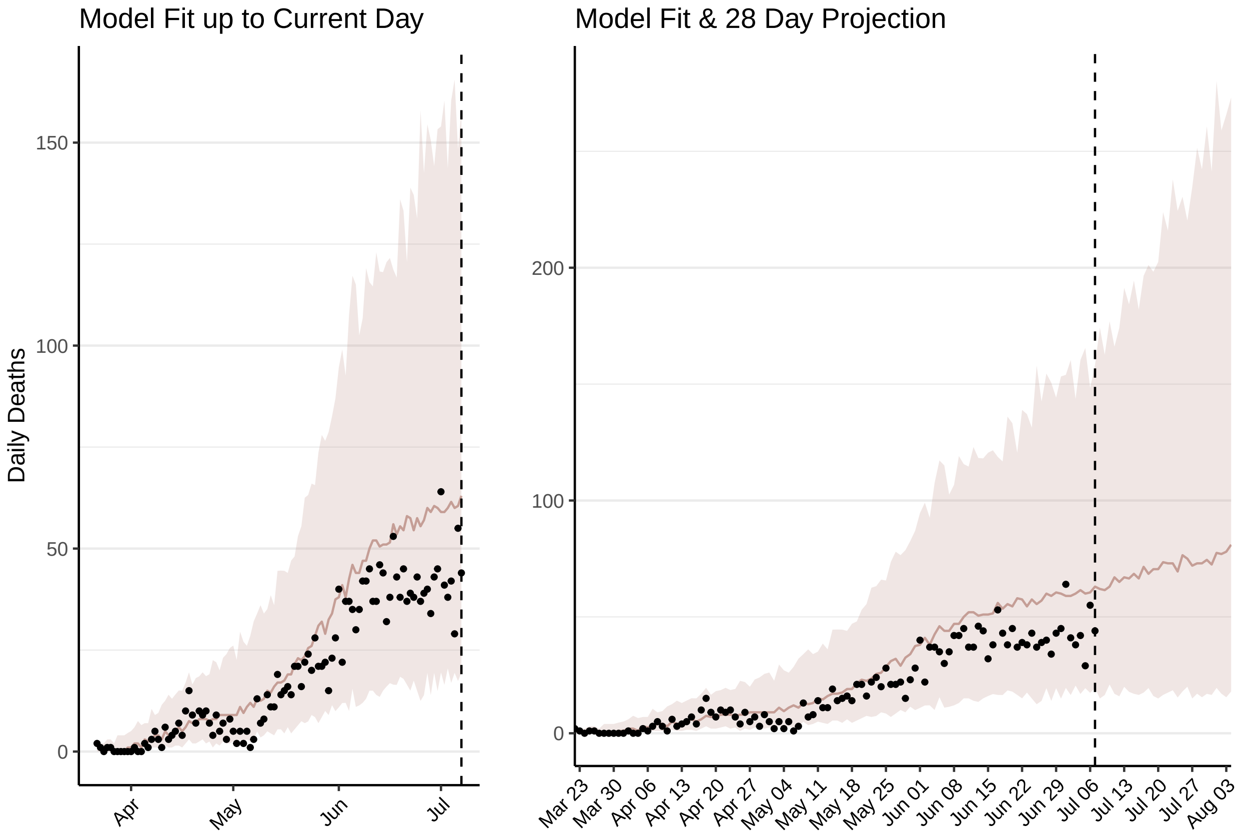

Figure 4: **Estimated daily deaths.** Projected deaths assuming the current level of interventions are maintained are shown in red (median and 95% quantile). Reported deaths are plotted in black. The plot on the left is focussed on the model fit prior to today, while the plot on the right forecasts the next 28 days.

Short-term Epidemic Scenarios

We make the following short-term projections of healthcare demand and new infections under the following three scenarios:

- **Scenario 1.** The epidemic continues to grow at the current rate.
- **Scenario 2.** Countries will further scale up interventions (either increasing current strategies or implementing new interventions) leading to a further 50% reduction in transmission.
- **Scenario 3.** Countries will relax current interventions by 50%

N.B. These scenarios currently assume that the impact of mobility on transmission will remain the same in the future as it has in the past. We are working to extend methods to estimate the impact of increases in mobility on transmission as lockdown and interventions are reversed. Consequently, projection are likely to represent an upper estimate of the healthcare demand and case load for each scenario

We estimate that over the next 4 weeks demand for hospital beds will change from 3,318 (95% CI: 2,926-3,709) patients requiring treatment with high-pressure oxygen at the current date to 4,261 (95% CI: 3,620-4,902) hospital beds being required on 2020-08-04 if no further interventions are introduced (Scenario 1). Similarly, we estimate that over the next 4 weeks demand for critical care (ICU) beds will change from 1,022 (95% CI: 901-1,143) patients requiring treatment with mechanical ventilation at the current date to 1,313 (95% CI: 1,120-1,505) by 2020-08-04. These projections assume that approximately 5% of all infections will require treatment with high-pressure oxygen and that approximately 30% of hospitalised cases will require treatment with mechanical ventilation (based on analysis of ongoing epidemics in Europe). **N.B. These scenarios are unlikely to show significant differences for the first week since there is a delay of approximately 10 days between infection and hospital admission. Consequently, the effectiveness of a change in policy is likely to be better captured by hospital admission data approximately 2 weeks after the policy change is implemented.**

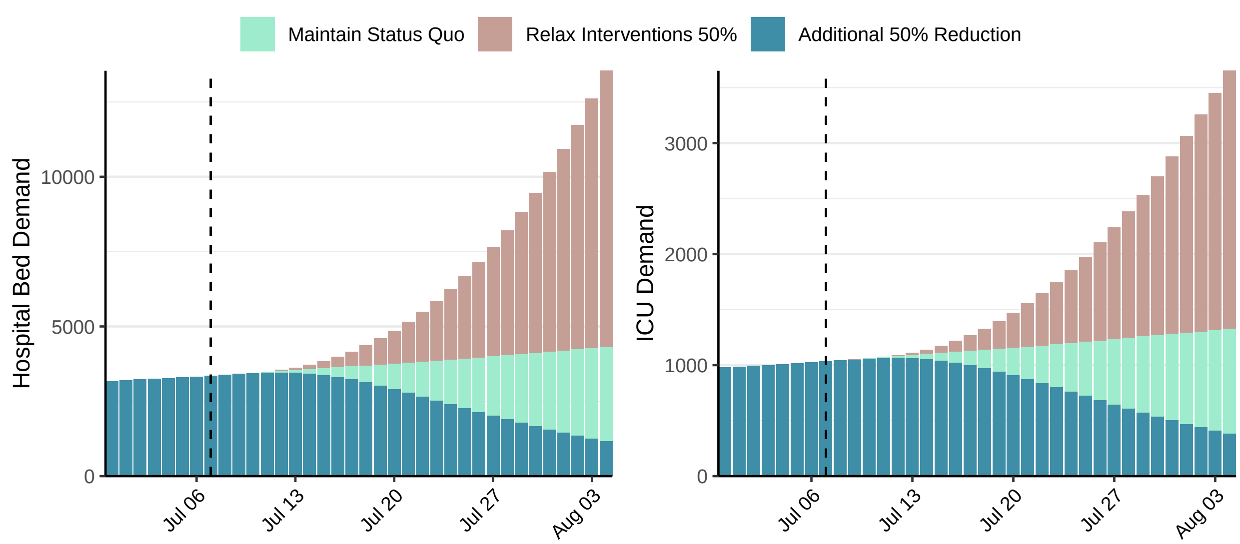

Figure 5: **Healthcare demands in the next 28 days.** Individuals needing an ICU bed are assumed to need mechanical ventilation. Projected demand for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

The impact of each scenario has a more immediate effect on the daily number of infections. The figure below shows the impact of each scenario on the estimated daily incidence of new infections. If interventions are scaled up (Scenario 2), the daily number of infections will change from 19,032 (95% CI: 16,577-21,487) at the current date to 1,999 (95% CI: 1,682-2,315) by 2020-08-04. If current interventions were relaxed by 50%, we estimate the daily number of infections will change from 19,032 (95% CI: 16,577-21,487) at the current date to 143,060 (95% CI: 119,374-166,746) by 2020-08-04.

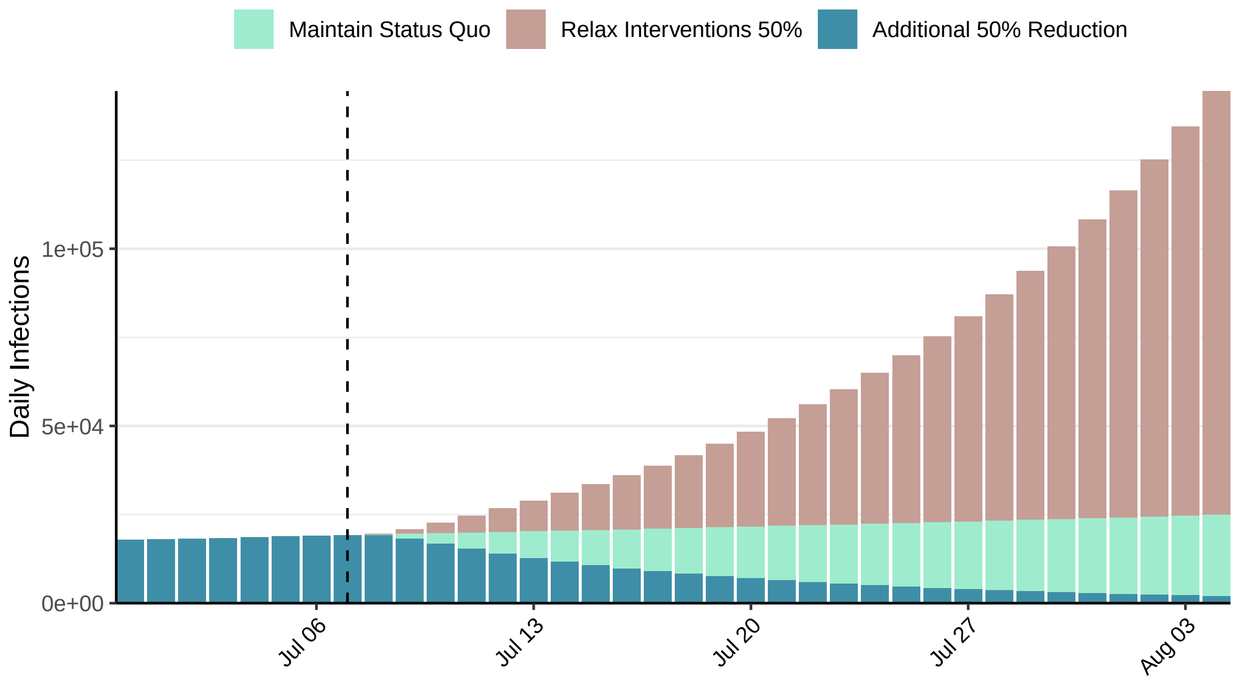

Figure 6: **Daily number of infections estimated by fitting to deaths.** Projected infections for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

To explore different scenarios, we recommend using our COVID-19 Scenario Analysis Tool - https://covidsim.org/, which can be used to simulate different intervention scenarios and explore the long term impact on healthcare demand.

Situation Report for COVID-19: Bulgaria, 2020-07-07

Download the report for Bulgaria, 2020-07-07 here. This report uses data from the European Centre for Disease Control. These data are updated daily and whilst there may be a short delay, they are generally consistent with Ministry reports. These data are then used to back-calculate an 'inferred number of COVID-19 infections' using mathematical modelling techniques (see Report 12 for further details) to estimate the number of people that have been infected and to make short-term projections for future healthcare needs.

Epidemiological Situation

Total Reported Cases	New Reported Cases	Total Reported Deaths	New Reported Deaths	Estimated R_t
5,914	174	250	4	1.13 (95% CI: 1.04-1.26)

The figure below shows the cumulative reported deaths as a function of the time since the 10th death was reported. Dashed lines show the expected trajectory for different doubling times of the epidemic. For example, with a doubling time of 3 days, if there are currently a total of 20 deaths reported, we would expect there to be 40 deaths in total reported in 3 days-time, 80 deaths in 6 days-time, 160 deaths in 9 days-time etc. For most epidemics, in the absence of interventions, we expect a doubling time of 3-4 days for this disease.

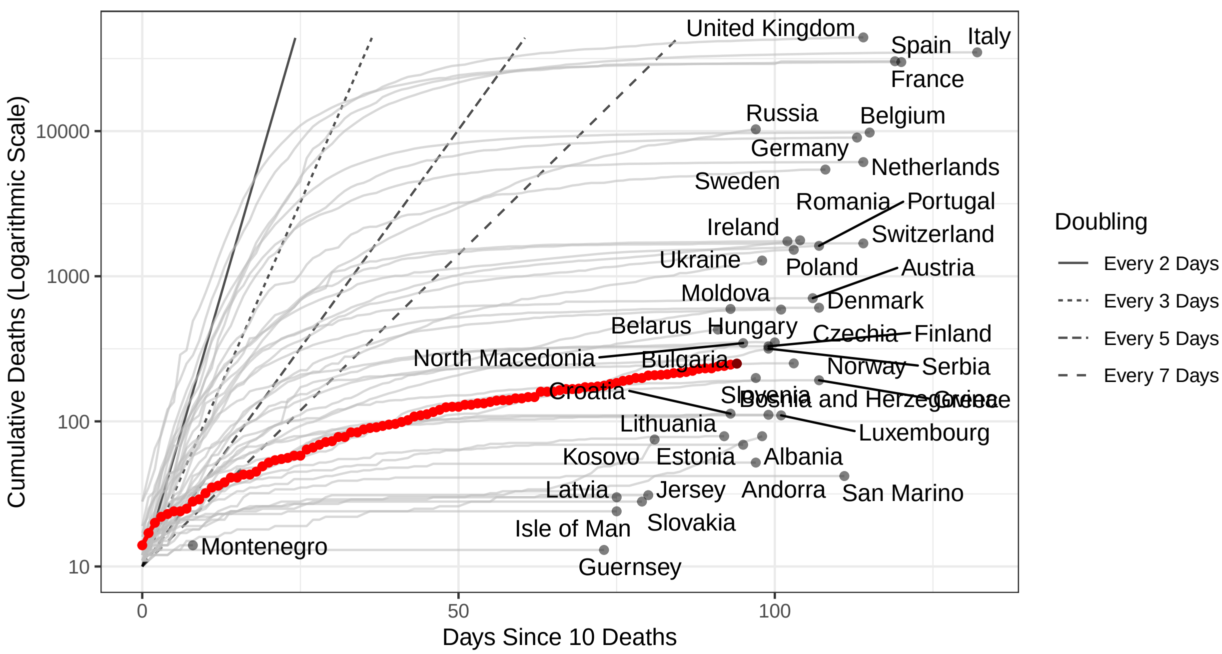

Figure 1: **Cumulative Deaths since 10 deaths.** Country not shown if fewer than 10 deaths.

COVID-19 Transmission Modelling

We assume that the deaths reported to date provide the best indication of the stage of the epidemic, as deaths are more consistently and accurately reported. Our current working estimate is that 1 death indicates that approximately 100 people will have been infected with the other 99 recovering (based on an infection fatality ratio of ~1%). These infections will have happened approximately 21 days previously – capturing a 5-day period from infection to onset of symptoms (the incubation period), 4 days from onset of symptoms to hospitalisation, and 12 days in hospital before death. With a 3-day doubling time, 100 infections that occurred 15 days ago will have generated 200 infections 12 days ago, 400 infections 9 days ago, 800 infections 6 days ago and 1,600 infections 3 days ago resulting in approximately 3,200 infections at the time the first death is observed.

To explore this, we fit our age-structured SEIR model (see Methods) to the time series of deaths in a country, in order to estimate the start date of the epidemic and the baseline R0. We assume that 100% of COVID-19 related deaths have been reported. We have also included the impact of interventions that have been put in place and their effect on human mobility and transmission based on the Google COVID-19 Community Mobility Reports. Using our mathematical model that formalises this approach, we estimate that there has been a total of 31,939 (95% CI: 28,629-35,249) infections over the past 4 weeks.

The figure below shows the estimated number of people infected over the past 4 weeks. The bar charts show, for comparison, the number of reported cases. The right-hand plot shows these data on a different scale as the estimated infections are likely to be much larger than the reported cases. **Importantly**, the estimated infections includes both asymptomatic and mild cases that would not necessarily be identified through surveillance. Consequently, the estimated infections are likely to be significantly higher than the reported cases (see our FAQ for further explanation of these differences and why the reported cases and estimated infections are unlikely to match).

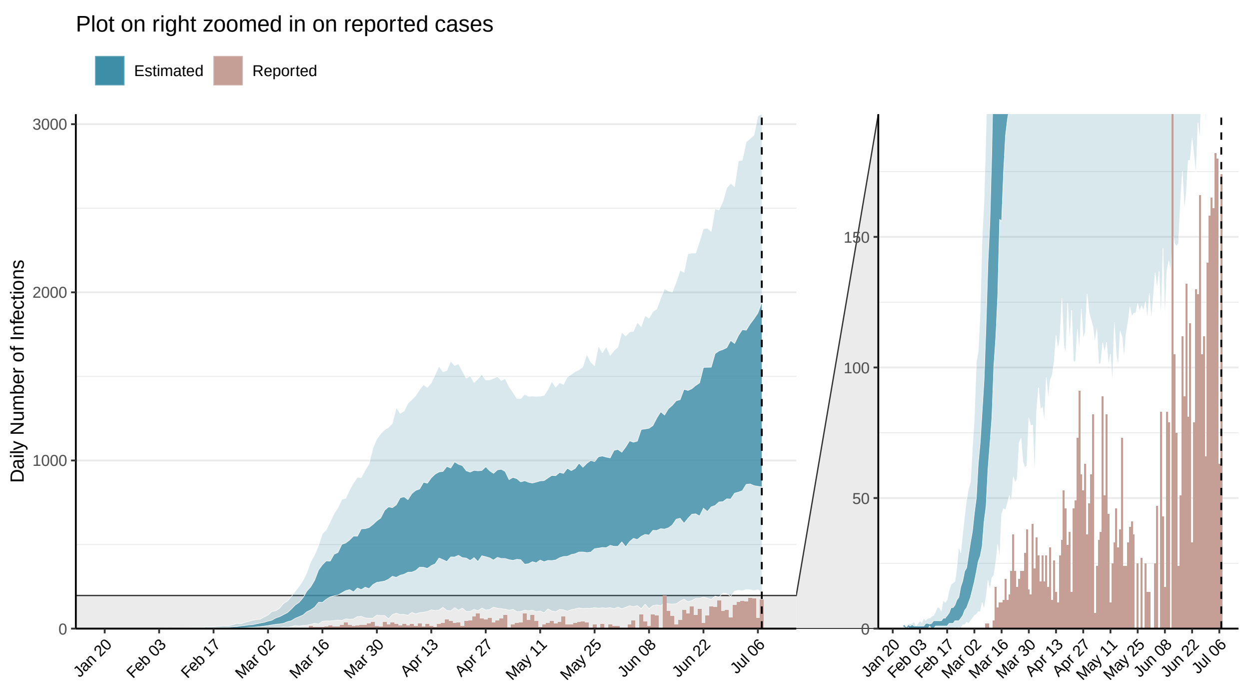

Figure 2: **Daily number of infections estimated by fitting to the current total of deaths.** Reported cases are shown in red. Model estimated infections are shown in blue (dark blue 50% interquartile range, light blue 95% quantile). The dashed line shows the current day.

By fitting to the time series of deaths, we are able to estimate a time-varying reproduction number, R_t. R_t is the the average number of secondary infections caused by a single infected person at a given time. If R_t is above 1, the rate of transmission is increasing and the number of new infections is increasing. R_t is assumed to change in relation to mobility fall in proportion. When fitting our model we assume that 100% of COVID-19 related deaths have been reported (please see our FAQ section for more information about this assumption). We also assume a fixed date at which the impact of mobility on transmission changes from pre-lockdown levels to post-lockdown levels, which may cause large changes in Rt. We are working to refine how this switch occurs and to formally calculate its shape.

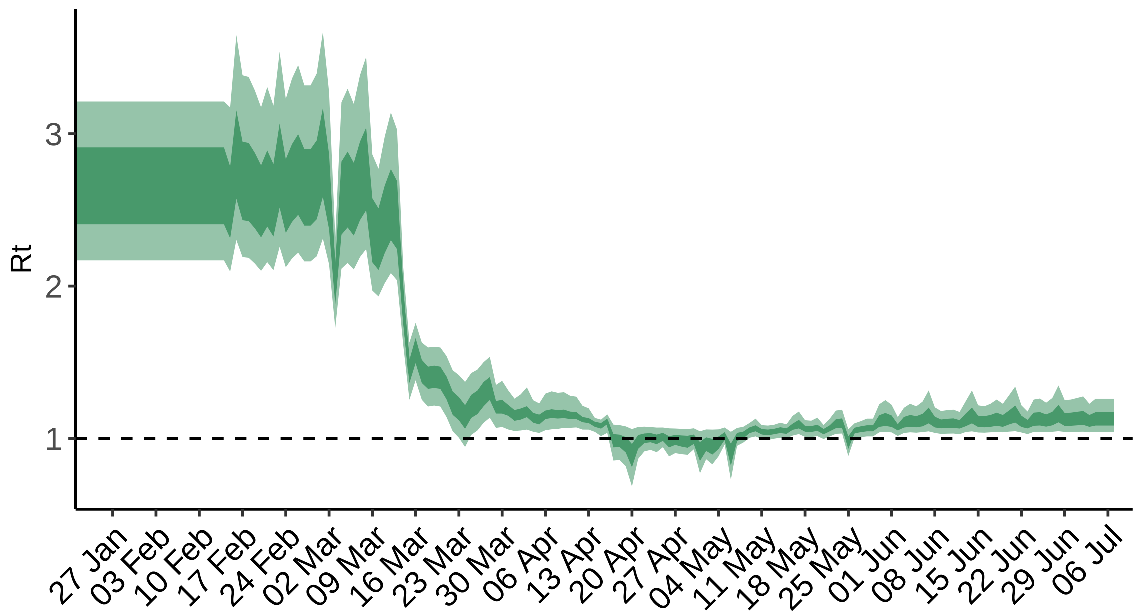

Figure 3: **Time-varying reproduction number, R_t.** R_t is the average number of secondary infections caused by a single infected person at time equal to t. $R_t < 1$ indicates a slowing epidemic in which new infections are not increasing. $R_t > 1$ indicates a growing epidemic in which new infections are increasing over time. Dark green shows the 50% CI and light green shows the 95% CI.

Using the model fit, we can forecast the expected trajectory for cumulative deaths, which is shown in the figure below. This assumes a severity pattern by age that is consistent with that observed in China, Europe and the U.S to date. This projection assumes that transmission is maintained at the current level of transmission as estimated by the final R_t value.

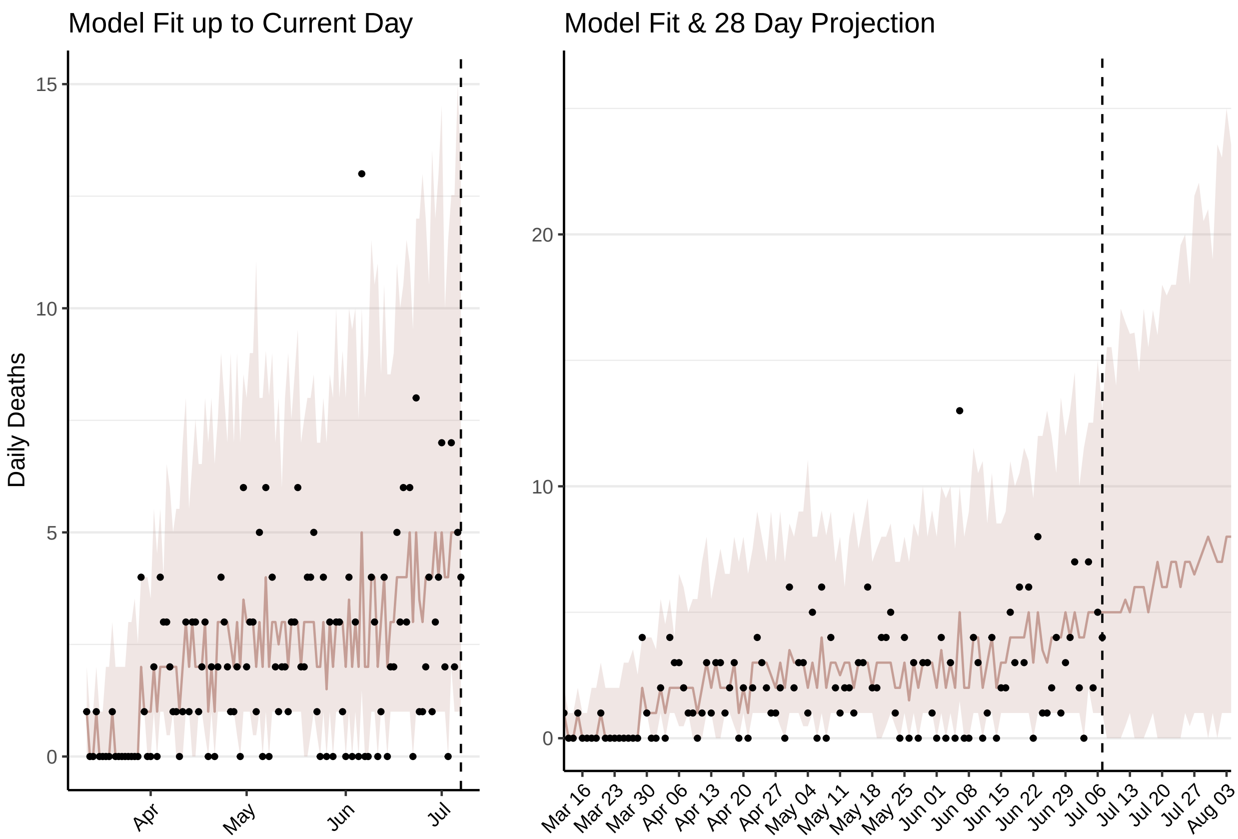

Figure 4: **Estimated daily deaths.** Projected deaths assuming the current level of interventions are maintained are shown in red (median and 95% quantile). Reported deaths are plotted in black. The plot on the left is focussed on the model fit prior to today, while the plot on the right forecasts the next 28 days.

Short-term Epidemic Scenarios

We make the following short-term projections of healthcare demand and new infections under the following three scenarios:

- **Scenario 1.** The epidemic continues to grow at the current rate.
- **Scenario 2.** Countries will further scale up interventions (either increasing current strategies or implementing new interventions) leading to a further 50% reduction in transmission.
- **Scenario 3.** Countries will relax current interventions by 50%

N.B. These scenarios currently assume that the impact of mobility on transmission will remain the same in the future as it has in the past. We are working to extend methods to estimate the impact of increases in mobility on transmission as lockdown and interventions are reversed. Consequently, projection are likely to represent an upper estimate of the healthcare demand and case load for each scenario

We estimate that over the next 4 weeks demand for hospital beds will change from 271 (95% CI: 243-300) patients requiring treatment with high-pressure oxygen at the current date to 445 (95% CI: 391-499) hospital beds being required on 2020-08-04 if no further interventions are introduced (Scenario 1). Similarly, we estimate that over the next 4 weeks demand for critical care (ICU) beds will change from 83 (95% CI: 74-92) patients requiring treatment with mechanical ventilation at the current date to 138 (95% CI: 121-155) by 2020-08-04. These projections assume that approximately 5% of all infections will require treatment with high-pressure oxygen and that approximately 30% of hospitalised cases will require treatment with mechanical ventilation (based on analysis of ongoing epidemics in Europe). **N.B. These scenarios are unlikely to show significant differences for the first week since there is a delay of approximately 10 days between infection and hospital admission. Consequently, the effectiveness of a change in policy is likely to be better captured by hospital admission data approximately 2 weeks after the policy change is implemented.**

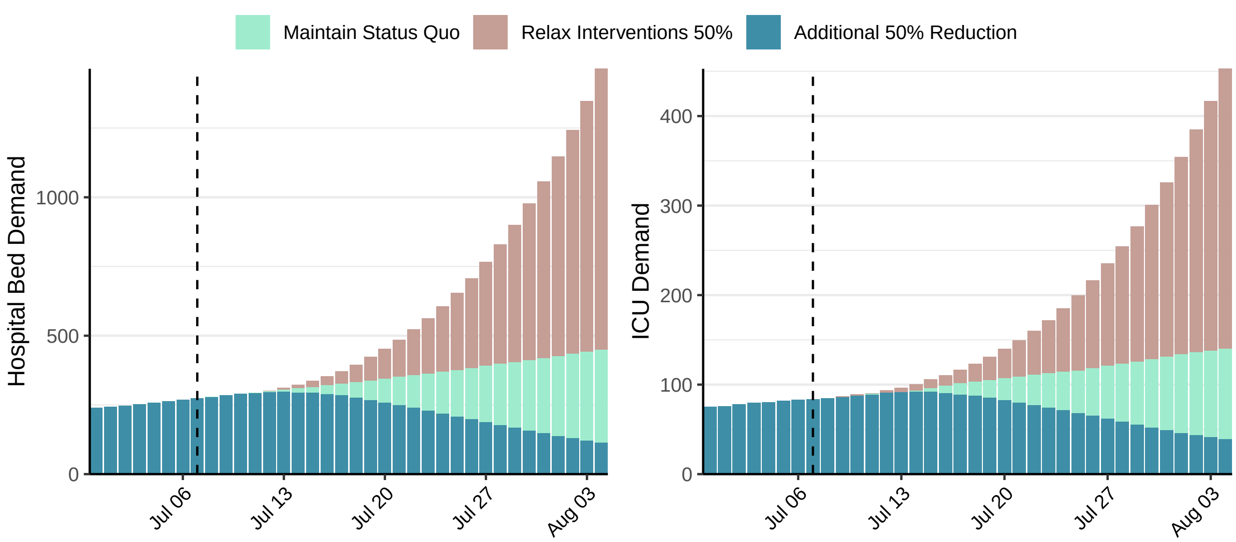

Figure 5: **Healthcare demands in the next 28 days.** Individuals needing an ICU bed are assumed to need mechanical ventilation. Projected demand for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

The impact of each scenario has a more immediate effect on the daily number of infections. The figure below shows the impact of each scenario on the estimated daily incidence of new infections. If interventions are scaled up (Scenario 2), the daily number of infections will change from 1,425 (95% CI: 1,270-1,580) at the current date to 178 (95% CI: 156-200) by 2020-08-04. If current interventions were relaxed by 50%, we estimate the daily number of infections will change from 1,425 (95% CI: 1,270-1,580) at the current date to 13,464 (95% CI: 11,790-15,137) by 2020-08-04.

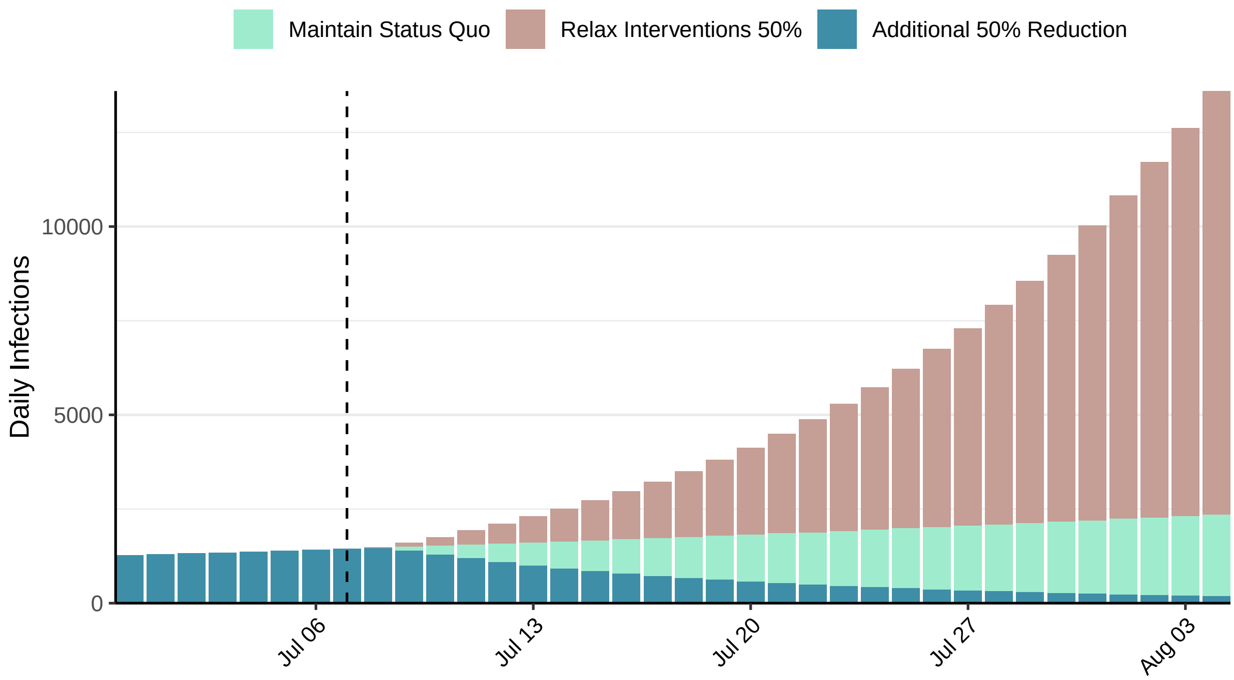

Figure 6: **Daily number of infections estimated by fitting to deaths.** Projected infections for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

To explore different scenarios, we recommend using our COVID-19 Scenario Analysis Tool - https://covidsim.org/, which can be used to simulate different intervention scenarios and explore the long term impact on healthcare demand.

Situation Report for COVID-19: Bosnia and Herzegovina, 2020-07-07

Download the report for Bosnia and Herzegovina, 2020-07-07 here. This report uses data from the European Centre for Disease Control. These data are updated daily and whilst there may be a short delay, they are generally consistent with Ministry reports. These data are then used to back-calculate an 'inferred number of COVID-19 infections' using mathematical modelling techniques (see Report 12 for further details) to estimate the number of people that have been infected and to make short-term projections for future healthcare needs.

Epidemiological Situation

Total Reported Cases	New Reported Cases	Total Reported Deaths	New Reported Deaths	Estimated R_t
5,458	209	199	9	1.09 (95% CI: 0.99-1.21)

The figure below shows the cumulative reported deaths as a function of the time since the 10th death was reported. Dashed lines show the expected trajectory for different doubling times of the epidemic. For example, with a doubling time of 3 days, if there are currently a total of 20 deaths reported, we would expect there to be 40 deaths in total reported in 3 days-time, 80 deaths in 6 days-time, 160 deaths in 9 days-time etc. For most epidemics, in the absence of interventions, we expect a doubling time of 3-4 days for this disease.

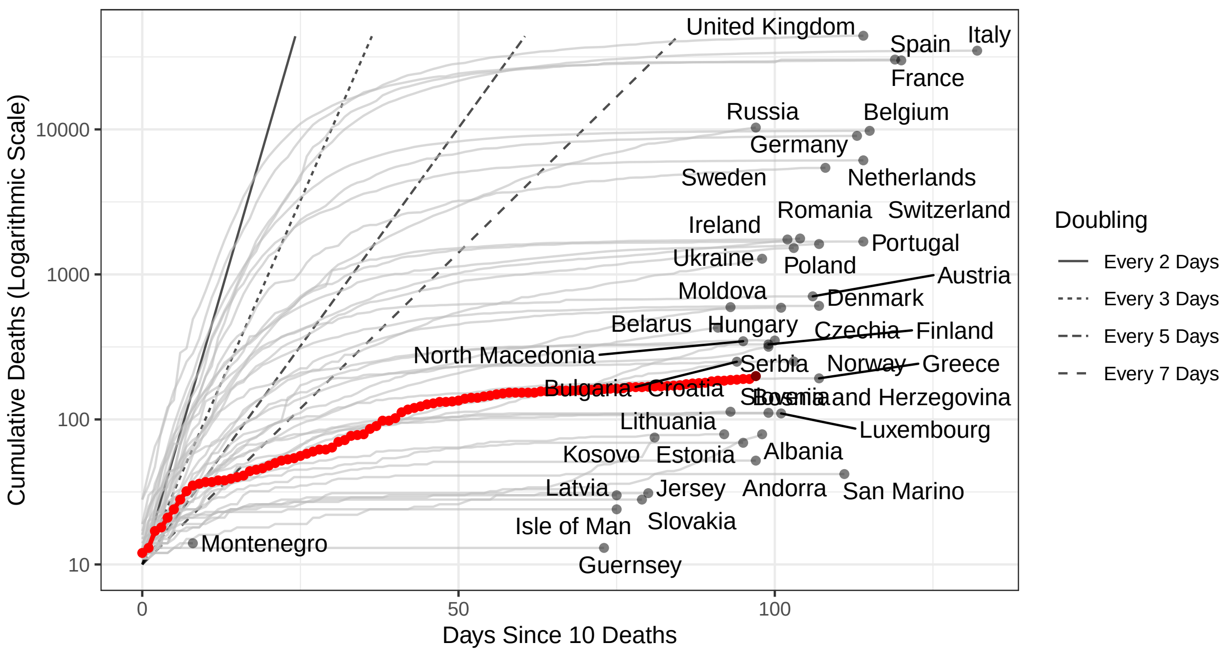

Figure 1: **Cumulative Deaths since 10 deaths.** Country not shown if fewer than 10 deaths.

COVID-19 Transmission Modelling

We assume that the deaths reported to date provide the best indication of the stage of the epidemic, as deaths are more consistently and accurately reported. Our current working estimate is that 1 death indicates that approximately 100 people will have been infected with the other 99 recovering (based on an infection fatality ratio of ~1%). These infections will have happened approximately 21 days previously – capturing a 5-day period from infection to onset of symptoms (the incubation period), 4 days from onset of symptoms to hospitalisation, and 12 days in hospital before death. With a 3-day doubling time, 100 infections that occurred 15 days ago will have generated 200 infections 12 days ago, 400 infections 9 days ago, 800 infections 6 days ago and 1,600 infections 3 days ago resulting in approximately 3,200 infections at the time the first death is observed.

To explore this, we fit our age-structured SEIR model (see Methods) to the time series of deaths in a country, in order to estimate the start date of the epidemic and the baseline R0. We assume that 100% of COVID-19 related deaths have been reported. We have also included the impact of interventions that have been put in place and their effect on human mobility and transmission based on the Google COVID-19 Community Mobility Reports. Using our mathematical model that formalises this approach, we estimate that there has been a total of 16,056 (95% CI: 14,709-17,403) infections over the past 4 weeks.

The figure below shows the estimated number of people infected over the past 4 weeks. The bar charts show, for comparison, the number of reported cases. The right-hand plot shows these data on a different scale as the estimated infections are likely to be much larger than the reported cases. **Importantly**, the estimated infections includes both asymptomatic and mild cases that would not necessarily be identified through surveillance. Consequently, the estimated infections are likely to be significantly higher than the reported cases (see our FAQ for further explanation of these differences and why the reported cases and estimated infections are unlikely to match).

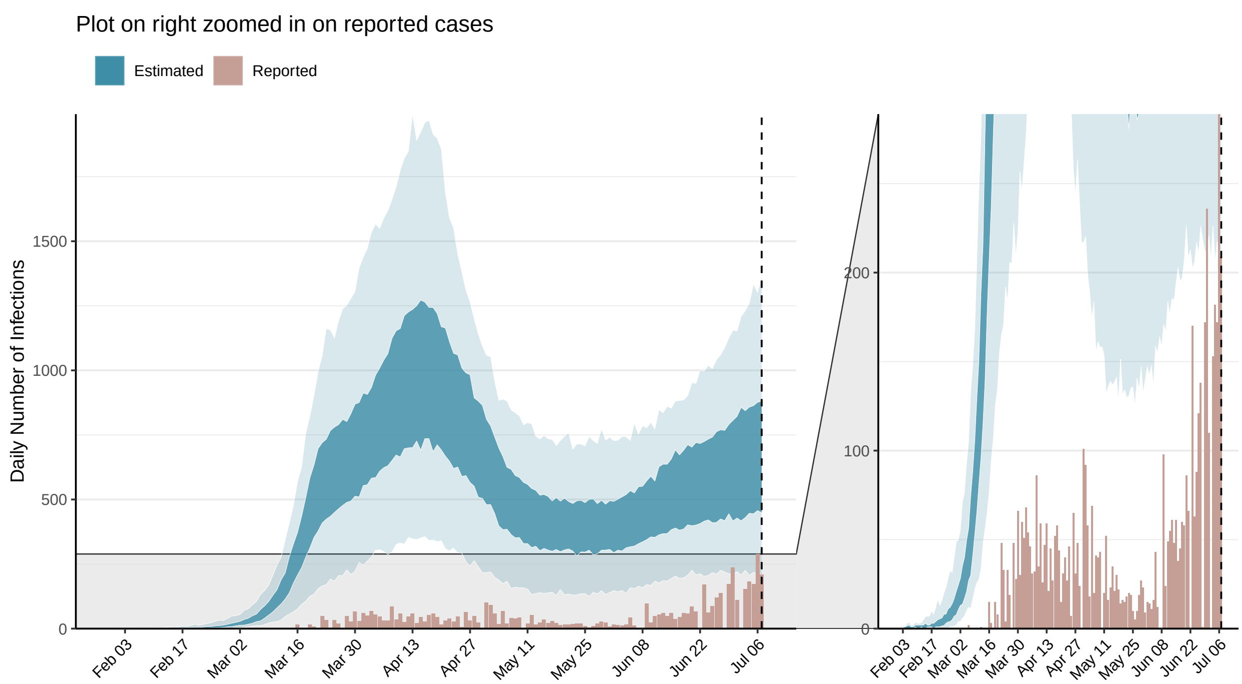

Figure 2: **Daily number of infections estimated by fitting to the current total of deaths.** Reported cases are shown in red. Model estimated infections are shown in blue (dark blue 50% interquartile range, light blue 95% quantile). The dashed line shows the current day.

By fitting to the time series of deaths, we are able to estimate a time-varying reproduction number, R_t. R_t is the the average number of secondary infections caused by a single infected person at a given time. If R_t is above 1, the rate of transmission is increasing and the number of new infections is increasing. R_t is assumed to change in relation to mobility fall in proportion. When fitting our model we assume that 100% of COVID-19 related deaths have been reported (please see our FAQ section for more information about this assumption). We also assume a fixed date at which the impact of mobility on transmission changes from pre-lockdown levels to post-lockdown levels, which may cause large changes in Rt. We are working to refine how this switch occurs and to formally calculate its shape.

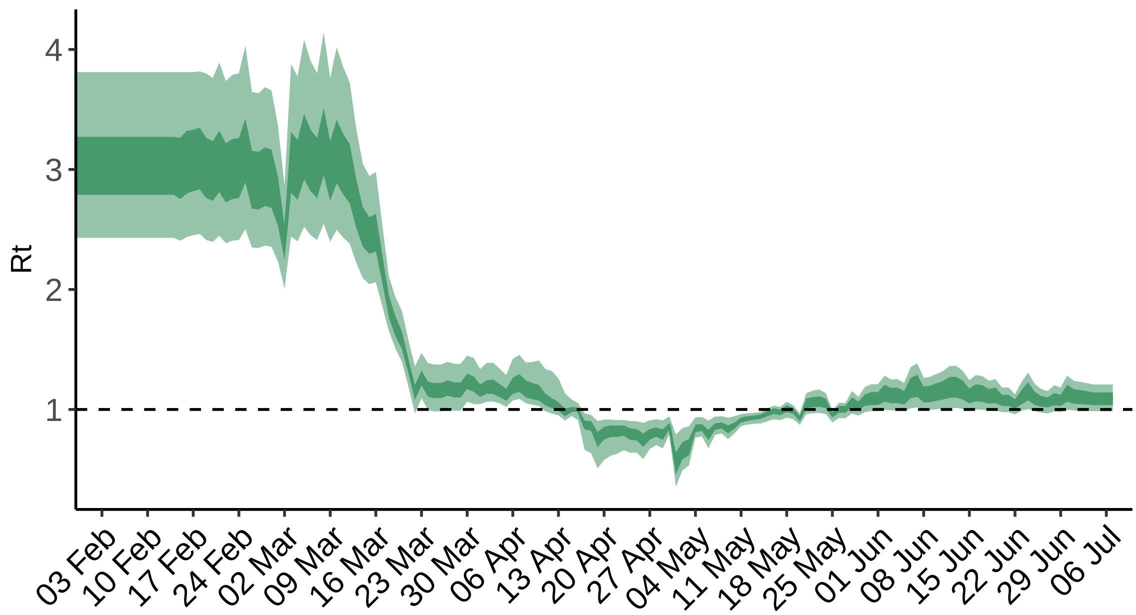

Figure 3: **Time-varying reproduction number, R_t.** R_t is the average number of secondary infections caused by a single infected person at time equal to t. $R_t < 1$ indicates a slowing epidemic in which new infections are not increasing. $R_t > 1$ indicates a growing epidemic in which new infections are increasing over time. Dark green shows the 50% CI and light green shows the 95% CI.

Using the model fit, we can forecast the expected trajectory for cumulative deaths, which is shown in the figure below. This assumes a severity pattern by age that is consistent with that observed in China, Europe and the U.S to date. This projection assumes that transmission is maintained at the current level of transmission as estimated by the final R_t value.

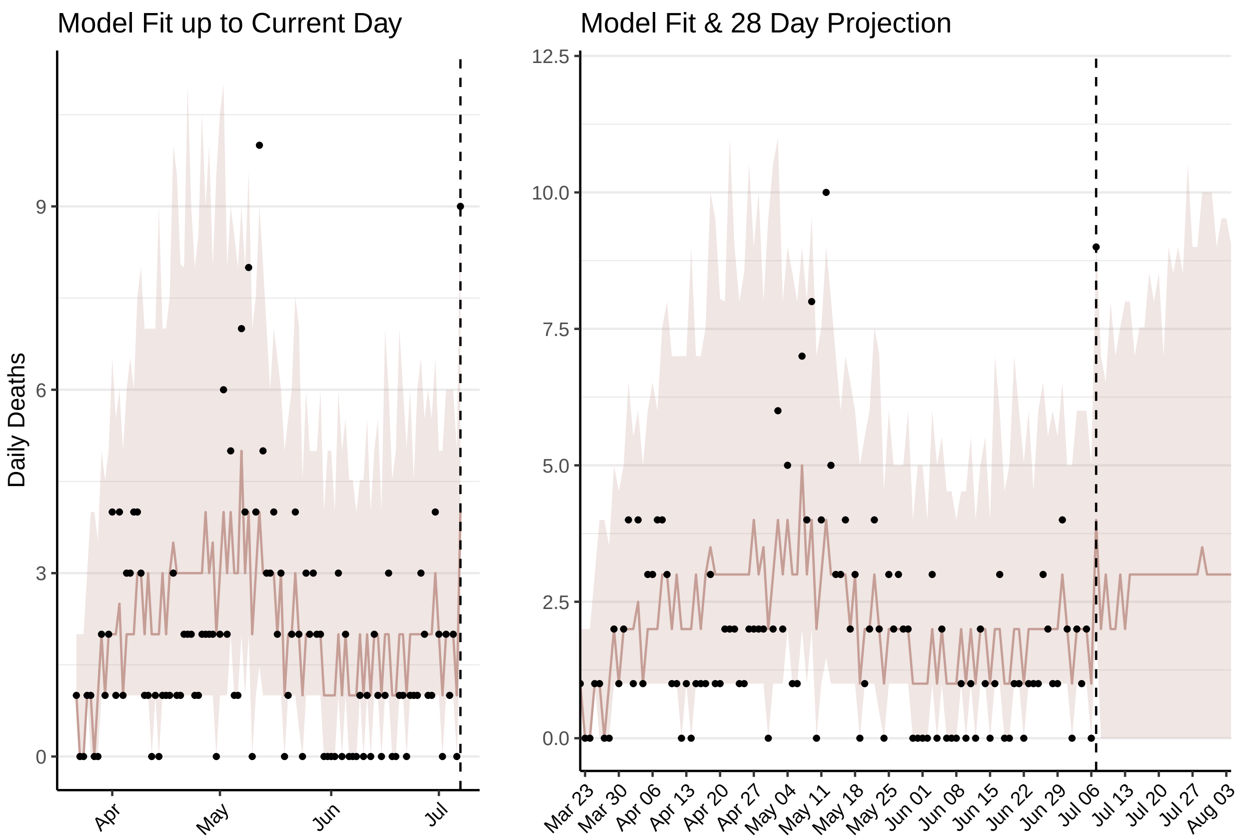

Figure 4: **Estimated daily deaths.** Projected deaths assuming the current level of interventions are maintained are shown in red (median and 95% quantile). Reported deaths are plotted in black. The plot on the left is focussed on the model fit prior to today, while the plot on the right forecasts the next 28 days.

Short-term Epidemic Scenarios

We make the following short-term projections of healthcare demand and new infections under the following three scenarios:

- **Scenario 1.** The epidemic continues to grow at the current rate.
- **Scenario 2.** Countries will further scale up interventions (either increasing current strategies or implementing new interventions) leading to a further 50% reduction in transmission.
- **Scenario 3.** Countries will relax current interventions by 50%

N.B. These scenarios currently assume that the impact of mobility on transmission will remain the same in the future as it has in the past. We are working to extend methods to estimate the impact of increases in mobility on transmission as lockdown and interventions are reversed. Consequently, projection are likely to represent an upper estimate of the healthcare demand and case load for each scenario

We estimate that over the next 4 weeks demand for hospital beds will change from 129 (95% CI: 118-140) patients requiring treatment with high-pressure oxygen at the current date to 183 (95% CI: 162-204) hospital beds being required on 2020-08-04 if no further interventions are introduced (Scenario 1). Similarly, we estimate that over the next 4 weeks demand for critical care (ICU) beds will change from 39 (95% CI: 36-43) patients requiring treatment with mechanical ventilation at the current date to 55 (95% CI: 48-62) by 2020-08-04. These projections assume that approximately 5% of all infections will require treatment with high-pressure oxygen and that approximately 30% of hospitalised cases will require treatment with mechanical ventilation (based on analysis of ongoing epidemics in Europe). **N.B. These scenarios are unlikely to show significant differences for the first week since there is a delay of approximately 10 days between infection and hospital admission. Consequently, the effectiveness of a change in policy is likely to be better captured by hospital admission data approximately 2 weeks after the policy change is implemented.**

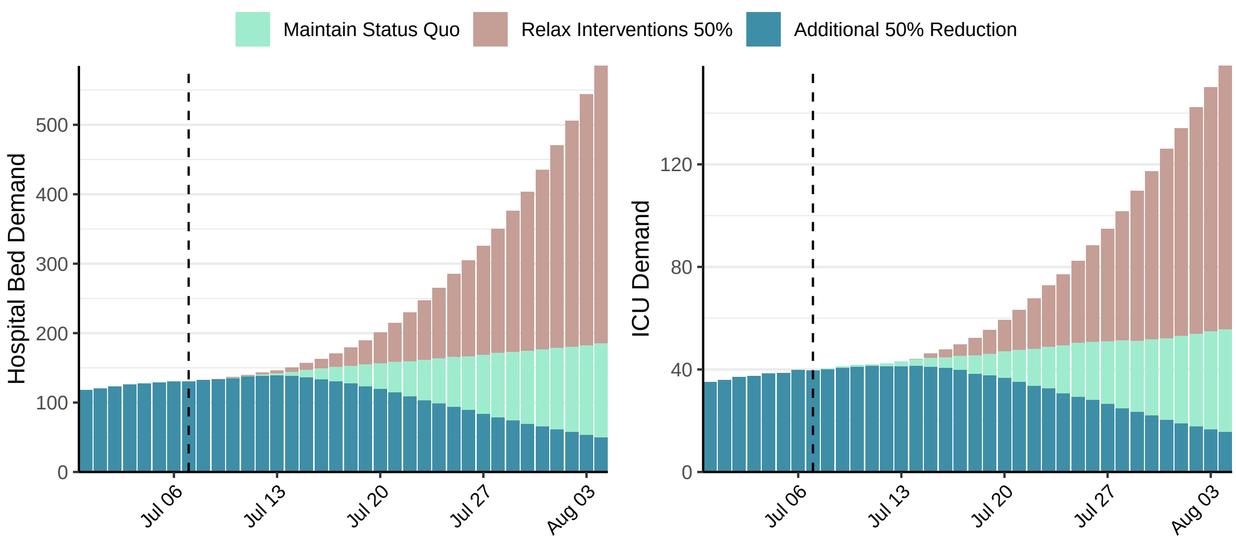

Figure 5: **Healthcare demands in the next 28 days.** Individuals needing an ICU bed are assumed to need mechanical ventilation. Projected demand for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

The impact of each scenario has a more immediate effect on the daily number of infections. The figure below shows the impact of each scenario on the estimated daily incidence of new infections. If interventions are scaled up (Scenario 2), the daily number of infections will change from 671 (95% CI: 606-736) at the current date to 73 (95% CI: 64-83) by 2020-08-04. If current interventions were relaxed by 50%, we estimate the daily number of infections will change from 671 (95% CI: 606-736) at the current date to 5,197 (95% CI: 4,539-5,855) by 2020-08-04.

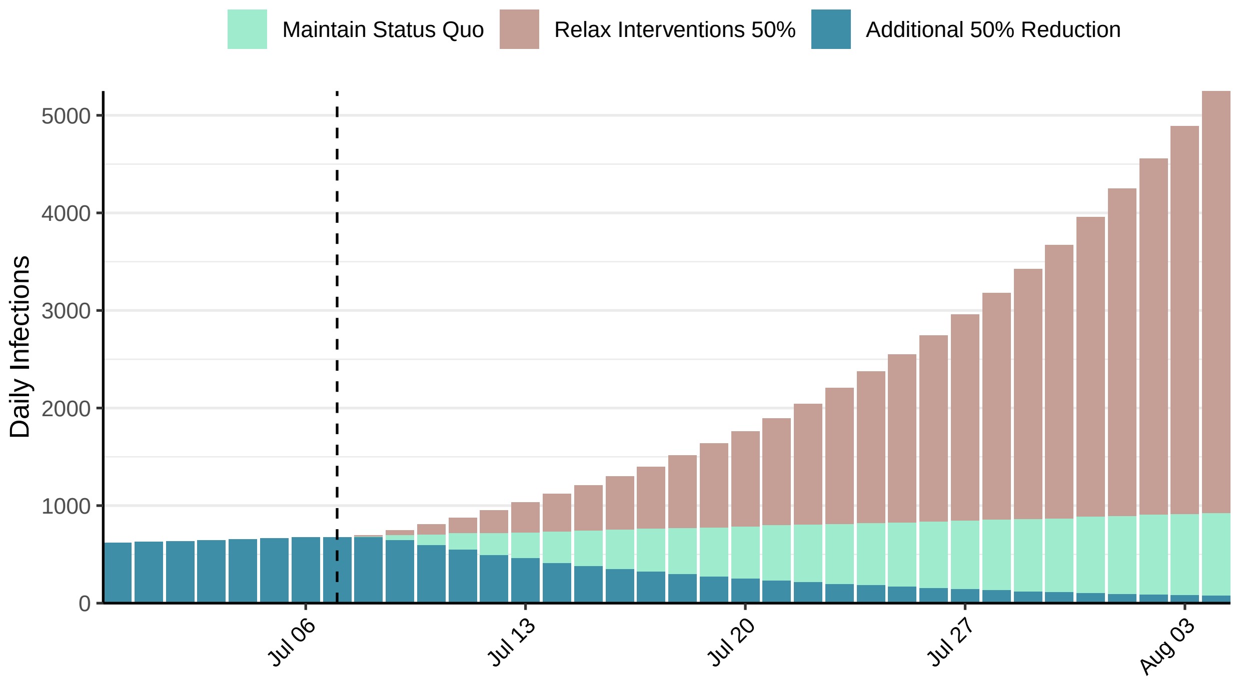

Figure 6: **Daily number of infections estimated by fitting to deaths.** Projected infections for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

To explore different scenarios, we recommend using our COVID-19 Scenario Analysis Tool - https://covidsim.org/, which can be used to simulate different intervention scenarios and explore the long term impact on healthcare demand.

Situation Report for COVID-19: Belarus, 2020-07-07

Download the report for Belarus, 2020-07-07 here. This report uses data from the European Centre for Disease Control. These data are updated daily and whilst there may be a short delay, they are generally consistent with Ministry reports. These data are then used to back-calculate an 'inferred number of COVID-19 infections' using mathematical modelling techniques (see Report 12 for further details) to estimate the number of people that have been infected and to make short-term projections for future healthcare needs.

Epidemiological Situation

Total Reported Cases	New Reported Cases	Total Reported Deaths	New Reported Deaths	Estimated R_t
63,804	250	429	6	1.08 (95% CI: 0.98-1.19)

The figure below shows the cumulative reported deaths as a function of the time since the 10th death was reported. Dashed lines show the expected trajectory for different doubling times of the epidemic. For example, with a doubling time of 3 days, if there are currently a total of 20 deaths reported, we would expect there to be 40 deaths in total reported in 3 days-time, 80 deaths in 6 days-time, 160 deaths in 9 days-time etc. For most epidemics, in the absence of interventions, we expect a doubling time of 3-4 days for this disease.

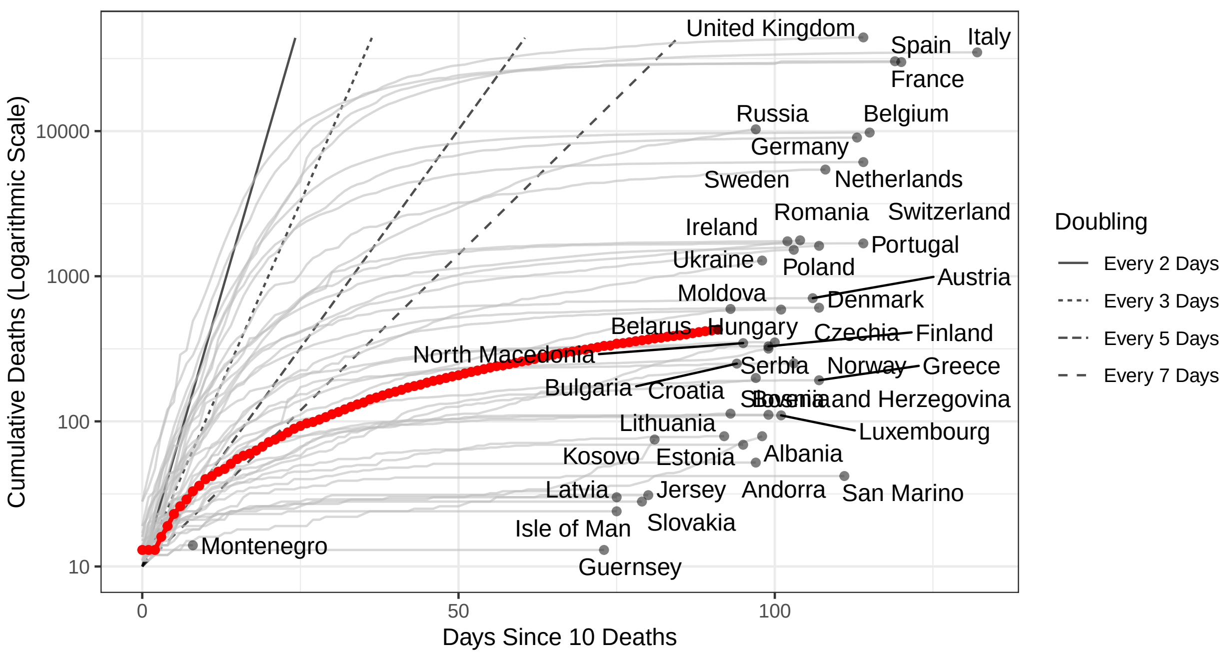

Figure 1: **Cumulative Deaths since 10 deaths.** Country not shown if fewer than 10 deaths.

COVID-19 Transmission Modelling

We assume that the deaths reported to date provide the best indication of the stage of the epidemic, as deaths are more consistently and accurately reported. Our current working estimate is that 1 death indicates that approximately 100 people will have been infected with the other 99 recovering (based on an infection fatality ratio of ~1%). These infections will have happened approximately 21 days previously – capturing a 5-day period from infection to onset of symptoms (the incubation period), 4 days from onset of symptoms to hospitalisation, and 12 days in hospital before death. With a 3-day doubling time, 100 infections that occurred 15 days ago will have generated 200 infections 12 days ago, 400 infections 9 days ago, 800 infections 6 days ago and 1,600 infections 3 days ago resulting in approximately 3,200 infections at the time the first death is observed.

To explore this, we fit our age-structured SEIR model (see Methods) to the time series of deaths in a country, in order to estimate the start date of the epidemic and the baseline R0. We assume that 100% of COVID-19 related deaths have been reported. We have also included the impact of interventions that have been put in place and their effect on human mobility and transmission based on the Google COVID-19 Community Mobility Reports. Using our mathematical model that formalises this approach, we estimate that there has been a total of 58,242 (95% CI: 54,484-62,000) infections over the past 4 weeks.

The figure below shows the estimated number of people infected over the past 4 weeks. The bar charts show, for comparison, the number of reported cases. The right-hand plot shows these data on a different scale as the estimated infections are likely to be much larger than the reported cases. **Importantly**, the estimated infections includes both asymptomatic and mild cases that would not necessarily be identified through surveillance. Consequently, the estimated infections are likely to be significantly higher than the reported cases (see our FAQ for further explanation of these differences and why the reported cases and estimated infections are unlikely to match).

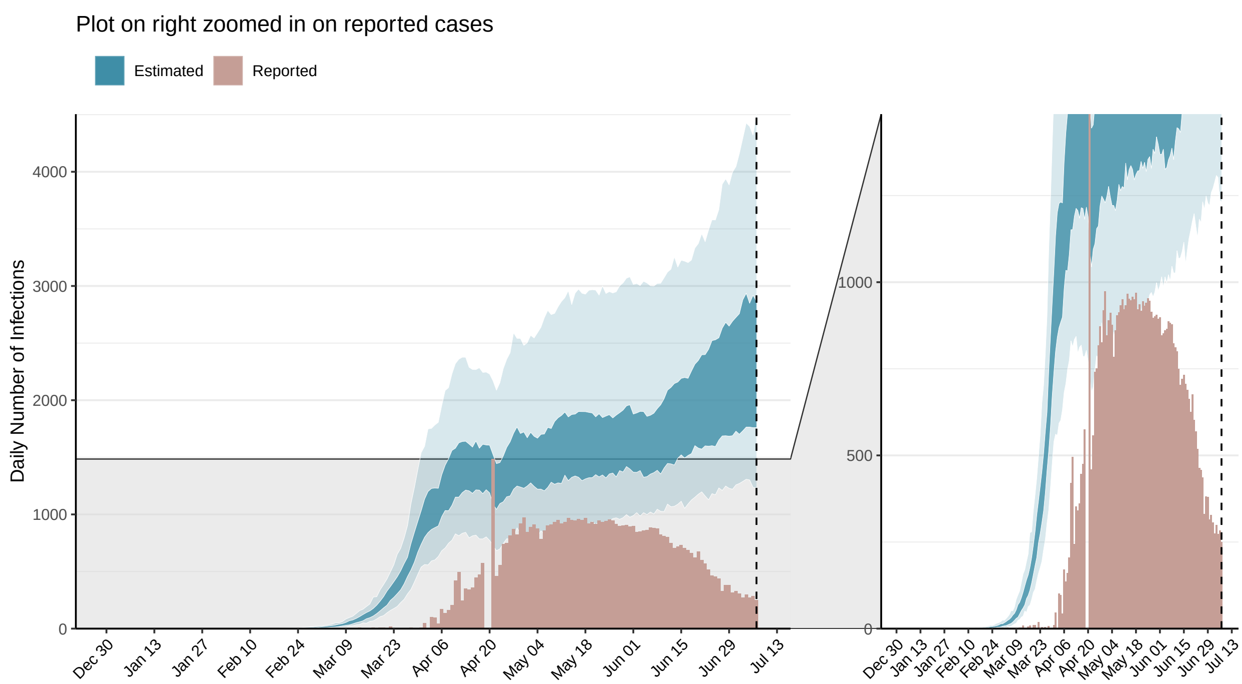

Figure 2: **Daily number of infections estimated by fitting to the current total of deaths.** Reported cases are shown in red. Model estimated infections are shown in blue (dark blue 50% interquartile range, light blue 95% quantile). The dashed line shows the current day.

By fitting to the time series of deaths, we are able to estimate a time-varying reproduction number, R_t. R_t is the the average number of secondary infections caused by a single infected person at a given time. If R_t is above 1, the rate of transmission is increasing and the number of new infections is increasing. R_t is assumed to change in relation to mobility fall in proportion. When fitting our model we assume that 100% of COVID-19 related deaths have been reported (please see our FAQ section for more information about this assumption). We also assume a fixed date at which the impact of mobility on transmission changes from pre-lockdown levels to post-lockdown levels, which may cause large changes in Rt. We are working to refine how this switch occurs and to formally calculate its shape.

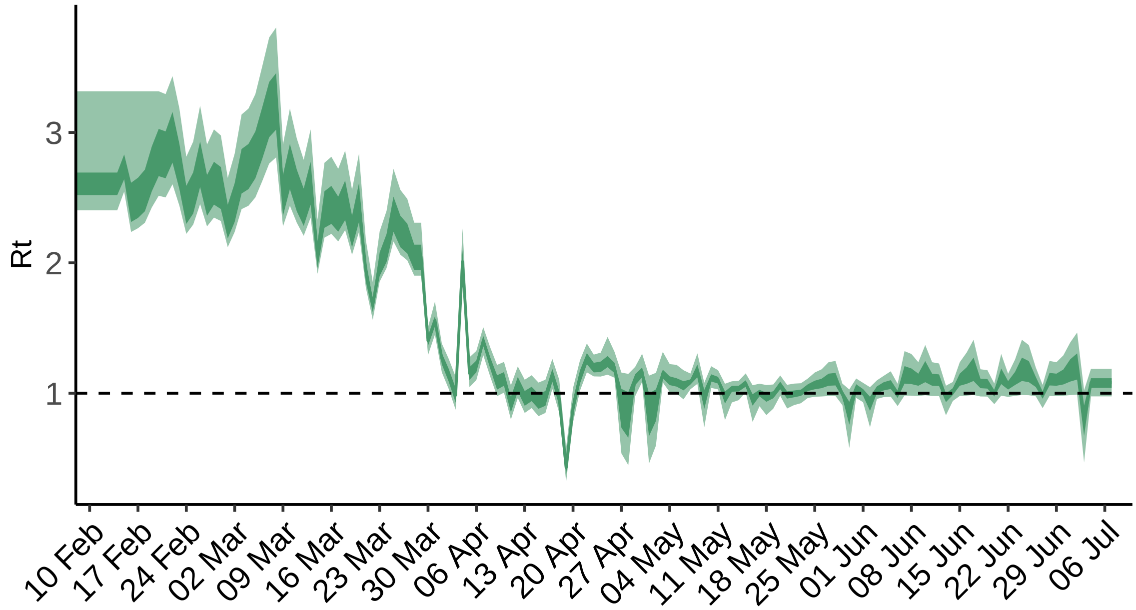

Figure 3: **Time-varying reproduction number, R_t.** R_t is the average number of secondary infections caused by a single infected person at time equal to t. $R_t < 1$ indicates a slowing epidemic in which new infections are not increasing. $R_t > 1$ indicates a growing epidemic in which new infections are increasing over time. Dark green shows the 50% CI and light green shows the 95% CI.

Using the model fit, we can forecast the expected trajectory for cumulative deaths, which is shown in the figure below. This assumes a severity pattern by age that is consistent with that observed in China, Europe and the U.S to date. This projection assumes that transmission is maintained at the current level of transmission as estimated by the final R_t value.

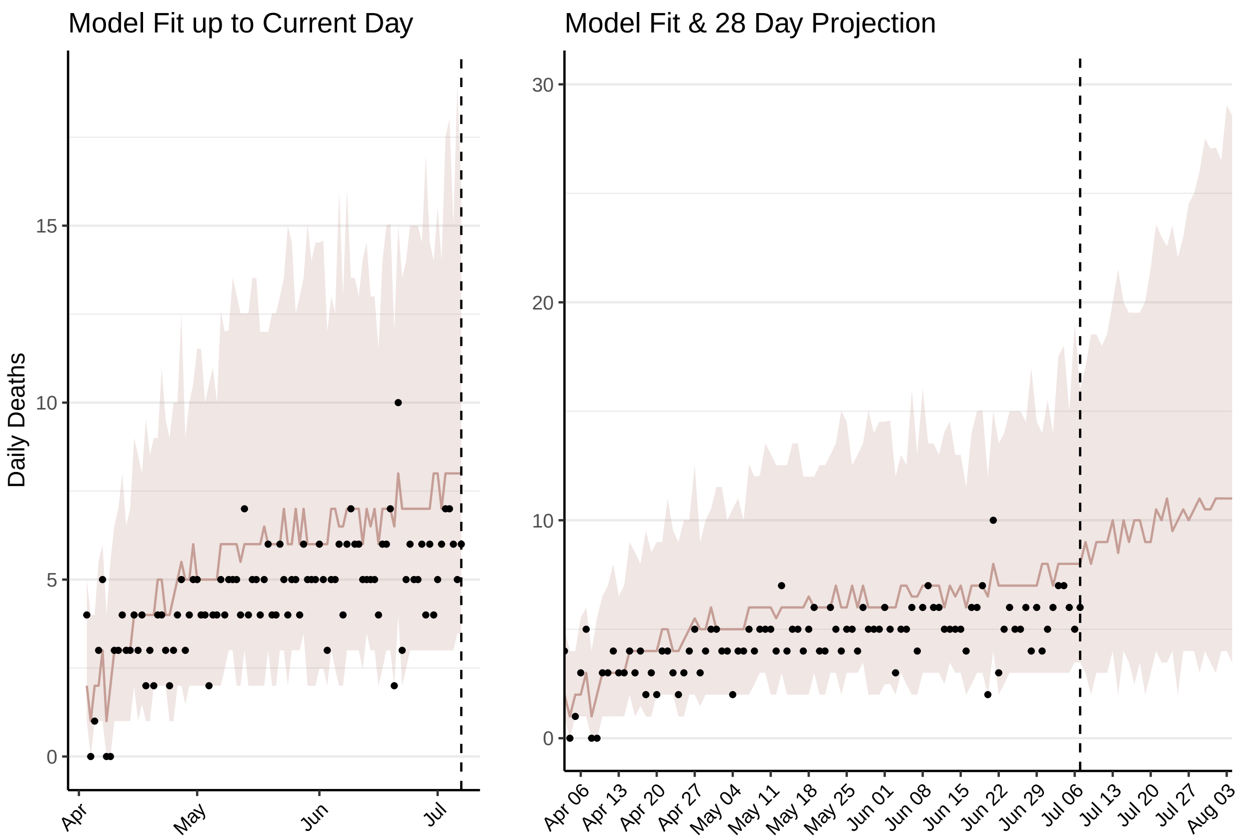

Figure 4: **Estimated daily deaths.** Projected deaths assuming the current level of interventions are maintained are shown in red (median and 95% quantile). Reported deaths are plotted in black. The plot on the left is focussed on the model fit prior to today, while the plot on the right forecasts the next 28 days.

Short-term Epidemic Scenarios

We make the following short-term projections of healthcare demand and new infections under the following three scenarios:

- **Scenario 1.** The epidemic continues to grow at the current rate.
- **Scenario 2.** Countries will further scale up interventions (either increasing current strategies or implementing new interventions) leading to a further 50% reduction in transmission.
- **Scenario 3.** Countries will relax current interventions by 50%

N.B. These scenarios currently assume that the impact of mobility on transmission will remain the same in the future as it has in the past. We are working to extend methods to estimate the impact of increases in mobility on transmission as lockdown and interventions are reversed. Consequently, projection are likely to represent an upper estimate of the healthcare demand and case load for each scenario

We estimate that over the next 4 weeks demand for hospital beds will change from 462 (95% CI: 431-493) patients requiring treatment with high-pressure oxygen at the current date to 619 (95% CI: 560-678) hospital beds being required on 2020-08-04 if no further interventions are introduced (Scenario 1). Similarly, we estimate that over the next 4 weeks demand for critical care (ICU) beds will change from 133 (95% CI: 124-143) patients requiring treatment with mechanical ventilation at the current date to 179 (95% CI: 162-196) by 2020-08-04. These projections assume that approximately 5% of all infections will require treatment with high-pressure oxygen and that approximately 30% of hospitalised cases will require treatment with mechanical ventilation (based on analysis of ongoing epidemics in Europe). **N.B. These scenarios are unlikely to show significant differences for the first week since there is a delay of approximately 10 days between infection and hospital admission. Consequently, the effectiveness of a change in policy is likely to be better captured by hospital admission data approximately 2 weeks after the policy change is implemented.**

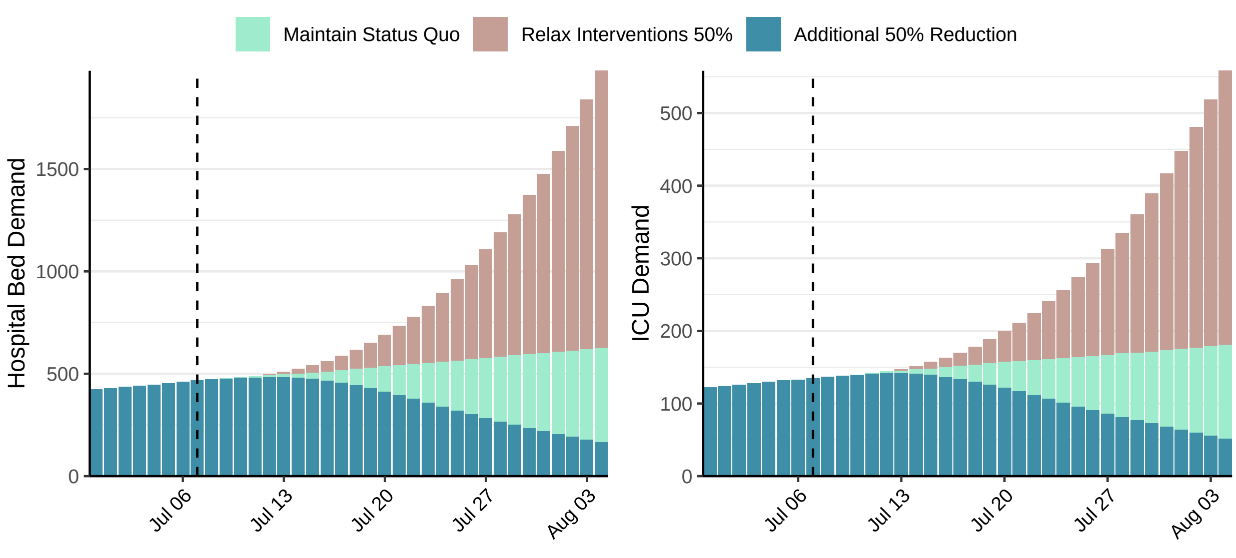

Figure 5: **Healthcare demands in the next 28 days.** Individuals needing an ICU bed are assumed to need mechanical ventilation. Projected demand for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

The impact of each scenario has a more immediate effect on the daily number of infections. The figure below shows the impact of each scenario on the estimated daily incidence of new infections. If interventions are scaled up (Scenario 2), the daily number of infections will change from 2,390 (95% CI: 2,209-2,570) at the current date to 260 (95% CI: 234-287) by 2020-08-04. If current interventions were relaxed by 50%, we estimate the daily number of infections will change from 2,390 (95% CI: 2,209-2,570) at the current date to 18,135 (95% CI: 16,205-20,064) by 2020-08-04.

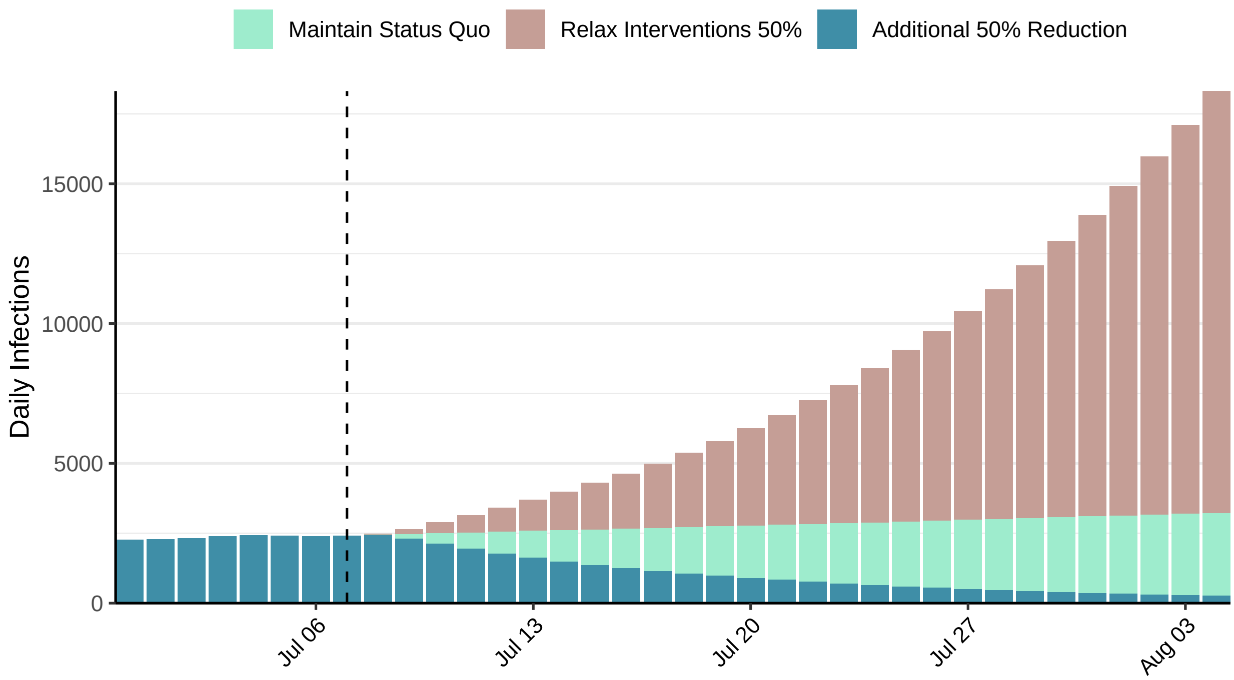

Figure 6: **Daily number of infections estimated by fitting to deaths.** Projected infections for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

To explore different scenarios, we recommend using our COVID-19 Scenario Analysis Tool - https://covidsim.org/, which can be used to simulate different intervention scenarios and explore the long term impact on healthcare demand.

Situation Report for COVID-19: Belize, 2020-07-07

Download the report for Belize, 2020-07-07 here. This report uses data from the European Centre for Disease Control. These data are updated daily and whilst there may be a short delay, they are generally consistent with Ministry reports. These data are then used to back-calculate an 'inferred number of COVID-19 infections' using mathematical modelling techniques (see Report 12 for further details) to estimate the number of people that have been infected and to make short-term projections for future healthcare needs.

Epidemiological Situation

Total Reported Cases	New Reported Cases	Total Reported Deaths	New Reported Deaths	Estimated R_t
30	0	2	0	0.37 (95% CI: 0.03-1.13)

The figure below shows the cumulative reported deaths as a function of the time since the 10th death was reported. Dashed lines show the expected trajectory for different doubling times of the epidemic. For example, with a doubling time of 3 days, if there are currently a total of 20 deaths reported, we would expect there to be 40 deaths in total reported in 3 days-time, 80 deaths in 6 days-time, 160 deaths in 9 days-time etc. For most epidemics, in the absence of interventions, we expect a doubling time of 3-4 days for this disease. **N.B. Belize is not shown in the following plot as only 2 deaths have been reported to date**

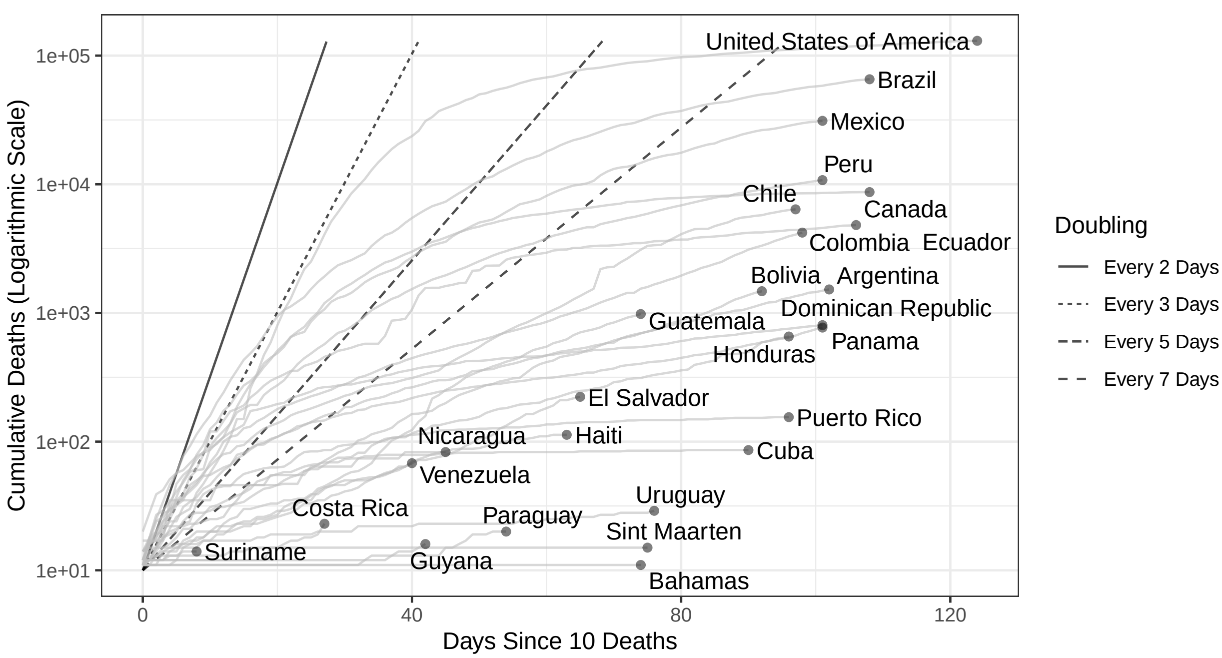

Figure 1: **Cumulative Deaths since 10 deaths.** Country not shown if fewer than 10 deaths.

COVID-19 Transmission Modelling

We assume that the deaths reported to date provide the best indication of the stage of the epidemic, as deaths are more consistently and accurately reported. Our current working estimate is that 1 death indicates that approximately 100 people will have been infected with the other 99 recovering (based on an infection fatality ratio of ~1%). These infections will have happened approximately 21 days previously – capturing a 5-day period from infection to onset of symptoms (the incubation period), 4 days from onset of symptoms to hospitalisation, and 12 days in hospital before death. With a 3-day doubling time, 100 infections that occurred 15 days ago will have generated 200 infections 12 days ago, 400 infections 9 days ago, 800 infections 6 days ago and 1,600 infections 3 days ago resulting in approximately 3,200 infections at the time the first death is observed.

To explore this, we fit our age-structured SEIR model (see Methods) to the time series of deaths in a country, in order to estimate the start date of the epidemic and the baseline R0. We assume that 100% of COVID-19 related deaths have been reported. We have also included the impact of interventions that have been put in place and their effect on human mobility and transmission based on the Google COVID-19 Community Mobility Reports. Using our mathematical model that formalises this approach, we estimate that there has been a total of 2 (95% CI: 0-4) infections over the past 4 weeks.

The figure below shows the estimated number of people infected over the past 4 weeks. The bar charts show, for comparison, the number of reported cases. The right-hand plot shows these data on a different scale as the estimated infections are likely to be much larger than the reported cases. **Importantly**, the estimated infections includes both asymptomatic and mild cases that would not necessarily be identified through surveillance. Consequently, the estimated infections are likely to be significantly higher than the reported cases (see our FAQ for further explanation of these differences and why the reported cases and estimated infections are unlikely to match).

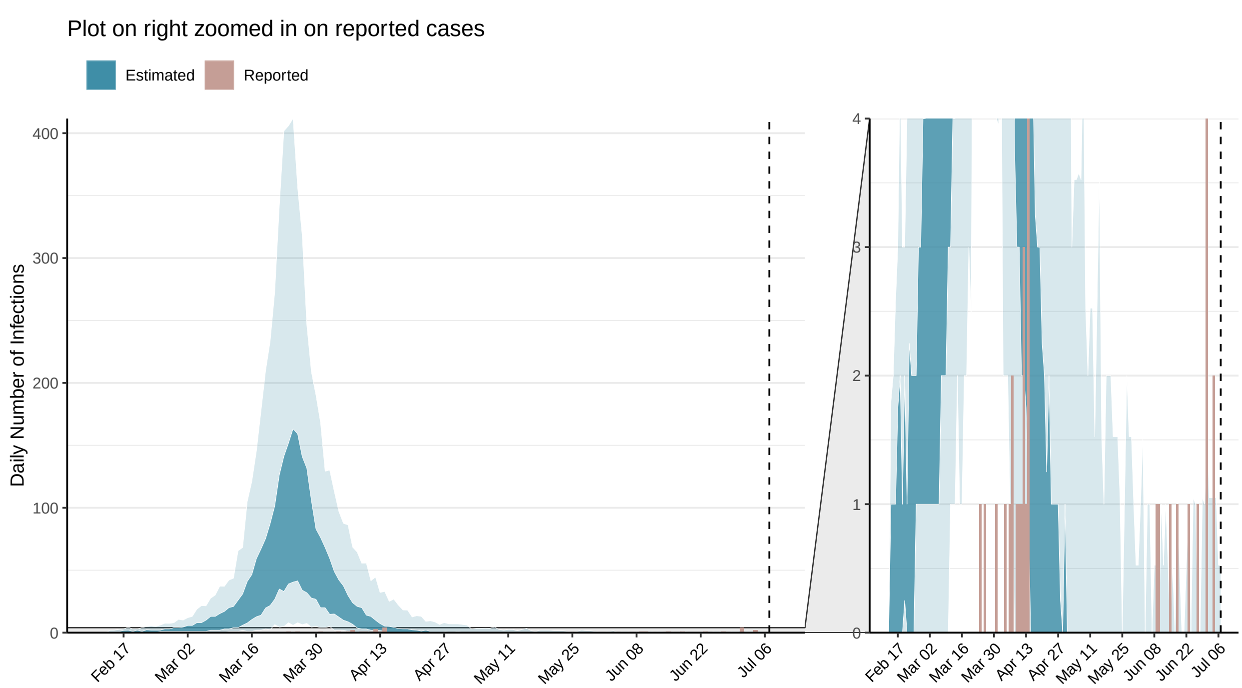

Figure 2: **Daily number of infections estimated by fitting to the current total of deaths.** Reported cases are shown in red. Model estimated infections are shown in blue (dark blue 50% interquartile range, light blue 95% quantile). The dashed line shows the current day.

By fitting to the time series of deaths, we are able to estimate a time-varying reproduction number, R_t. R_t is the the average number of secondary infections caused by a single infected person at a given time. If R_t is above 1, the rate of transmission is increasing and the number of new infections is increasing. R_t is assumed to change in relation to mobility fall in proportion. When fitting our model we assume that 100% of COVID-19 related deaths have been reported (please see our FAQ section for more information about this assumption). We also assume a fixed date at which the impact of mobility on transmission changes from pre-lockdown levels to post-lockdown levels, which may cause large changes in Rt. We are working to refine how this switch occurs and to formally calculate its shape.

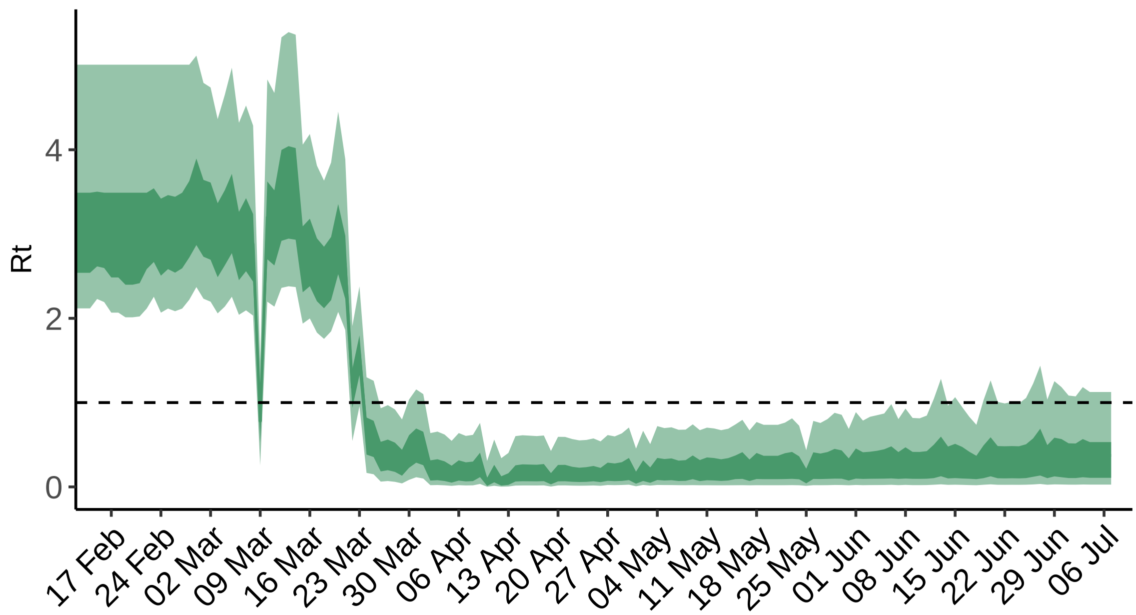

Figure 3: **Time-varying reproduction number, R_t.** R_t is the average number of secondary infections caused by a single infected person at time equal to t. $R_t < 1$ indicates a slowing epidemic in which new infections are not increasing. $R_t > 1$ indicates a growing epidemic in which new infections are increasing over time. Dark green shows the 50% CI and light green shows the 95% CI.

Using the model fit, we can forecast the expected trajectory for cumulative deaths, which is shown in the figure below. This assumes a severity pattern by age that is consistent with that observed in China, Europe and the U.S to date. This projection assumes that transmission is maintained at the current level of transmission as estimated by the final R_t value.

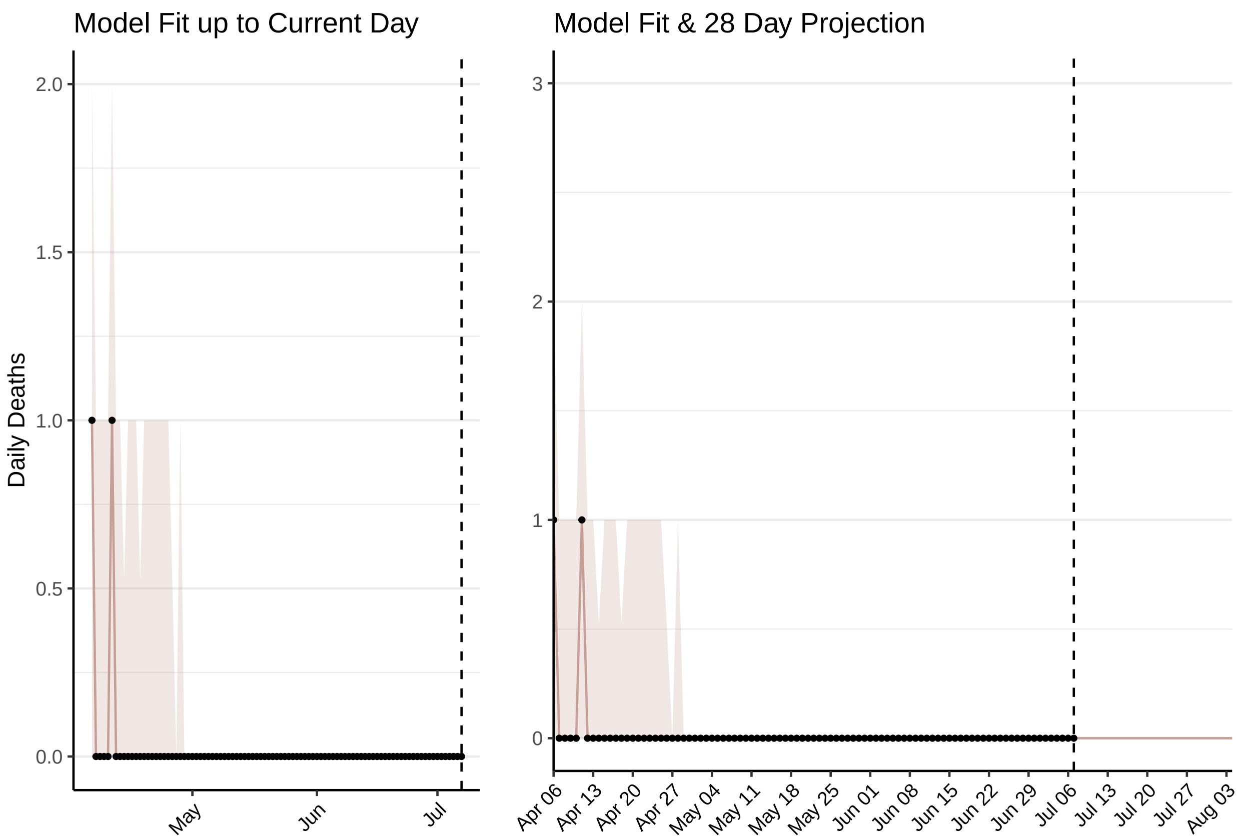

Figure 4: **Estimated daily deaths.** Projected deaths assuming the current level of interventions are maintained are shown in red (median and 95% quantile). Reported deaths are plotted in black. The plot on the left is focussed on the model fit prior to today, while the plot on the right forecasts the next 28 days.

Short-term Epidemic Scenarios

We make the following short-term projections of healthcare demand and new infections under the following three scenarios:

- **Scenario 1.** The epidemic continues to grow at the current rate.
- **Scenario 2.** Countries will further scale up interventions (either increasing current strategies or implementing new interventions) leading to a further 50% reduction in transmission.
- **Scenario 3.** Countries will relax current interventions by 50%

N.B. These scenarios currently assume that the impact of mobility on transmission will remain the same in the future as it has in the past. We are working to extend methods to estimate the impact of increases in mobility on transmission as lockdown and interventions are reversed. Consequently, projection are likely to represent an upper estimate of the healthcare demand and case load for each scenario

We estimate that over the next 4 weeks demand for hospital beds will change from 0 (95% CI: 0-0) patients requiring treatment with high-pressure oxygen at the current date to 0 (95% CI: 0-0) hospital beds being required on 2020-08-04 if no further interventions are introduced (Scenario 1). Similarly, we estimate that over the next 4 weeks demand for critical care (ICU) beds will change from 0 (95% CI: NaN-NaN) patients requiring treatment with mechanical ventilation at the current date to 0 (95% CI: 0-0) by 2020-08-04. These projections assume that approximately 5% of all infections will require treatment with high-pressure oxygen and that approximately 30% of hospitalised cases will require treatment with mechanical ventilation (based on analysis of ongoing epidemics in Europe). **N.B. These scenarios are unlikely to show significant differences for the first week since there is a delay of approximately 10 days between infection and hospital admission. Consequently, the effectiveness of a change in policy is likely to be better captured by hospital admission data approximately 2 weeks after the policy change is implemented.**

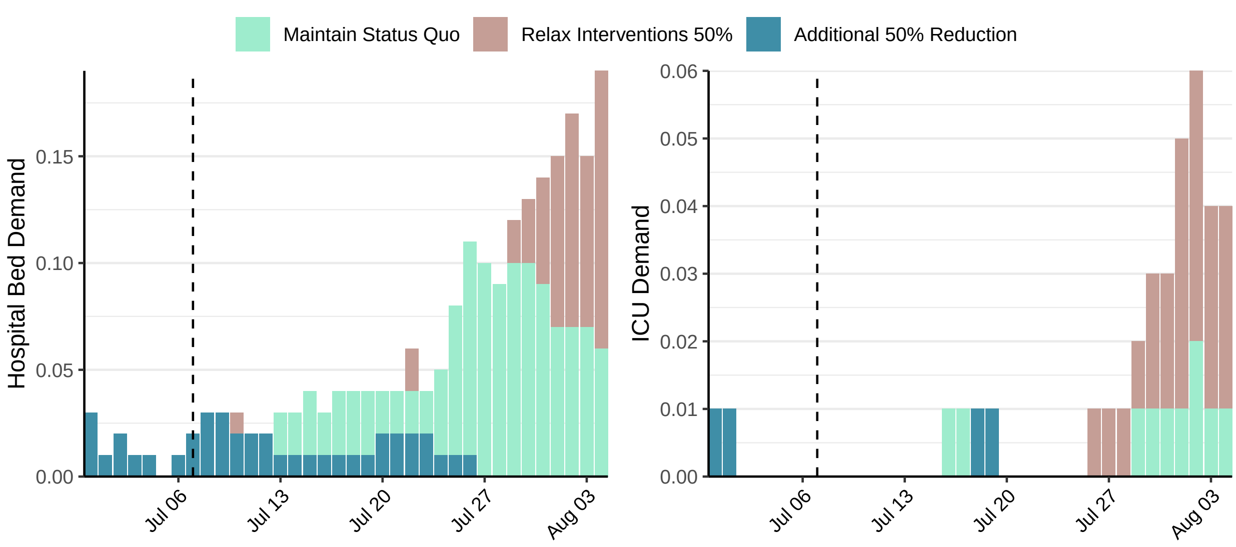

Figure 5: **Healthcare demands in the next 28 days.** Individuals needing an ICU bed are assumed to need mechanical ventilation. Projected demand for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

The impact of each scenario has a more immediate effect on the daily number of infections. The figure below shows the impact of each scenario on the estimated daily incidence of new infections. If interventions are scaled up (Scenario 2), the daily number of infections will change from 0 (95% CI: 0-0) at the current date to 0 (95% CI: NaN-NaN) by 2020-08-04. If current interventions were relaxed by 50%, we estimate the daily number of infections will change from 0 (95% CI: 0-0) at the current date to 5 (95% CI: -4-14) by 2020-08-04.

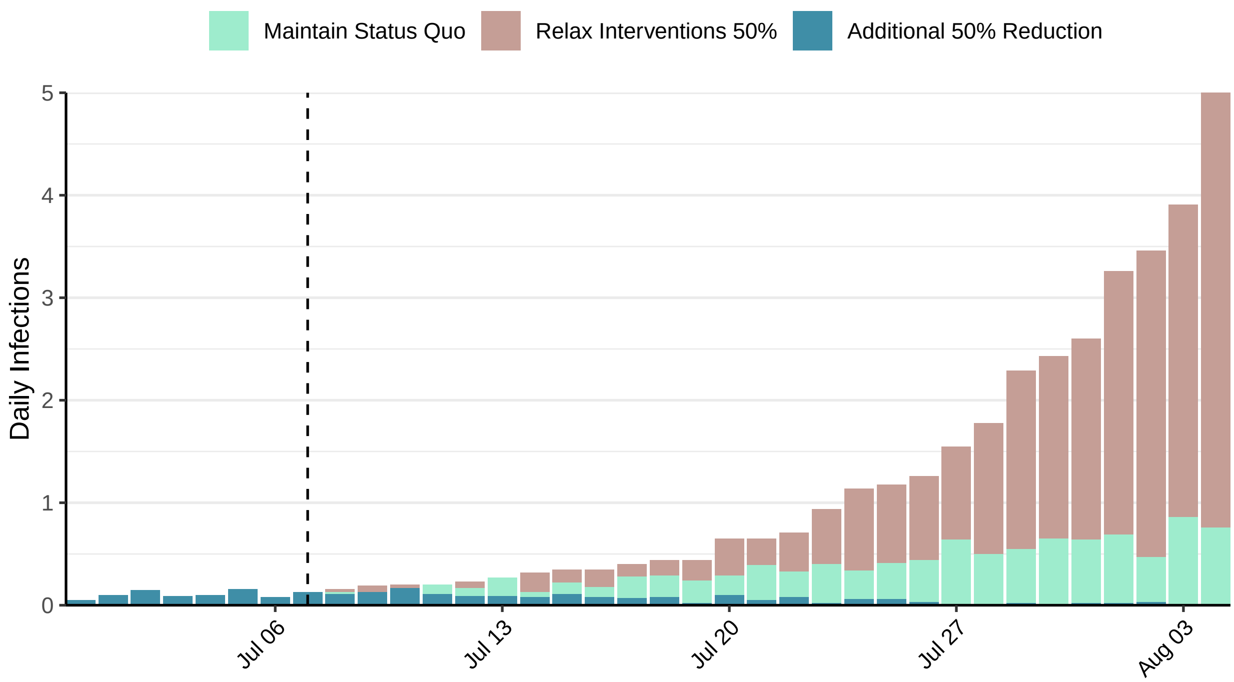

Figure 6: **Daily number of infections estimated by fitting to deaths.** Projected infections for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

To explore different scenarios, we recommend using our COVID-19 Scenario Analysis Tool - https://covidsim.org/, which can be used to simulate different intervention scenarios and explore the long term impact on healthcare demand.

Situation Report for COVID-19: Bolivia, 2020-07-07

Download the report for Bolivia, 2020-07-07 here. This report uses data from the European Centre for Disease Control. These data are updated daily and whilst there may be a short delay, they are generally consistent with Ministry reports. These data are then used to back-calculate an 'inferred number of COVID-19 infections' using mathematical modelling techniques (see Report 12 for further details) to estimate the number of people that have been infected and to make short-term projections for future healthcare needs.

Epidemiological Situation

Total Reported Cases	New Reported Cases	Total Reported Deaths	New Reported Deaths	Estimated R_t
40,509	1,212	1,476	42	1.24 (95% CI: 1.19-1.3)

The figure below shows the cumulative reported deaths as a function of the time since the 10th death was reported. Dashed lines show the expected trajectory for different doubling times of the epidemic. For example, with a doubling time of 3 days, if there are currently a total of 20 deaths reported, we would expect there to be 40 deaths in total reported in 3 days-time, 80 deaths in 6 days-time, 160 deaths in 9 days-time etc. For most epidemics, in the absence of interventions, we expect a doubling time of 3-4 days for this disease.

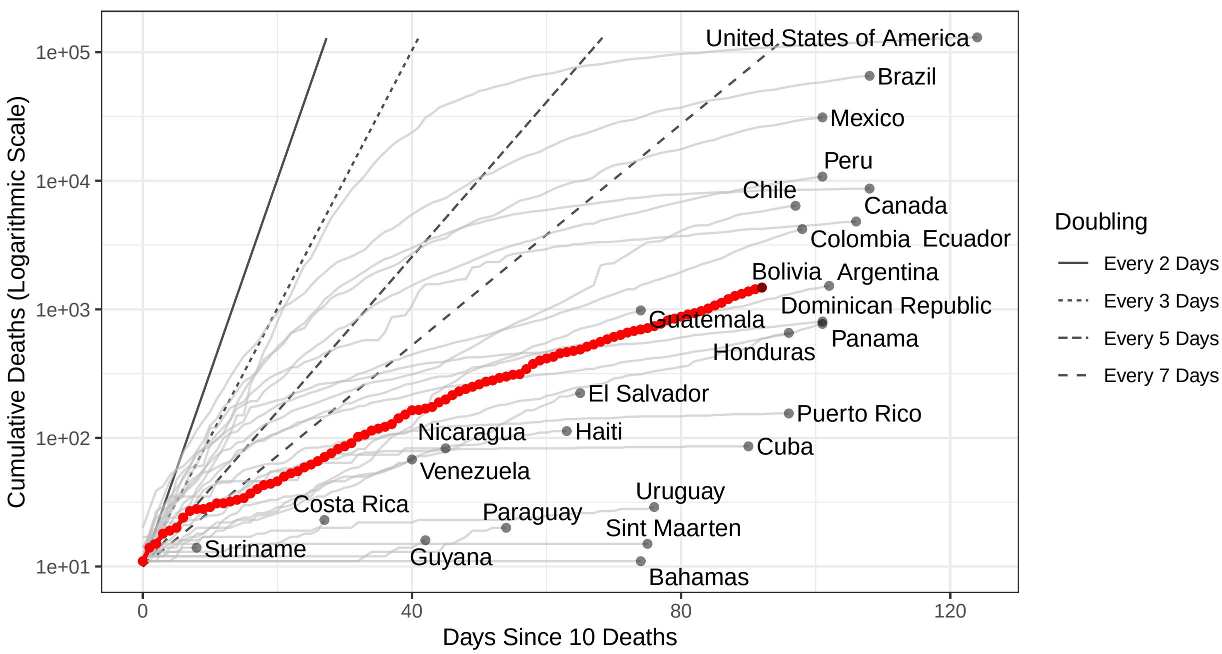

Figure 1: **Cumulative Deaths since 10 deaths.** Country not shown if fewer than 10 deaths.

COVID-19 Transmission Modelling

We assume that the deaths reported to date provide the best indication of the stage of the epidemic, as deaths are more consistently and accurately reported. Our current working estimate is that 1 death indicates that approximately 100 people will have been infected with the other 99 recovering (based on an infection fatality ratio of ~1%). These infections will have happened approximately 21 days previously – capturing a 5-day period from infection to onset of symptoms (the incubation period), 4 days from onset of symptoms to hospitalisation, and 12 days in hospital before death. With a 3-day doubling time, 100 infections that occurred 15 days ago will have generated 200 infections 12 days ago, 400 infections 9 days ago, 800 infections 6 days ago and 1,600 infections 3 days ago resulting in approximately 3,200 infections at the time the first death is observed.

To explore this, we fit our age-structured SEIR model (see Methods) to the time series of deaths in a country, in order to estimate the start date of the epidemic and the baseline R0. We assume that 100% of COVID-19 related deaths have been reported. We have also included the impact of interventions that have been put in place and their effect on human mobility and transmission based on the Google COVID-19 Community Mobility Reports. Using our mathematical model that formalises this approach, we estimate that there has been a total of 513,275 (95% CI: 482,128-544,422) infections over the past 4 weeks.

The figure below shows the estimated number of people infected over the past 4 weeks. The bar charts show, for comparison, the number of reported cases. The right-hand plot shows these data on a different scale as the estimated infections are likely to be much larger than the reported cases. **Importantly**, the estimated infections includes both asymptomatic and mild cases that would not necessarily be identified through surveillance. Consequently, the estimated infections are likely to be significantly higher than the reported cases (see our FAQ for further explanation of these differences and why the reported cases and estimated infections are unlikely to match).

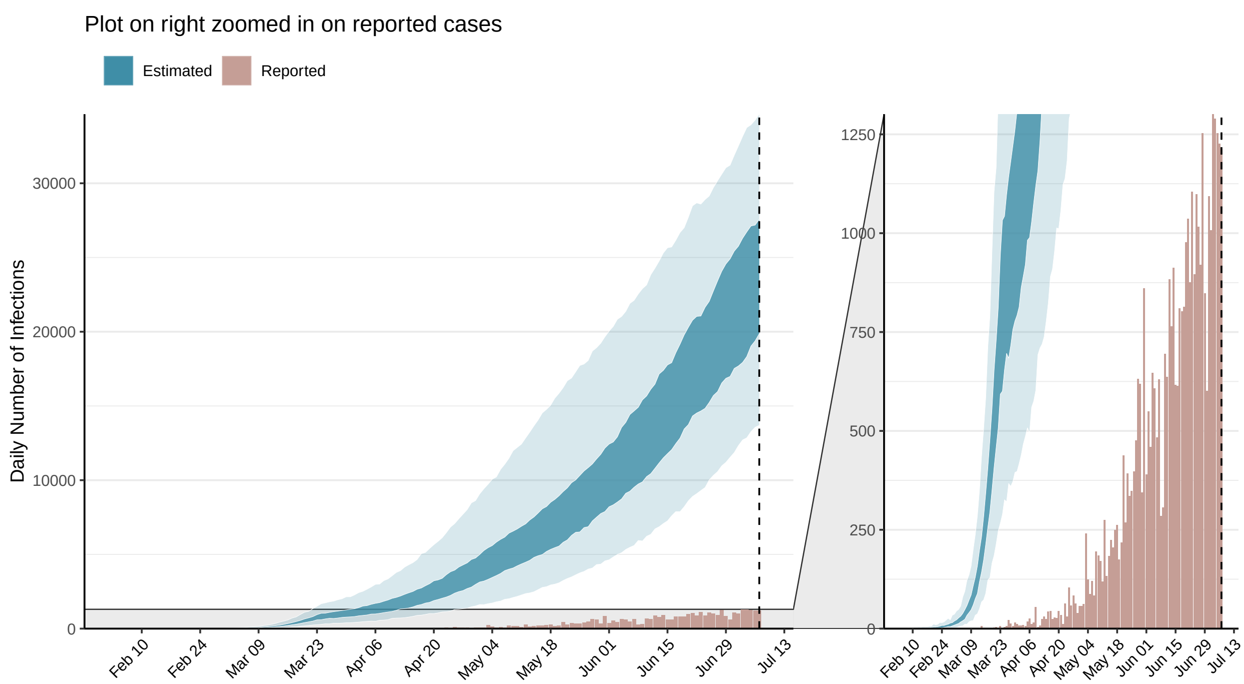

Figure 2: **Daily number of infections estimated by fitting to the current total of deaths.** Reported cases are shown in red. Model estimated infections are shown in blue (dark blue 50% interquartile range, light blue 95% quantile). The dashed line shows the current day.

By fitting to the time series of deaths, we are able to estimate a time-varying reproduction number, R_t. R_t is the the average number of secondary infections caused by a single infected person at a given time. If R_t is above 1, the rate of transmission is increasing and the number of new infections is increasing. R_t is assumed to change in relation to mobility fall in proportion. When fitting our model we assume that 100% of COVID-19 related deaths have been reported (please see our FAQ section for more information about this assumption). We also assume a fixed date at which the impact of mobility on transmission changes from pre-lockdown levels to post-lockdown levels, which may cause large changes in Rt. We are working to refine how this switch occurs and to formally calculate its shape.

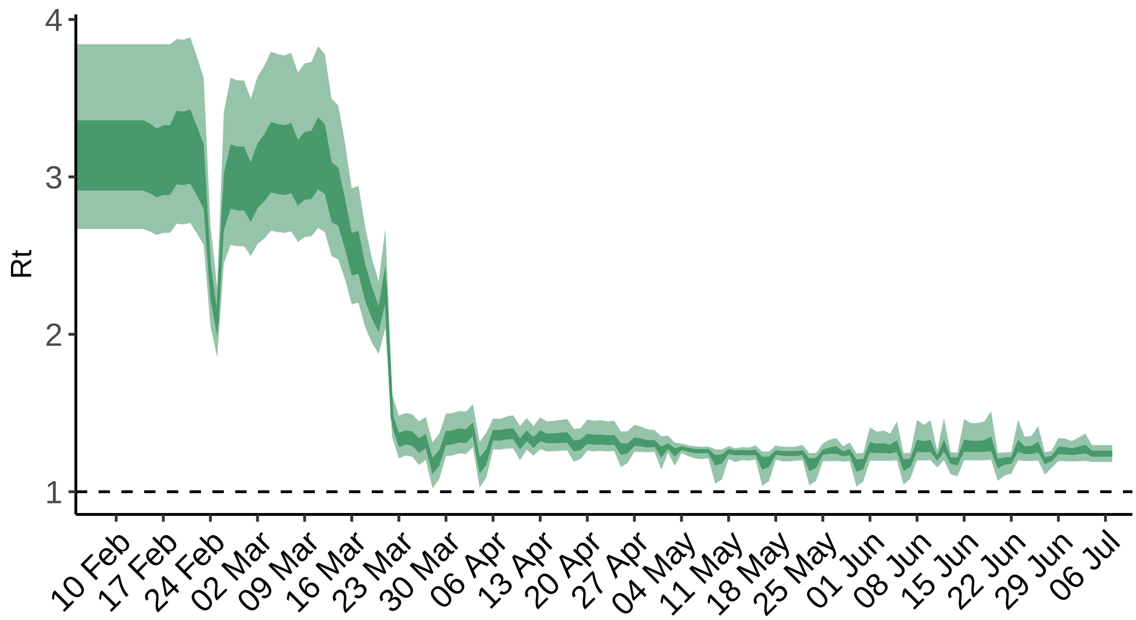

Figure 3: **Time-varying reproduction number, R_t.** R_t is the average number of secondary infections caused by a single infected person at time equal to t. $R_t < 1$ indicates a slowing epidemic in which new infections are not increasing. $R_t > 1$ indicates a growing epidemic in which new infections are increasing over time. Dark green shows the 50% CI and light green shows the 95% CI.

Using the model fit, we can forecast the expected trajectory for cumulative deaths, which is shown in the figure below. This assumes a severity pattern by age that is consistent with that observed in China, Europe and the U.S to date. This projection assumes that transmission is maintained at the current level of transmission as estimated by the final R_t value. **N.B. Bolivia is forecast to be close to or surpassing our best estimates for healthcare capacity in the next 28 days.** Estimates of deaths in the next 28 days may be inaccurate due to our working assumptions for mortality in individuals who do not receive appropriate treatment. See our methods for more information.

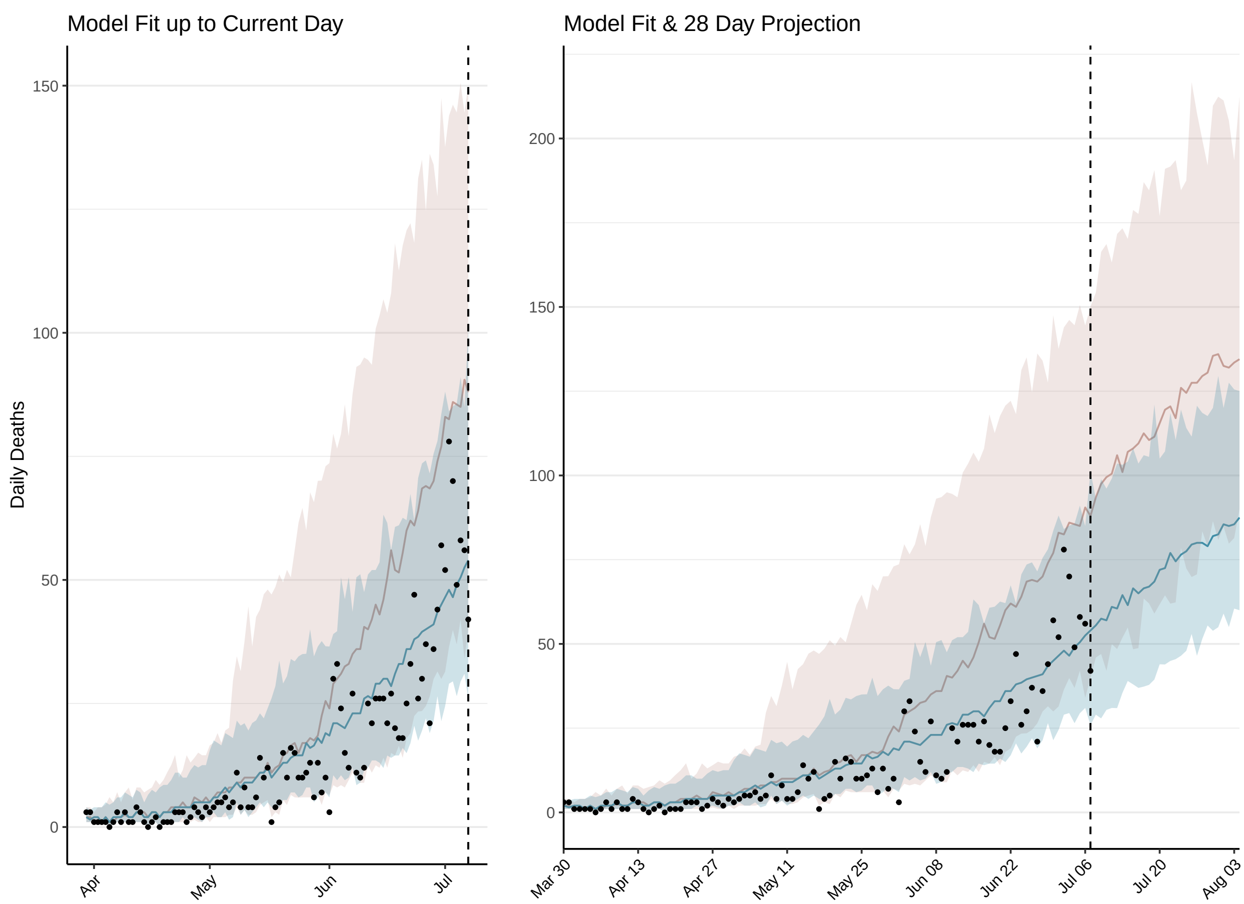

Figure 4: **Estimated daily deaths.** Projected deaths assuming the current level of interventions are maintained are shown in red (median and 95% quantile). Reported deaths are plotted in black. The plot on the left is focussed on the model fit prior to today, while the plot on the right forecasts the next 28 days. The forecasted deaths in blue assumes healthcare capacity has been surged to ensure sufficient supply of ICU and hospital beds. The red curve assumes no surging in healthcare capacity and subsequently projects increased deaths.

Short-term Epidemic Scenarios

We make the following short-term projections of healthcare demand and new infections under the following three scenarios:

- **Scenario 1.** The epidemic continues to grow at the current rate.
- **Scenario 2.** Countries will further scale up interventions (either increasing current strategies or implementing new interventions) leading to a further 50% reduction in transmission.
- **Scenario 3.** Countries will relax current interventions by 50%

N.B. These scenarios currently assume that the impact of mobility on transmission will remain the same in the future as it has in the past. We are working to extend methods to estimate the impact of increases in mobility on transmission as lockdown and interventions are reversed. Consequently, projection are likely to represent an upper estimate of the healthcare demand and case load for each scenario

We estimate that over the next 4 weeks demand for hospital beds will change from 2,654 (95% CI: 2,491-2,817) patients requiring treatment with high-pressure oxygen at the current date to 3,874 (95% CI: 3,694-4,054) hospital beds being required on 2020-08-04 if no further interventions are introduced (Scenario 1). Similarly, we estimate that over the next 4 weeks demand for critical care (ICU) beds will change from 361 (95% CI: 349-372) patients requiring treatment with mechanical ventilation at the current date to 411 (95% CI: 400-422) by 2020-08-04. These projections assume that approximately 5% of all infections will require treatment with high-pressure oxygen and that approximately 30% of hospitalised cases will require treatment with mechanical ventilation (based on analysis of ongoing epidemics in Europe). **N.B. These scenarios are unlikely to show significant differences for the first week since there is a delay of approximately 10 days between infection and hospital admission. Consequently, the effectiveness of a change in policy is likely to be better captured by hospital admission data approximately 2 weeks after the policy change is implemented.**

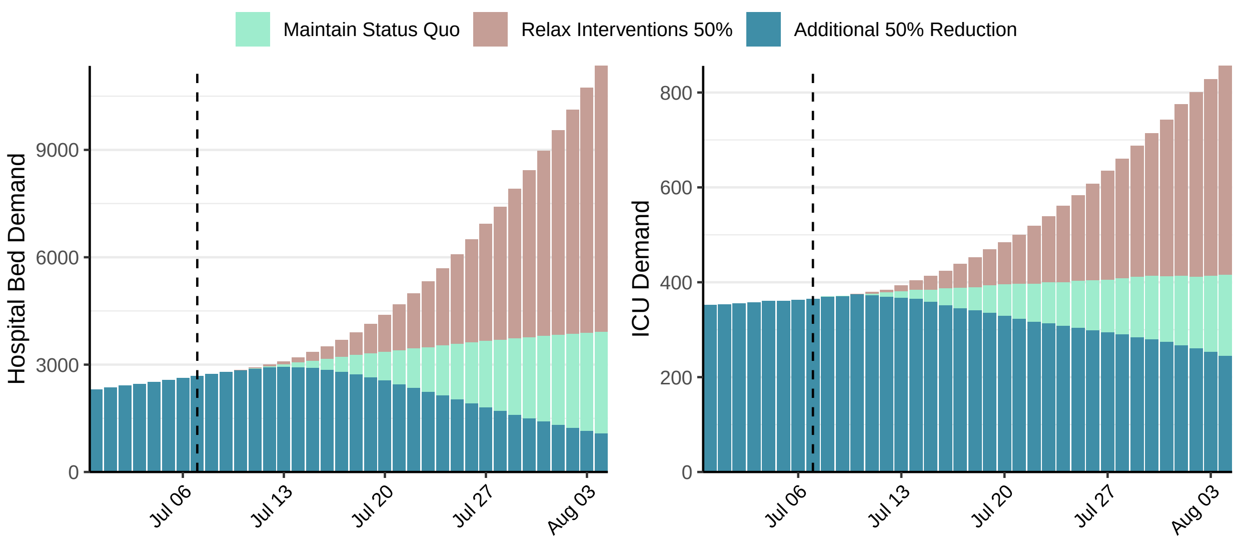

Figure 5: **Healthcare demands in the next 28 days.** Individuals needing an ICU bed are assumed to need mechanical ventilation. Projected demand for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

The impact of each scenario has a more immediate effect on the daily number of infections. The figure below shows the impact of each scenario on the estimated daily incidence of new infections. If interventions are scaled up (Scenario 2), the daily number of infections will change from 23,343 (95% CI: 22,094-24,591) at the current date to 2,546 (95% CI: 2,430-2,663) by 2020-08-04. If current interventions were relaxed by 50%, we estimate the daily number of infections will change from 23,343 (95% CI: 22,094-24,591) at the current date to 120,132 (95% CI: 115,941-124,323) by 2020-08-04.

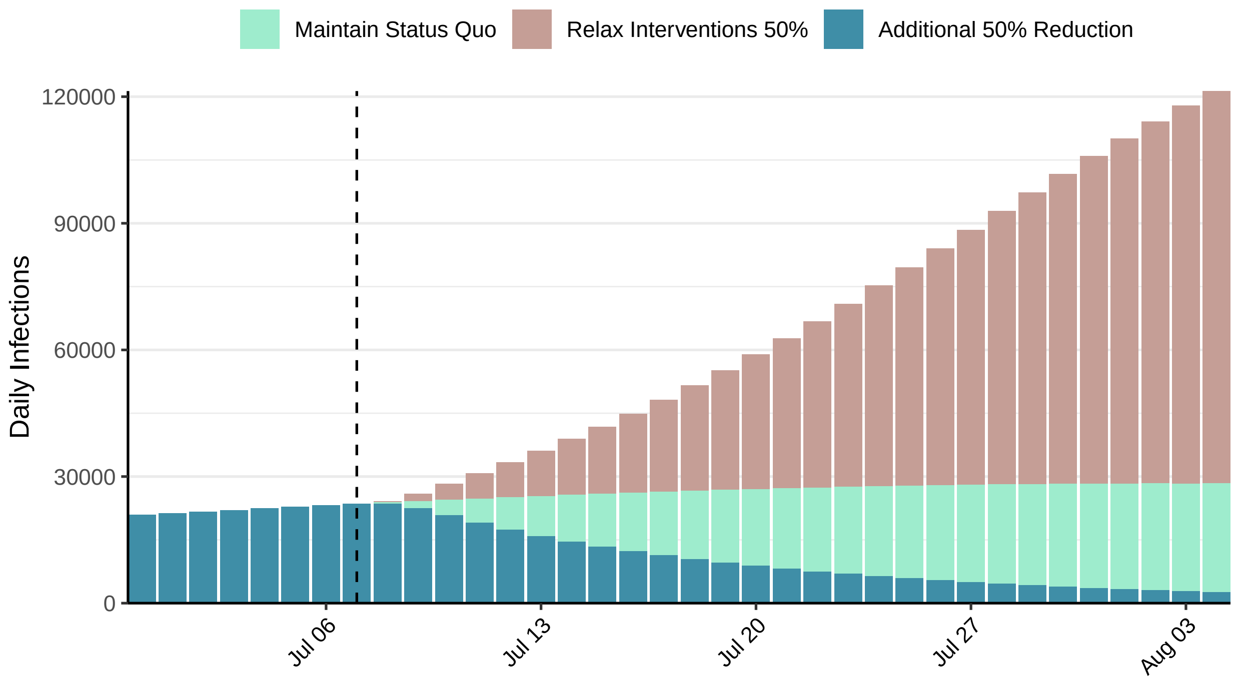

Figure 6: **Daily number of infections estimated by fitting to deaths.** Projected infections for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

To explore different scenarios, we recommend using our COVID-19 Scenario Analysis Tool - https://covidsim.org/, which can be used to simulate different intervention scenarios and explore the long term impact on healthcare demand.

Situation Report for COVID-19: Brazil, 2020-07-07

Download the report for Brazil, 2020-07-07 here. This report uses data from the European Centre for Disease Control. These data are updated daily and whilst there may be a short delay, they are generally consistent with Ministry reports. These data are then used to back-calculate an 'inferred number of COVID-19 infections' using mathematical modelling techniques (see Report 12 for further details) to estimate the number of people that have been infected and to make short-term projections for future healthcare needs.

Epidemiological Situation

Total Reported Cases	New Reported Cases	Total Reported Deaths	New Reported Deaths	Estimated R_t
1,623,284	20,229	65,487	620	1.16 (95% CI: 1.11-1.23)

The figure below shows the cumulative reported deaths as a function of the time since the 10th death was reported. Dashed lines show the expected trajectory for different doubling times of the epidemic. For example, with a doubling time of 3 days, if there are currently a total of 20 deaths reported, we would expect there to be 40 deaths in total reported in 3 days-time, 80 deaths in 6 days-time, 160 deaths in 9 days-time etc. For most epidemics, in the absence of interventions, we expect a doubling time of 3-4 days for this disease.

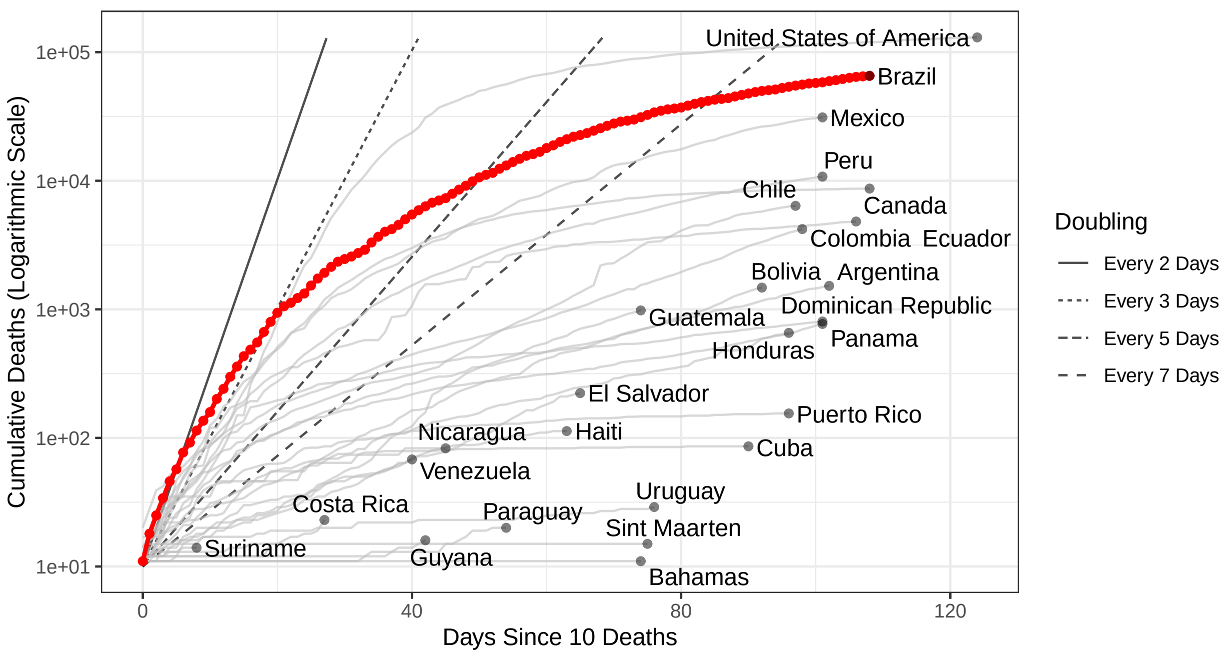

Figure 1: **Cumulative Deaths since 10 deaths.** Country not shown if fewer than 10 deaths.

COVID-19 Transmission Modelling

We assume that the deaths reported to date provide the best indication of the stage of the epidemic, as deaths are more consistently and accurately reported. Our current working estimate is that 1 death indicates that approximately 100 people will have been infected with the other 99 recovering (based on an infection fatality ratio of ~1%). These infections will have happened approximately 21 days previously – capturing a 5-day period from infection to onset of symptoms (the incubation period), 4 days from onset of symptoms to hospitalisation, and 12 days in hospital before death. With a 3-day doubling time, 100 infections that occurred 15 days ago will have generated 200 infections 12 days ago, 400 infections 9 days ago, 800 infections 6 days ago and 1,600 infections 3 days ago resulting in approximately 3,200 infections at the time the first death is observed.

To explore this, we fit our age-structured SEIR model (see Methods) to the time series of deaths in a country, in order to estimate the start date of the epidemic and the baseline R0. We assume that 100% of COVID-19 related deaths have been reported. We have also included the impact of interventions that have been put in place and their effect on human mobility and transmission based on the Google COVID-19 Community Mobility Reports. Using our mathematical model that formalises this approach, we estimate that there has been a total of 8,305,862 (95% CI: 8,037,483-8,574,240) infections over the past 4 weeks.

The figure below shows the estimated number of people infected over the past 4 weeks. The bar charts show, for comparison, the number of reported cases. The right-hand plot shows these data on a different scale as the estimated infections are likely to be much larger than the reported cases. **Importantly**, the estimated infections includes both asymptomatic and mild cases that would not necessarily be identified through surveillance. Consequently, the estimated infections are likely to be significantly higher than the reported cases (see our FAQ for further explanation of these differences and why the reported cases and estimated infections are unlikely to match).

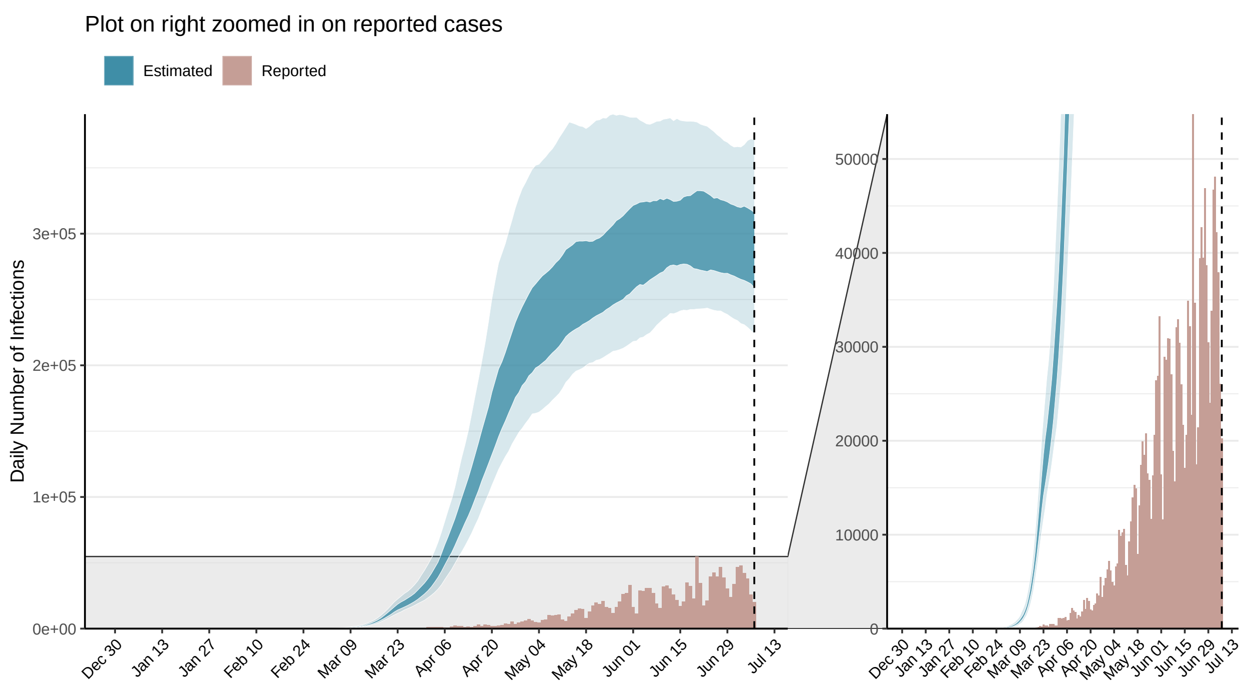

Figure 2: **Daily number of infections estimated by fitting to the current total of deaths.** Reported cases are shown in red. Model estimated infections are shown in blue (dark blue 50% interquartile range, light blue 95% quantile). The dashed line shows the current day.

By fitting to the time series of deaths, we are able to estimate a time-varying reproduction number, R_t. R_t is the the average number of secondary infections caused by a single infected person at a given time. If R_t is above 1, the rate of transmission is increasing and the number of new infections is increasing. R_t is assumed to change in relation to mobility fall in proportion. When fitting our model we assume that 100% of COVID-19 related deaths have been reported (please see our FAQ section for more information about this assumption). We also assume a fixed date at which the impact of mobility on transmission changes from pre-lockdown levels to post-lockdown levels, which may cause large changes in Rt. We are working to refine how this switch occurs and to formally calculate its shape.

For sub-national estimates of R_t, and further analysis of Brazil, please see Report 21

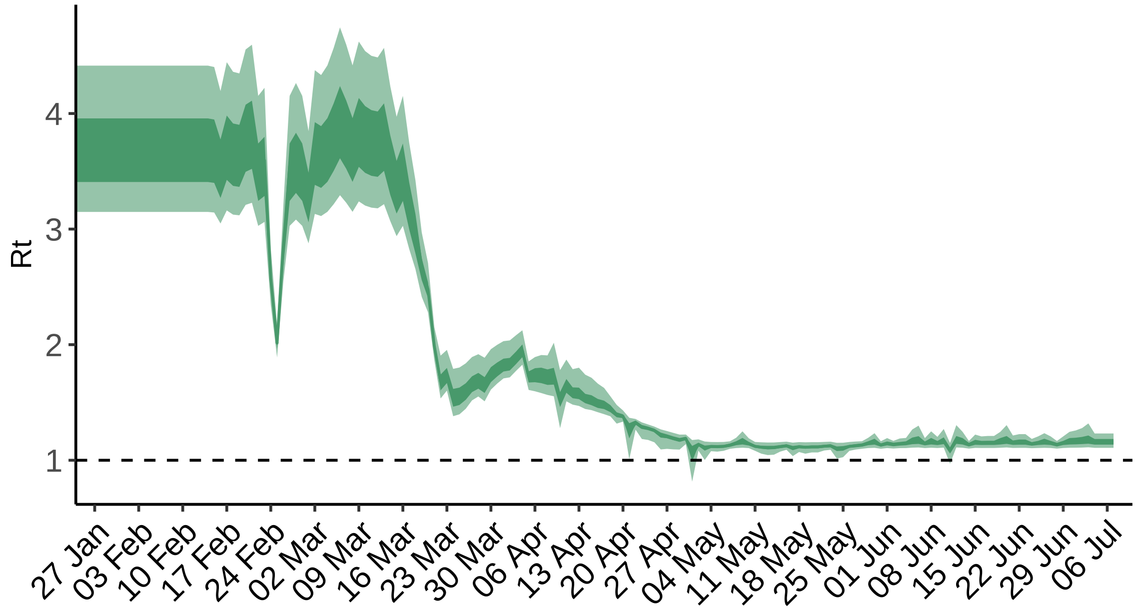

Figure 3: **Time-varying reproduction number, R_t.** R_t is the average number of secondary infections caused by a single infected person at time equal to t. $R_t < 1$ indicates a slowing epidemic in which new infections are not increasing. $R_t > 1$ indicates a growing epidemic in which new infections are increasing over time. Dark green shows the 50% CI and light green shows the 95% CI.

Using the model fit, we can forecast the expected trajectory for cumulative deaths, which is shown in the figure below. This assumes a severity pattern by age that is consistent with that observed in China, Europe and the U.S to date. This projection assumes that transmission is maintained at the current level of transmission as estimated by the final R_t value. **N.B. Brazil is forecast to be close to or surpassing our best estimates for healthcare capacity in the next 28 days.** Estimates of deaths in the next 28 days may be inaccurate due to our working assumptions for mortality in individuals who do not receive appropriate treatment. See our methods for more information.

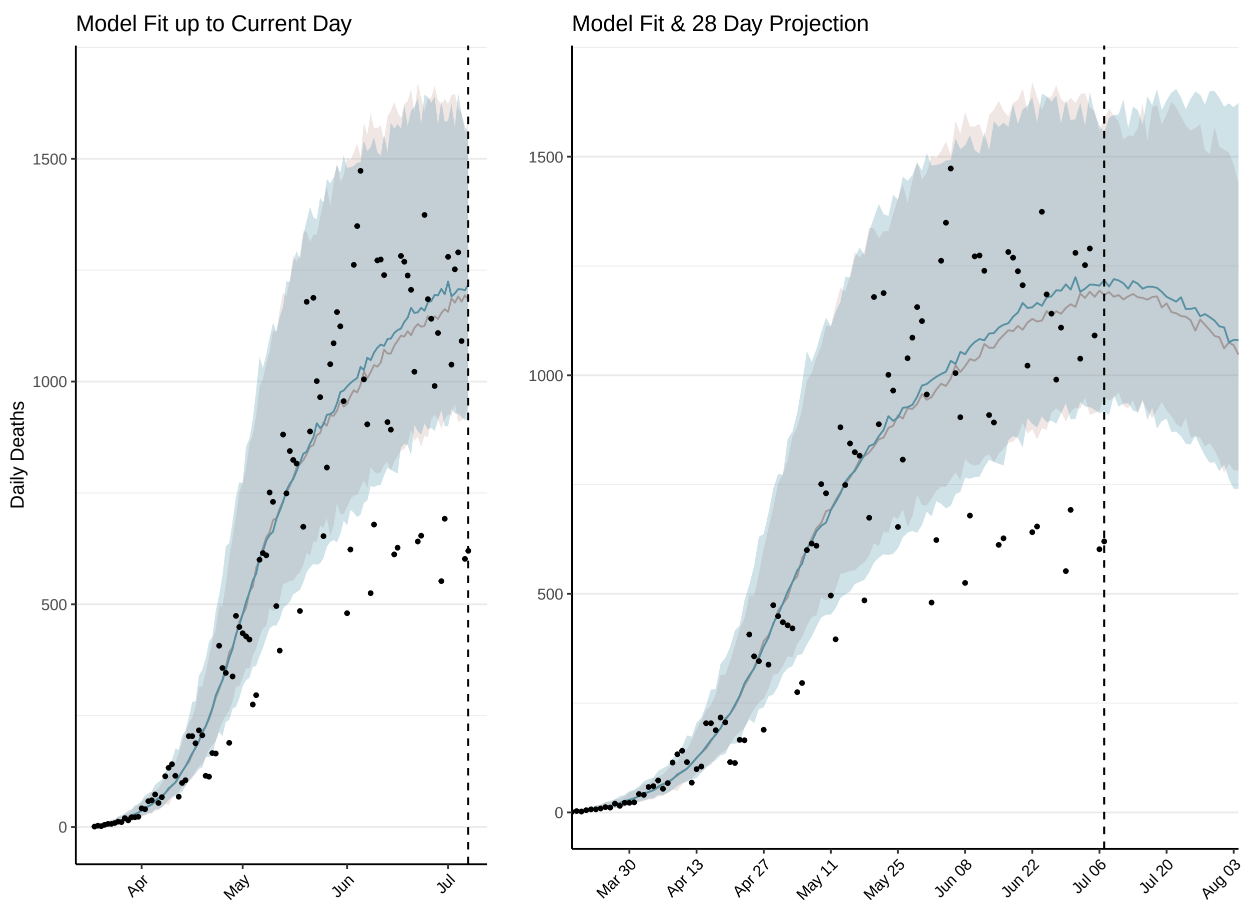

Figure 4: **Estimated daily deaths.** Projected deaths assuming the current level of interventions are maintained are shown in red (median and 95% quantile). Reported deaths are plotted in black. The plot on the left is focussed on the model fit prior to today, while the plot on the right forecasts the next 28 days. The forecasted deaths in blue assumes healthcare capacity has been surged to ensure sufficient supply of ICU and hospital beds. The red curve assumes no surging in healthcare capacity and subsequently projects increased deaths.

Short-term Epidemic Scenarios

We make the following short-term projections of healthcare demand and new infections under the following three scenarios:

- **Scenario 1.** The epidemic continues to grow at the current rate.
- **Scenario 2.** Countries will further scale up interventions (either increasing current strategies or implementing new interventions) leading to a further 50% reduction in transmission.
- **Scenario 3.** Countries will relax current interventions by 50%

N.B. These scenarios currently assume that the impact of mobility on transmission will remain the same in the future as it has in the past. We are working to extend methods to estimate the impact of increases in mobility on transmission as lockdown and interventions are reversed. Consequently, projection are likely to represent an upper estimate of the healthcare demand and case load for each scenario

We estimate that over the next 4 weeks demand for hospital beds will change from 53,785 (95% CI: 51,955-55,614) patients requiring treatment with high-pressure oxygen at the current date to 46,907 (95% CI: 44,866-48,948) hospital beds being required on 2020-08-04 if no further interventions are introduced (Scenario 1). Similarly, we estimate that over the next 4 weeks demand for critical care (ICU) beds will change from 17,319 (95% CI: 16,754-17,883) patients requiring treatment with mechanical ventilation at the current date to 15,294 (95% CI: 14,667-15,921) by 2020-08-04. These projections assume that approximately 5% of all infections will require treatment with high-pressure oxygen and that approximately 30% of hospitalised cases will require treatment with mechanical ventilation (based on analysis of ongoing epidemics in Europe). **N.B. These scenarios are unlikely to show significant differences for the first week since there is a delay of approximately 10 days between infection and hospital admission. Consequently, the effectiveness of a change in policy is likely to be better captured by hospital admission data approximately 2 weeks after the policy change is implemented.**

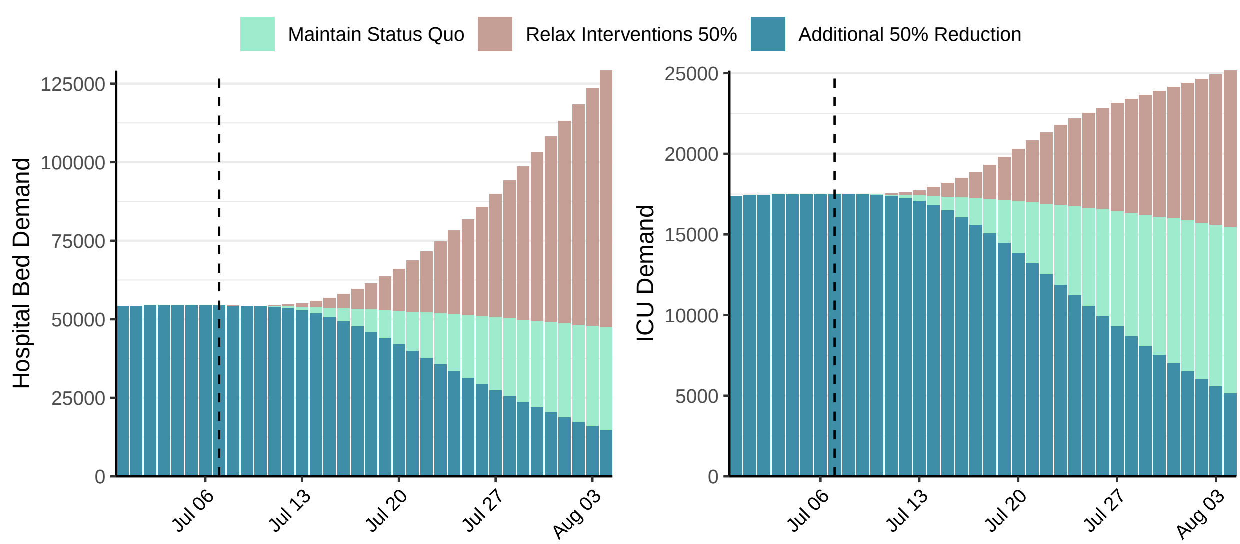

Figure 5: **Healthcare demands in the next 28 days.** Individuals needing an ICU bed are assumed to need mechanical ventilation. Projected demand for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

The impact of each scenario has a more immediate effect on the daily number of infections. The figure below shows the impact of each scenario on the estimated daily incidence of new infections. If interventions are scaled up (Scenario 2), the daily number of infections will change from 286,689 (95% CI: 276,421-296,957) at the current date to 20,490 (95% CI: 19,508-21,472) by 2020-08-04. If current interventions were relaxed by 50%, we estimate the daily number of infections will change from 286,689 (95% CI: 276,421-296,957) at the current date to 1,002,855 (95% CI: 958,046-1,047,664) by 2020-08-04.

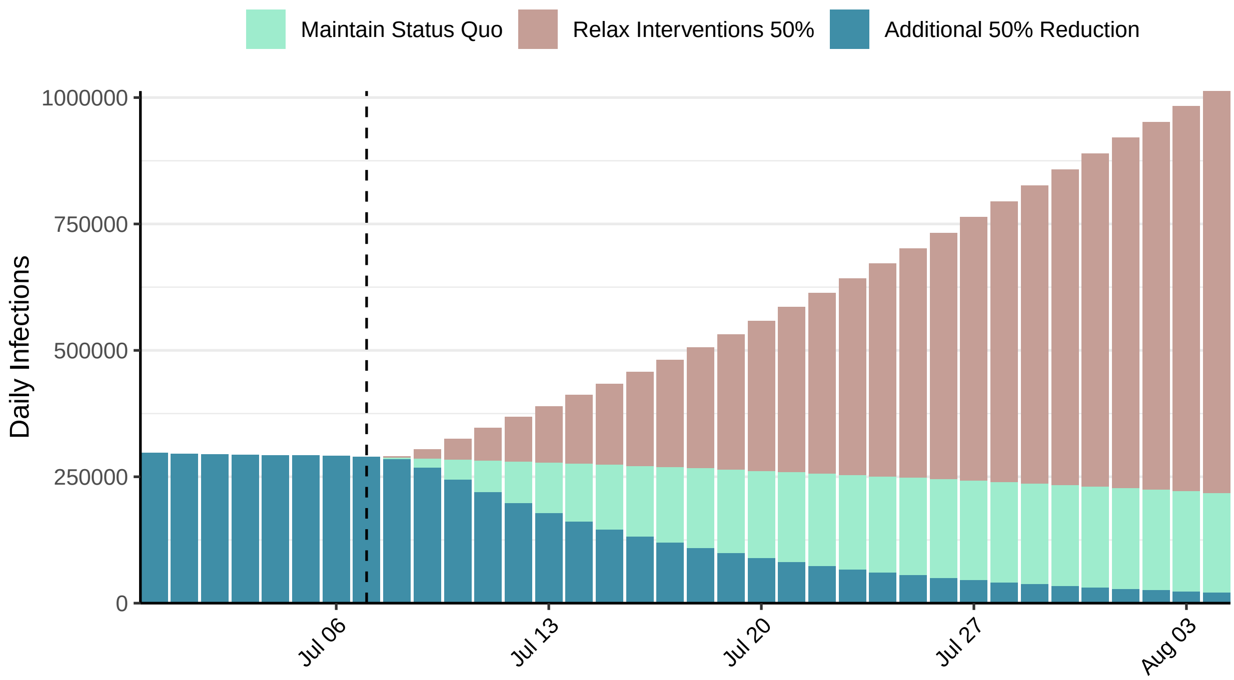

Figure 6: **Daily number of infections estimated by fitting to deaths.** Projected infections for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

To explore different scenarios, we recommend using our COVID-19 Scenario Analysis Tool - https://covidsim.org/, which can be used to simulate different intervention scenarios and explore the long term impact on healthcare demand.

Situation Report for COVID-19: Botswana, 2020-07-07

Download the report for Botswana, 2020-07-07 here. This report uses data from the European Centre for Disease Control. These data are updated daily and whilst there may be a short delay, they are generally consistent with Ministry reports. These data are then used to back-calculate an 'inferred number of COVID-19 infections' using mathematical modelling techniques (see Report 12 for further details) to estimate the number of people that have been infected and to make short-term projections for future healthcare needs.

Epidemiological Situation

Total Reported Cases	New Reported Cases	Total Reported Deaths	New Reported Deaths	Estimated R_t
275	0	1	0	0.86 (95% CI: 0.14-2.28)

The figure below shows the cumulative reported deaths as a function of the time since the 10th death was reported. Dashed lines show the expected trajectory for different doubling times of the epidemic. For example, with a doubling time of 3 days, if there are currently a total of 20 deaths reported, we would expect there to be 40 deaths in total reported in 3 days-time, 80 deaths in 6 days-time, 160 deaths in 9 days-time etc. For most epidemics, in the absence of interventions, we expect a doubling time of 3-4 days for this disease. **N.B. Botswana is not shown in the following plot as only 1 deaths have been reported to date**

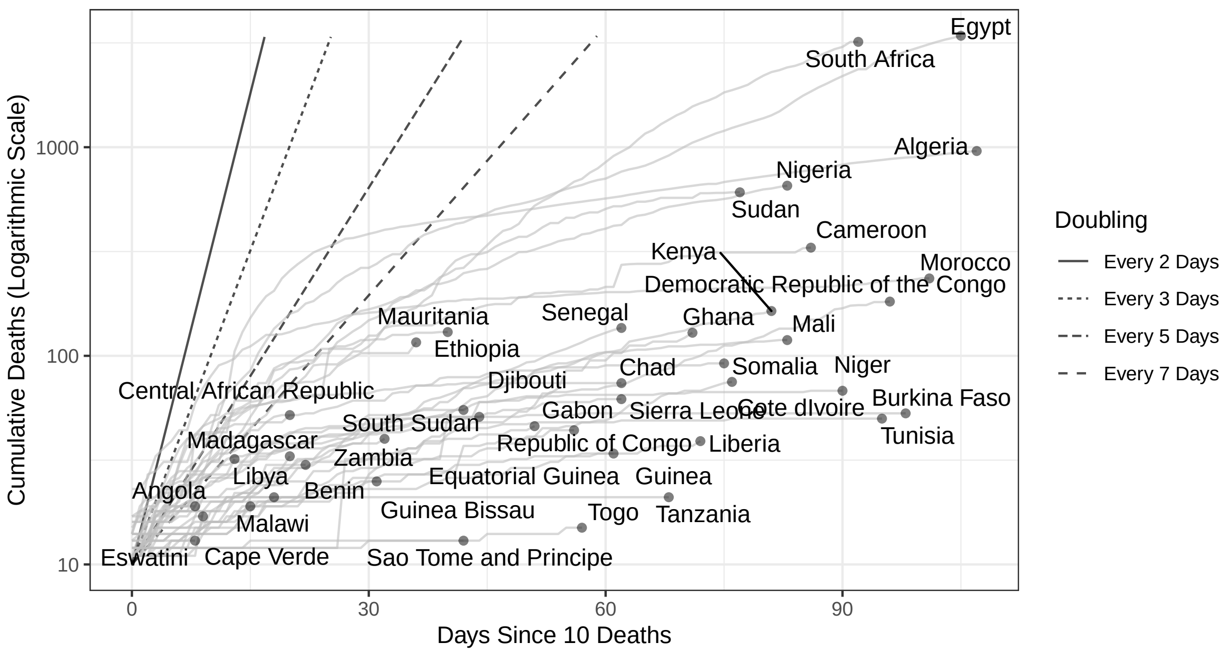

Figure 1: **Cumulative Deaths since 10 deaths.** Country not shown if fewer than 10 deaths.

COVID-19 Transmission Modelling

We assume that the deaths reported to date provide the best indication of the stage of the epidemic, as deaths are more consistently and accurately reported. Our current working estimate is that 1 death indicates that approximately 100 people will have been infected with the other 99 recovering (based on an infection fatality ratio of ~1%). These infections will have happened approximately 21 days previously – capturing a 5-day period from infection to onset of symptoms (the incubation period), 4 days from onset of symptoms to hospitalisation, and 12 days in hospital before death. With a 3-day doubling time, 100 infections that occurred 15 days ago will have generated 200 infections 12 days ago, 400 infections 9 days ago, 800 infections 6 days ago and 1,600 infections 3 days ago resulting in approximately 3,200 infections at the time the first death is observed.

To explore this, we fit our age-structured SEIR model (see Methods) to the time series of deaths in a country, in order to estimate the start date of the epidemic and the baseline R0. We assume that 100% of COVID-19 related deaths have been reported. We have also included the impact of interventions that have been put in place and their effect on human mobility and transmission based on the Google COVID-19 Community Mobility Reports. Using our mathematical model that formalises this approach, we estimate that there has been a total of 20 (95% CI: -1-42) infections over the past 4 weeks.

The figure below shows the estimated number of people infected over the past 4 weeks. The bar charts show, for comparison, the number of reported cases. The right-hand plot shows these data on a different scale as the estimated infections are likely to be much larger than the reported cases. **Importantly**, the estimated infections includes both asymptomatic and mild cases that would not necessarily be identified through surveillance. Consequently, the estimated infections are likely to be significantly higher than the reported cases (see our FAQ for further explanation of these differences and why the reported cases and estimated infections are unlikely to match).

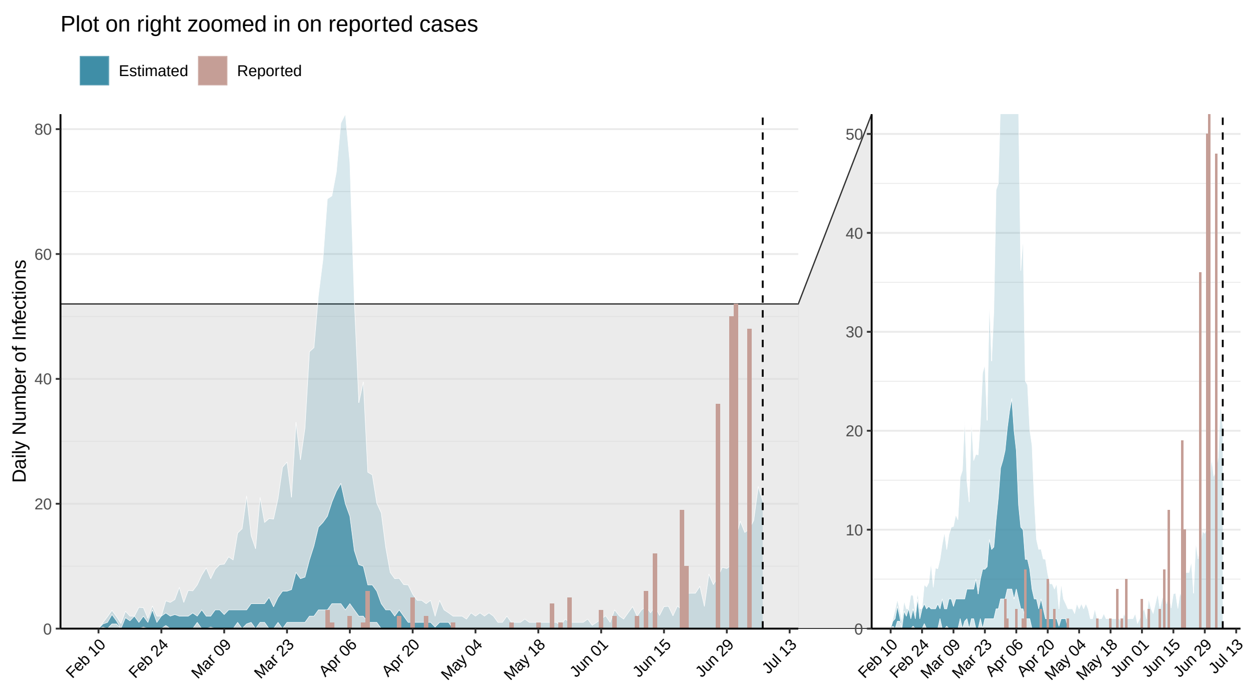

Figure 2: **Daily number of infections estimated by fitting to the current total of deaths.** Reported cases are shown in red. Model estimated infections are shown in blue (dark blue 50% interquartile range, light blue 95% quantile). The dashed line shows the current day.

By fitting to the time series of deaths, we are able to estimate a time-varying reproduction number, R_t. R_t is the the average number of secondary infections caused by a single infected person at a given time. If R_t is above 1, the rate of transmission is increasing and the number of new infections is increasing. R_t is assumed to change in relation to mobility fall in proportion. When fitting our model we assume that 100% of COVID-19 related deaths have been reported (please see our FAQ section for more information about this assumption). We also assume a fixed date at which the impact of mobility on transmission changes from pre-lockdown levels to post-lockdown levels, which may cause large changes in Rt. We are working to refine how this switch occurs and to formally calculate its shape.

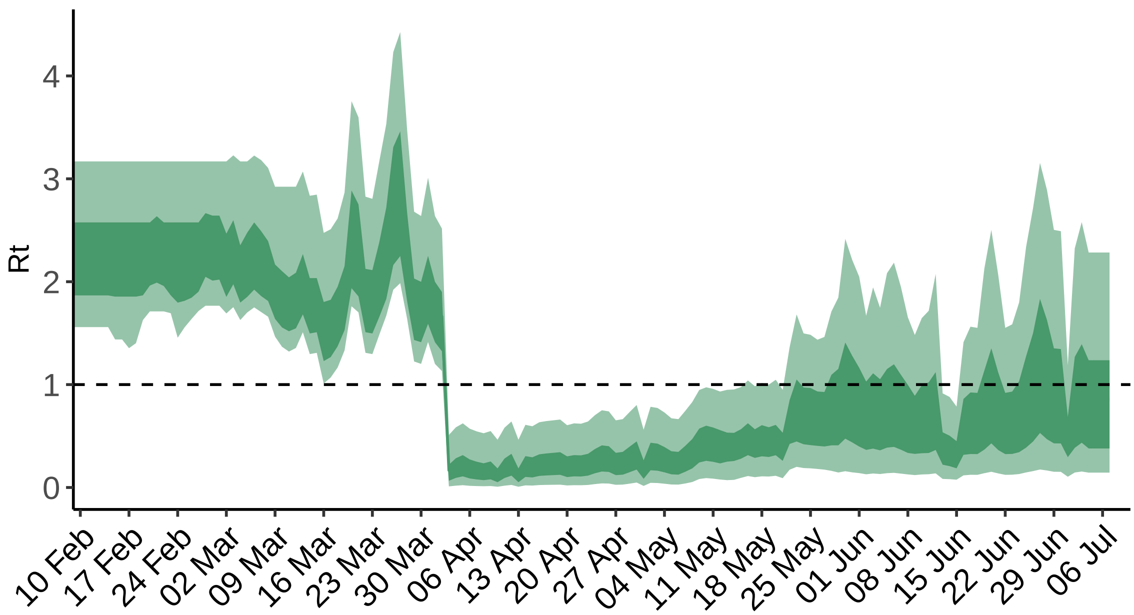

Figure 3: **Time-varying reproduction number, R_t.** R_t is the average number of secondary infections caused by a single infected person at time equal to t. $R_t < 1$ indicates a slowing epidemic in which new infections are not increasing. $R_t > 1$ indicates a growing epidemic in which new infections are increasing over time. Dark green shows the 50% CI and light green shows the 95% CI.

Using the model fit, we can forecast the expected trajectory for cumulative deaths, which is shown in the figure below. This assumes a severity pattern by age that is consistent with that observed in China, Europe and the U.S to date. This projection assumes that transmission is maintained at the current level of transmission as estimated by the final R_t value.

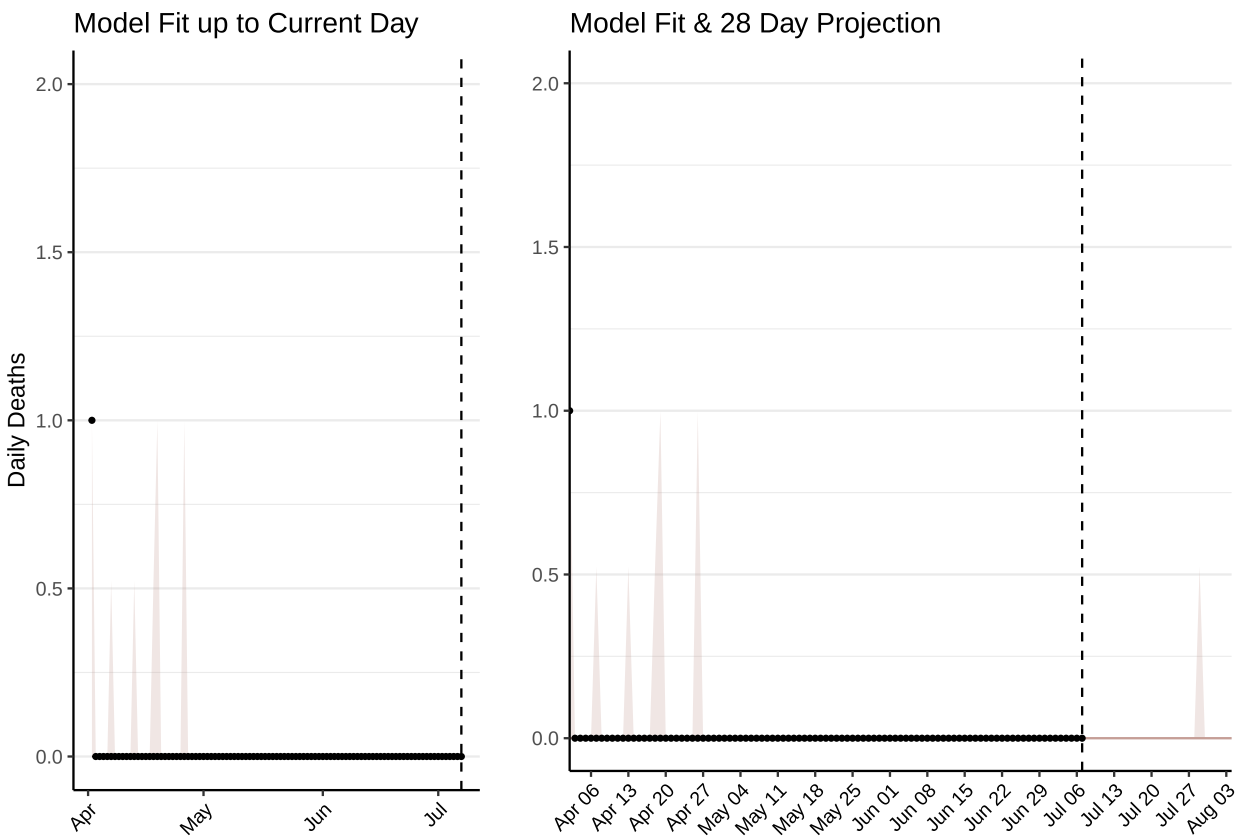

Figure 4: **Estimated daily deaths.** Projected deaths assuming the current level of interventions are maintained are shown in red (median and 95% quantile). Reported deaths are plotted in black. The plot on the left is focussed on the model fit prior to today, while the plot on the right forecasts the next 28 days.

Short-term Epidemic Scenarios

We make the following short-term projections of healthcare demand and new infections under the following three scenarios:

- **Scenario 1.** The epidemic continues to grow at the current rate.
- **Scenario 2.** Countries will further scale up interventions (either increasing current strategies or implementing new interventions) leading to a further 50% reduction in transmission.
- **Scenario 3.** Countries will relax current interventions by 50%

N.B. These scenarios currently assume that the impact of mobility on transmission will remain the same in the future as it has in the past. We are working to extend methods to estimate the impact of increases in mobility on transmission as lockdown and interventions are reversed. Consequently, projection are likely to represent an upper estimate of the healthcare demand and case load for each scenario

We estimate that over the next 4 weeks demand for hospital beds will change from 0 (95% CI: 0-0) patients requiring treatment with high-pressure oxygen at the current date to 5 (95% CI: -2-13) hospital beds being required on 2020-08-04 if no further interventions are introduced (Scenario 1). Similarly, we estimate that over the next 4 weeks demand for critical care (ICU) beds will change from 0 (95% CI: 0-0) patients requiring treatment with mechanical ventilation at the current date to 1 (95% CI: 0-3) by 2020-08-04. These projections assume that approximately 5% of all infections will require treatment with high-pressure oxygen and that approximately 30% of hospitalised cases will require treatment with mechanical ventilation (based on analysis of ongoing epidemics in Europe). **N.B. These scenarios are unlikely to show significant differences for the first week since there is a delay of approximately 10 days between infection and hospital admission. Consequently, the effectiveness of a change in policy is likely to be better captured by hospital admission data approximately 2 weeks after the policy change is implemented.**

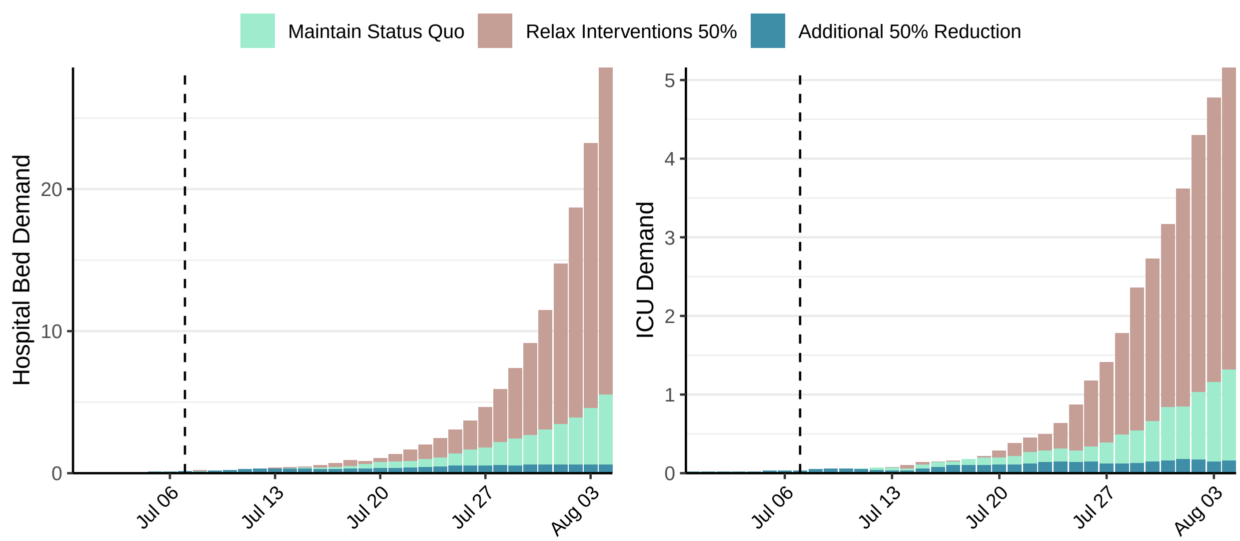

Figure 5: **Healthcare demands in the next 28 days.** Individuals needing an ICU bed are assumed to need mechanical ventilation. Projected demand for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

The impact of each scenario has a more immediate effect on the daily number of infections. The figure below shows the impact of each scenario on the estimated daily incidence of new infections. If interventions are scaled up (Scenario 2), the daily number of infections will change from 2 (95% CI: 0-5) at the current date to 4 (95% CI: -2-11) by 2020-08-04. If current interventions were relaxed by 50%, we estimate the daily number of infections will change from 2 (95% CI: 0-5) at the current date to 868 (95% CI: -359-2,094) by 2020-08-04.

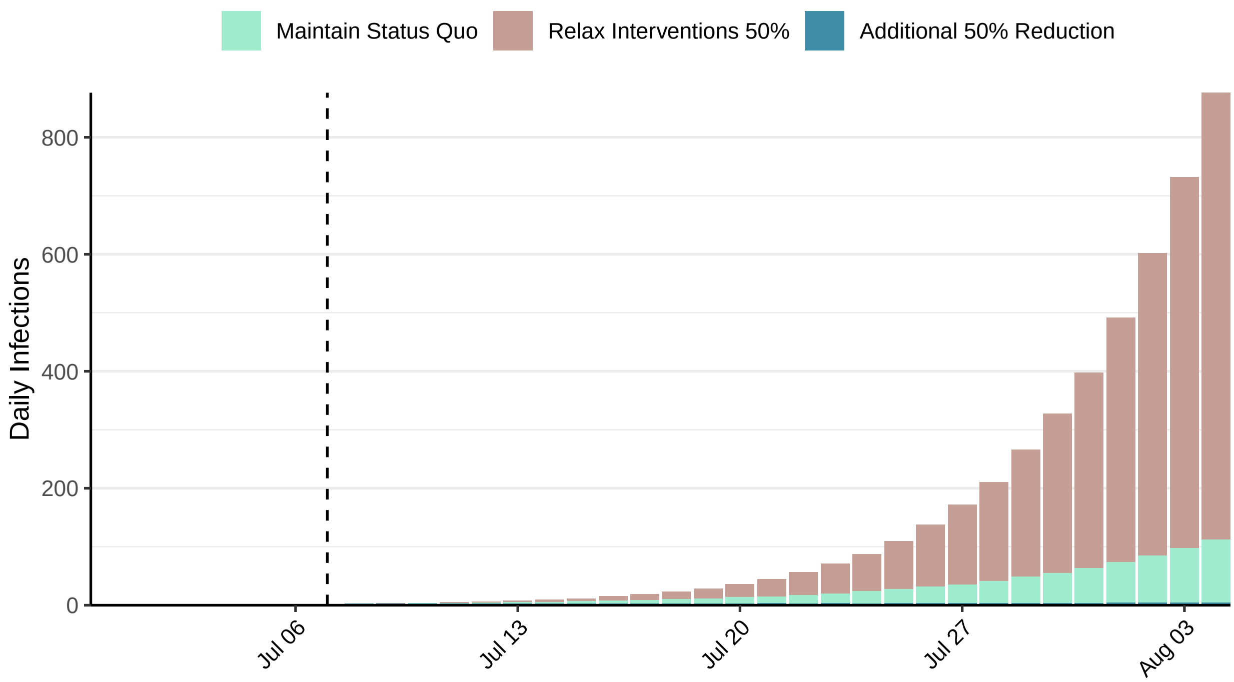

Figure 6: **Daily number of infections estimated by fitting to deaths.** Projected infections for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

To explore different scenarios, we recommend using our COVID-19 Scenario Analysis Tool - https://covidsim.org/, which can be used to simulate different intervention scenarios and explore the long term impact on healthcare demand.

Situation Report for COVID-19: Central African Republic, 2020-07-07

Download the report for Central African Republic, 2020-07-07 here. This report uses data from the European Centre for Disease Control. These data are updated daily and whilst there may be a short delay, they are generally consistent with Ministry reports. These data are then used to back-calculate an 'inferred number of COVID-19 infections' using mathematical modelling techniques (see Report 12 for further details) to estimate the number of people that have been infected and to make short-term projections for future healthcare needs.

Epidemiological Situation

Total Reported Cases	New Reported Cases	Total Reported Deaths	New Reported Deaths	Estimated R_t
4,033	64	52	4	1.35 (95% CI: 1.2-1.49)

The figure below shows the cumulative reported deaths as a function of the time since the 10th death was reported. Dashed lines show the expected trajectory for different doubling times of the epidemic. For example, with a doubling time of 3 days, if there are currently a total of 20 deaths reported, we would expect there to be 40 deaths in total reported in 3 days-time, 80 deaths in 6 days-time, 160 deaths in 9 days-time etc. For most epidemics, in the absence of interventions, we expect a doubling time of 3-4 days for this disease.

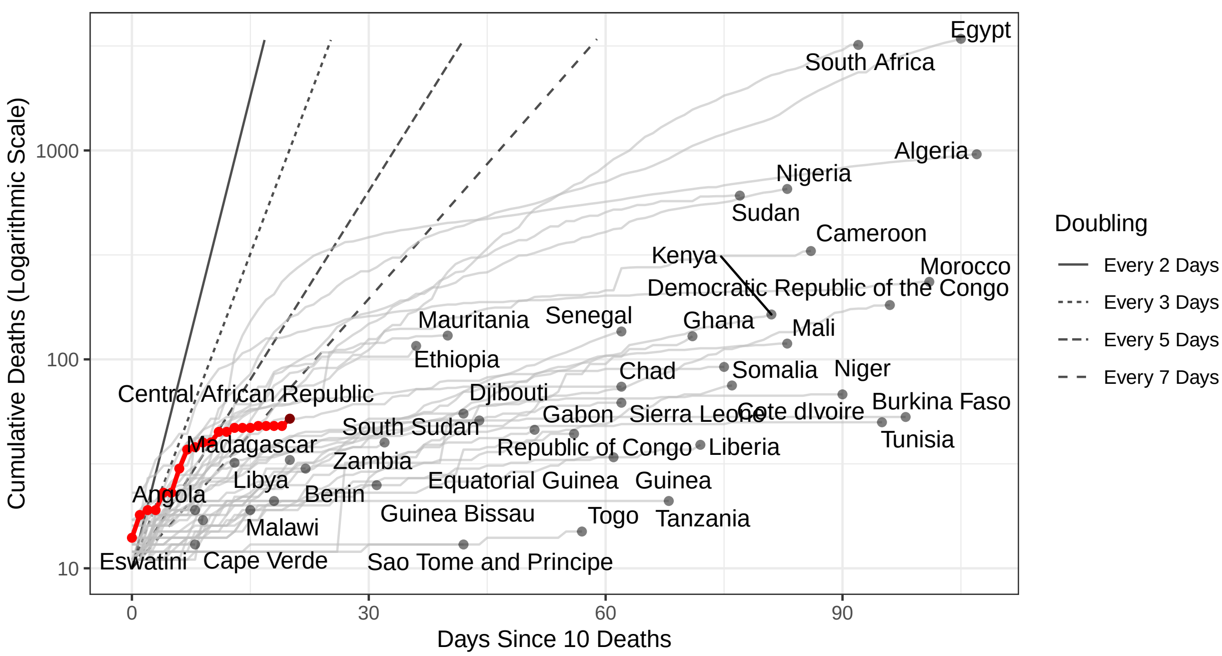

Figure 1: **Cumulative Deaths since 10 deaths.** Country not shown if fewer than 10 deaths.

COVID-19 Transmission Modelling

We assume that the deaths reported to date provide the best indication of the stage of the epidemic, as deaths are more consistently and accurately reported. Our current working estimate is that 1 death indicates that approximately 100 people will have been infected with the other 99 recovering (based on an infection fatality ratio of ~1%). These infections will have happened approximately 21 days previously – capturing a 5-day period from infection to onset of symptoms (the incubation period), 4 days from onset of symptoms to hospitalisation, and 12 days in hospital before death. With a 3-day doubling time, 100 infections that occurred 15 days ago will have generated 200 infections 12 days ago, 400 infections 9 days ago, 800 infections 6 days ago and 1,600 infections 3 days ago resulting in approximately 3,200 infections at the time the first death is observed.

To explore this, we fit our age-structured SEIR model (see Methods) to the time series of deaths in a country, in order to estimate the start date of the epidemic and the baseline R0. We assume that 100% of COVID-19 related deaths have been reported. We have also included the impact of interventions that have been put in place and their effect on human mobility and transmission based on the Google COVID-19 Community Mobility Reports. Using our mathematical model that formalises this approach, we estimate that there has been a total of 31,510 (95% CI: 27,455-35,564) infections over the past 4 weeks.

The figure below shows the estimated number of people infected over the past 4 weeks. The bar charts show, for comparison, the number of reported cases. The right-hand plot shows these data on a different scale as the estimated infections are likely to be much larger than the reported cases. **Importantly**, the estimated infections includes both asymptomatic and mild cases that would not necessarily be identified through surveillance. Consequently, the estimated infections are likely to be significantly higher than the reported cases (see our FAQ for further explanation of these differences and why the reported cases and estimated infections are unlikely to match).

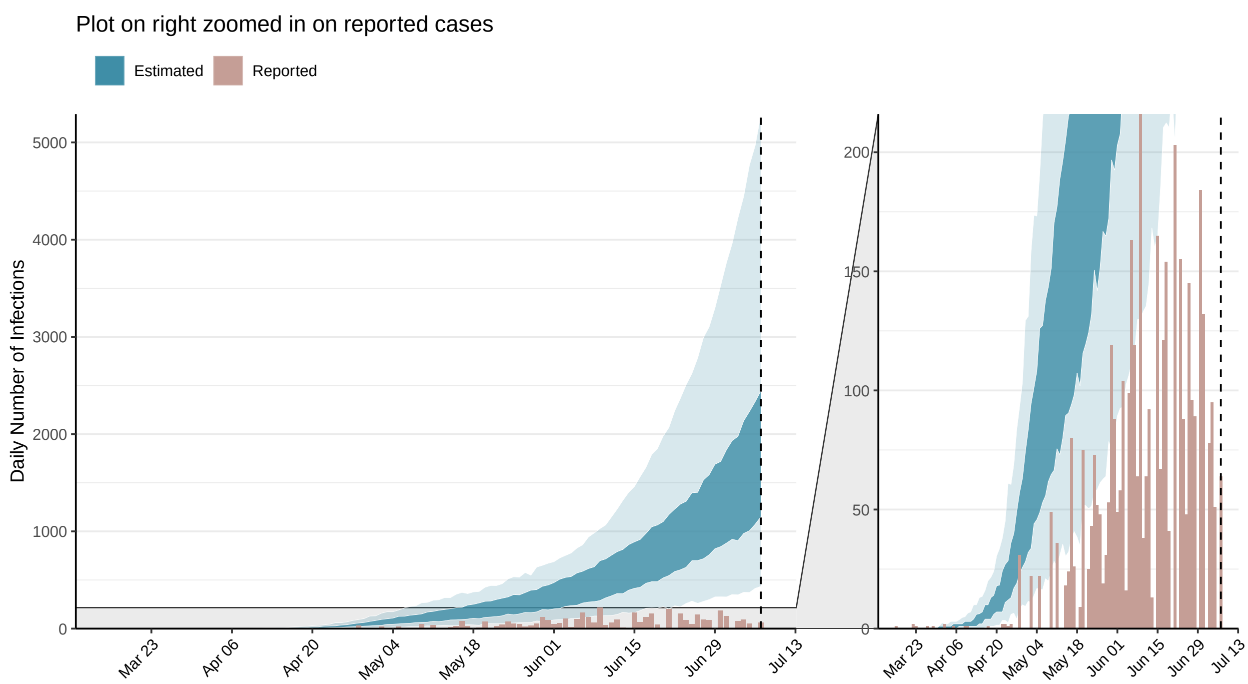

Figure 2: **Daily number of infections estimated by fitting to the current total of deaths.** Reported cases are shown in red. Model estimated infections are shown in blue (dark blue 50% interquartile range, light blue 95% quantile). The dashed line shows the current day.

By fitting to the time series of deaths, we are able to estimate a time-varying reproduction number, R_t. R_t is the the average number of secondary infections caused by a single infected person at a given time. If R_t is above 1, the rate of transmission is increasing and the number of new infections is increasing. R_t is assumed to change in relation to mobility fall in proportion. When fitting our model we assume that 100% of COVID-19 related deaths have been reported (please see our FAQ section for more information about this assumption). We also assume a fixed date at which the impact of mobility on transmission changes from pre-lockdown levels to post-lockdown levels, which may cause large changes in Rt. We are working to refine how this switch occurs and to formally calculate its shape.

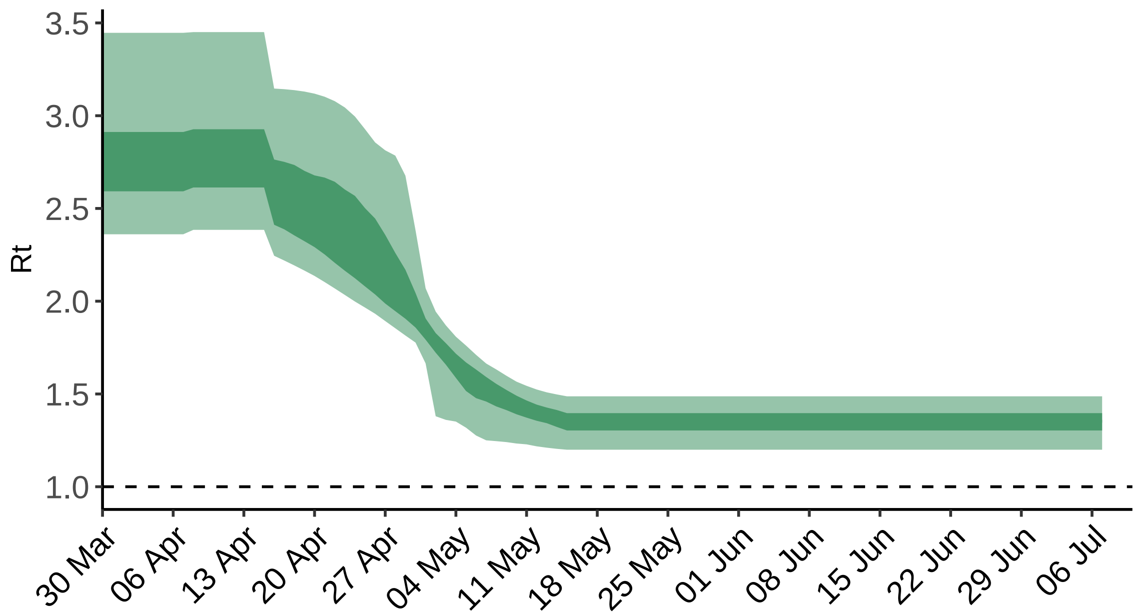

Figure 3: **Time-varying reproduction number, R_t.** R_t is the average number of secondary infections caused by a single infected person at time equal to t. $R_t < 1$ indicates a slowing epidemic in which new infections are not increasing. $R_t > 1$ indicates a growing epidemic in which new infections are increasing over time. Dark green shows the 50% CI and light green shows the 95% CI.

Using the model fit, we can forecast the expected trajectory for cumulative deaths, which is shown in the figure below. This assumes a severity pattern by age that is consistent with that observed in China, Europe and the U.S to date. This projection assumes that transmission is maintained at the current level of transmission as estimated by the final R_t value. **N.B. Central African Republic is forecast to be close to or surpassing our best estimates for healthcare capacity in the next 28 days.** Estimates of deaths in the next 28 days may be inaccurate due to our working assumptions for mortality in individuals who do not receive appropriate treatment. See our methods for more information.

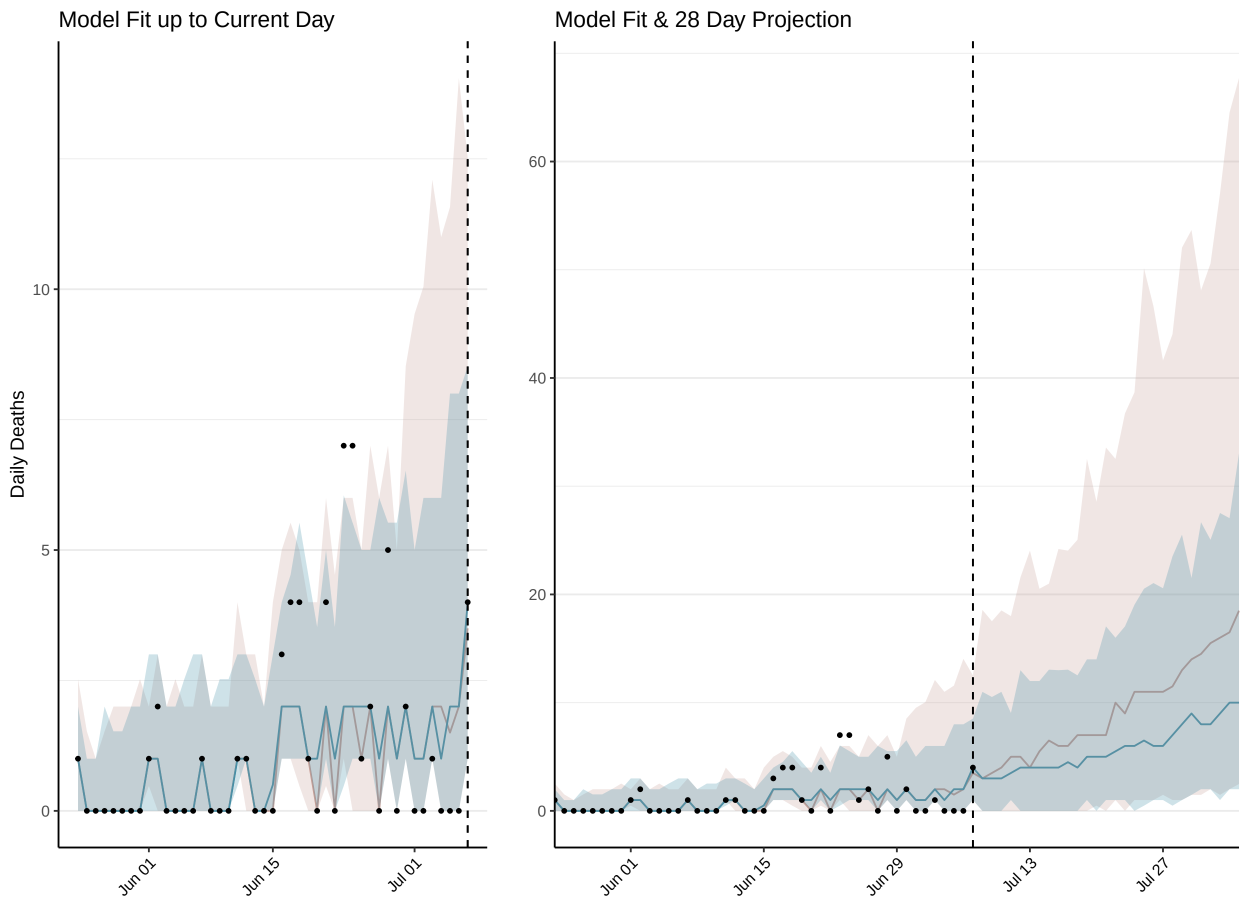

Figure 4: **Estimated daily deaths.** Projected deaths assuming the current level of interventions are maintained are shown in red (median and 95% quantile). Reported deaths are plotted in black. The plot on the left is focussed on the model fit prior to today, while the plot on the right forecasts the next 28 days. The forecasted deaths in blue assumes healthcare capacity has been surged to ensure sufficient supply of ICU and hospital beds. The red curve assumes no surging in healthcare capacity and subsequently projects increased deaths.

Short-term Epidemic Scenarios

We make the following short-term projections of healthcare demand and new infections under the following three scenarios:

- **Scenario 1.** The epidemic continues to grow at the current rate.
- **Scenario 2.** Countries will further scale up interventions (either increasing current strategies or implementing new interventions) leading to a further 50% reduction in transmission.
- **Scenario 3.** Countries will relax current interventions by 50%

N.B. These scenarios currently assume that the impact of mobility on transmission will remain the same in the future as it has in the past. We are working to extend methods to estimate the impact of increases in mobility on transmission as lockdown and interventions are reversed. Consequently, projection are likely to represent an upper estimate of the healthcare demand and case load for each scenario

We estimate that over the next 4 weeks demand for hospital beds will change from 171 (95% CI: 148-193) patients requiring treatment with high-pressure oxygen at the current date to 628 (95% CI: 543-712) hospital beds being required on 2020-08-04 if no further interventions are introduced (Scenario 1). Similarly, we estimate that over the next 4 weeks demand for critical care (ICU) beds will change from 38 (95% CI: 35-41) patients requiring treatment with mechanical ventilation at the current date to 65 (95% CI: 61-70) by 2020-08-04. These projections assume that approximately 5% of all infections will require treatment with high-pressure oxygen and that approximately 30% of hospitalised cases will require treatment with mechanical ventilation (based on analysis of ongoing epidemics in Europe). **N.B. These scenarios are unlikely to show significant differences for the first week since there is a delay of approximately 10 days between infection and hospital admission. Consequently, the effectiveness of a change in policy is likely to be better captured by hospital admission data approximately 2 weeks after the policy change is implemented.**

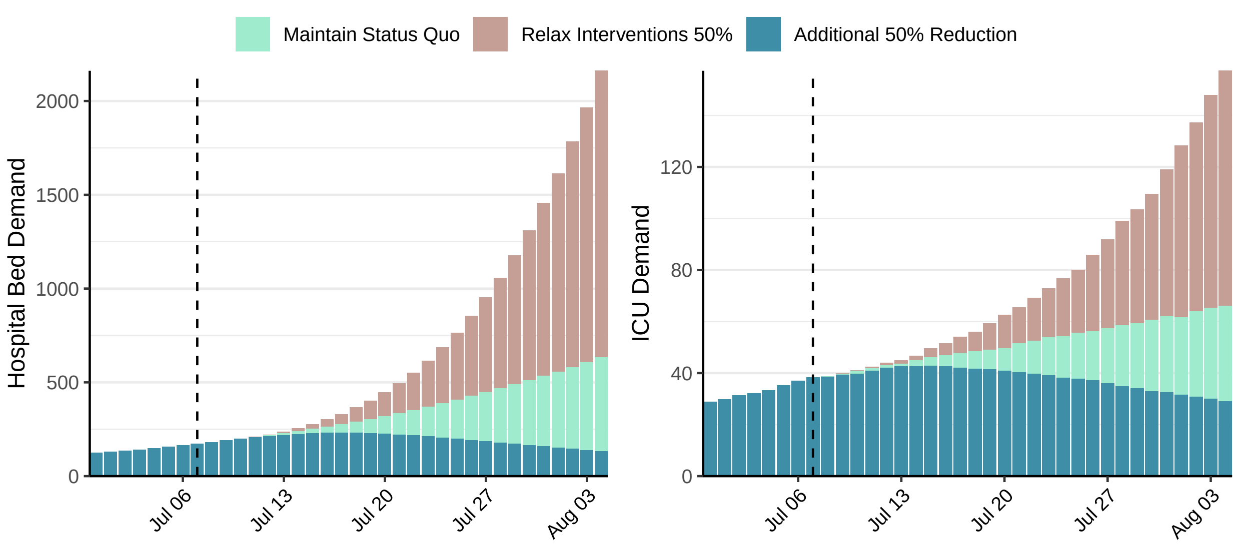

Figure 5: **Healthcare demands in the next 28 days.** Individuals needing an ICU bed are assumed to need mechanical ventilation. Projected demand for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

The impact of each scenario has a more immediate effect on the daily number of infections. The figure below shows the impact of each scenario on the estimated daily incidence of new infections. If interventions are scaled up (Scenario 2), the daily number of infections will change from 1,998 (95% CI: 1,727-2,269) at the current date to 491 (95% CI: 419-563) by 2020-08-04. If current interventions were relaxed by 50%, we estimate the daily number of infections will change from 1,998 (95% CI: 1,727-2,269) at the current date to 40,666 (95% CI: 36,037-45,295) by 2020-08-04.

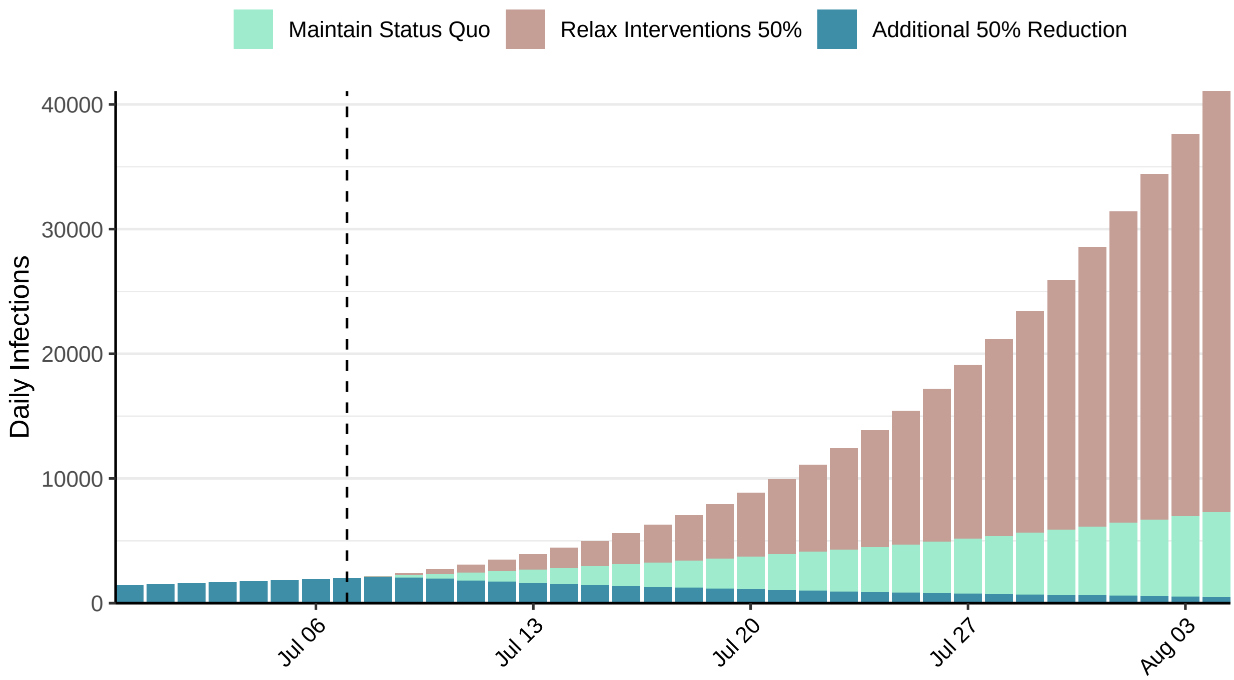

Figure 6: **Daily number of infections estimated by fitting to deaths.** Projected infections for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

To explore different scenarios, we recommend using our COVID-19 Scenario Analysis Tool - https://covidsim.org/, which can be used to simulate different intervention scenarios and explore the long term impact on healthcare demand.

Situation Report for COVID-19: Chile, 2020-07-07

Download the report for Chile, 2020-07-07 here. This report uses data from the European Centre for Disease Control. These data are updated daily and whilst there may be a short delay, they are generally consistent with Ministry reports. These data are then used to back-calculate an 'inferred number of COVID-19 infections' using mathematical modelling techniques (see Report 12 for further details) to estimate the number of people that have been infected and to make short-term projections for future healthcare needs.

Epidemiological Situation

Total Reported Cases	New Reported Cases	Total Reported Deaths	New Reported Deaths	Estimated R_t
298,557	3,025	6,384	76	1.23 (95% CI: 1.17-1.28)

The figure below shows the cumulative reported deaths as a function of the time since the 10th death was reported. Dashed lines show the expected trajectory for different doubling times of the epidemic. For example, with a doubling time of 3 days, if there are currently a total of 20 deaths reported, we would expect there to be 40 deaths in total reported in 3 days-time, 80 deaths in 6 days-time, 160 deaths in 9 days-time etc. For most epidemics, in the absence of interventions, we expect a doubling time of 3-4 days for this disease.

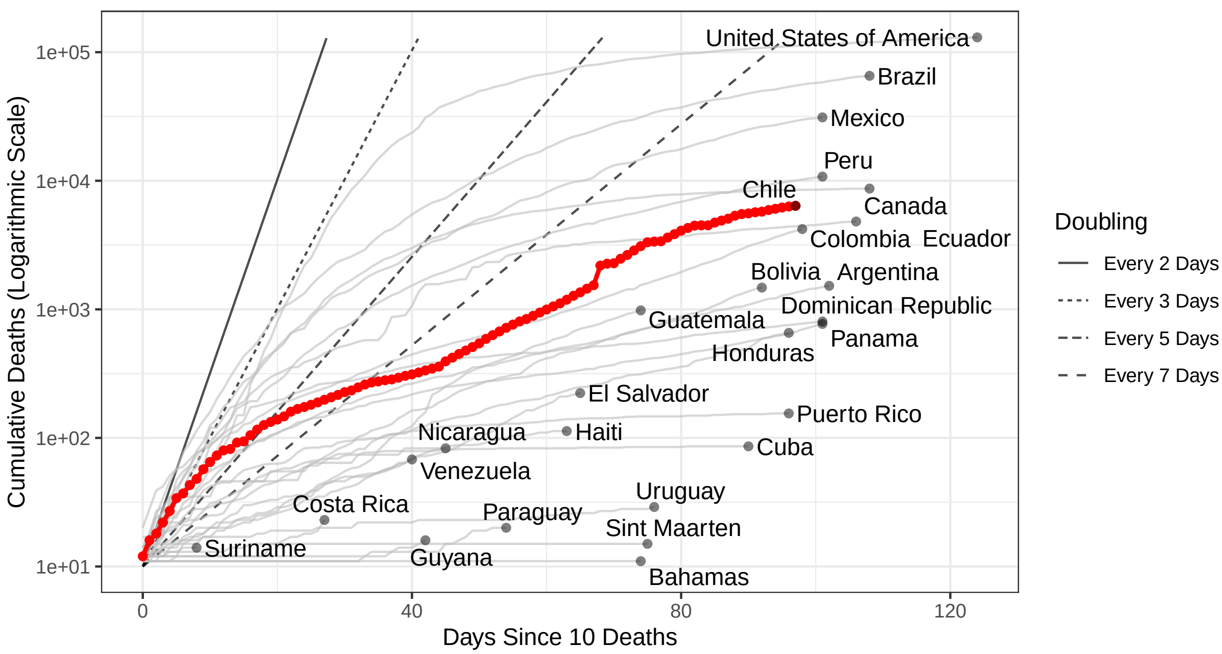

Figure 1: **Cumulative Deaths since 10 deaths.** Country not shown if fewer than 10 deaths.

COVID-19 Transmission Modelling

We assume that the deaths reported to date provide the best indication of the stage of the epidemic, as deaths are more consistently and accurately reported. Our current working estimate is that 1 death indicates that approximately 100 people will have been infected with the other 99 recovering (based on an infection fatality ratio of ~1%). These infections will have happened approximately 21 days previously – capturing a 5-day period from infection to onset of symptoms (the incubation period), 4 days from onset of symptoms to hospitalisation, and 12 days in hospital before death. With a 3-day doubling time, 100 infections that occurred 15 days ago will have generated 200 infections 12 days ago, 400 infections 9 days ago, 800 infections 6 days ago and 1,600 infections 3 days ago resulting in approximately 3,200 infections at the time the first death is observed.

To explore this, we fit our age-structured SEIR model (see Methods) to the time series of deaths in a country, in order to estimate the start date of the epidemic and the baseline R0. We assume that 100% of COVID-19 related deaths have been reported. We have also included the impact of interventions that have been put in place and their effect on human mobility and transmission based on the Google COVID-19 Community Mobility Reports. Using our mathematical model that formalises this approach, we estimate that there has been a total of 1,323,618 (95% CI: 1,276,451-1,370,786) infections over the past 4 weeks.

The figure below shows the estimated number of people infected over the past 4 weeks. The bar charts show, for comparison, the number of reported cases. The right-hand plot shows these data on a different scale as the estimated infections are likely to be much larger than the reported cases. **Importantly**, the estimated infections includes both asymptomatic and mild cases that would not necessarily be identified through surveillance. Consequently, the estimated infections are likely to be significantly higher than the reported cases (see our FAQ for further explanation of these differences and why the reported cases and estimated infections are unlikely to match).

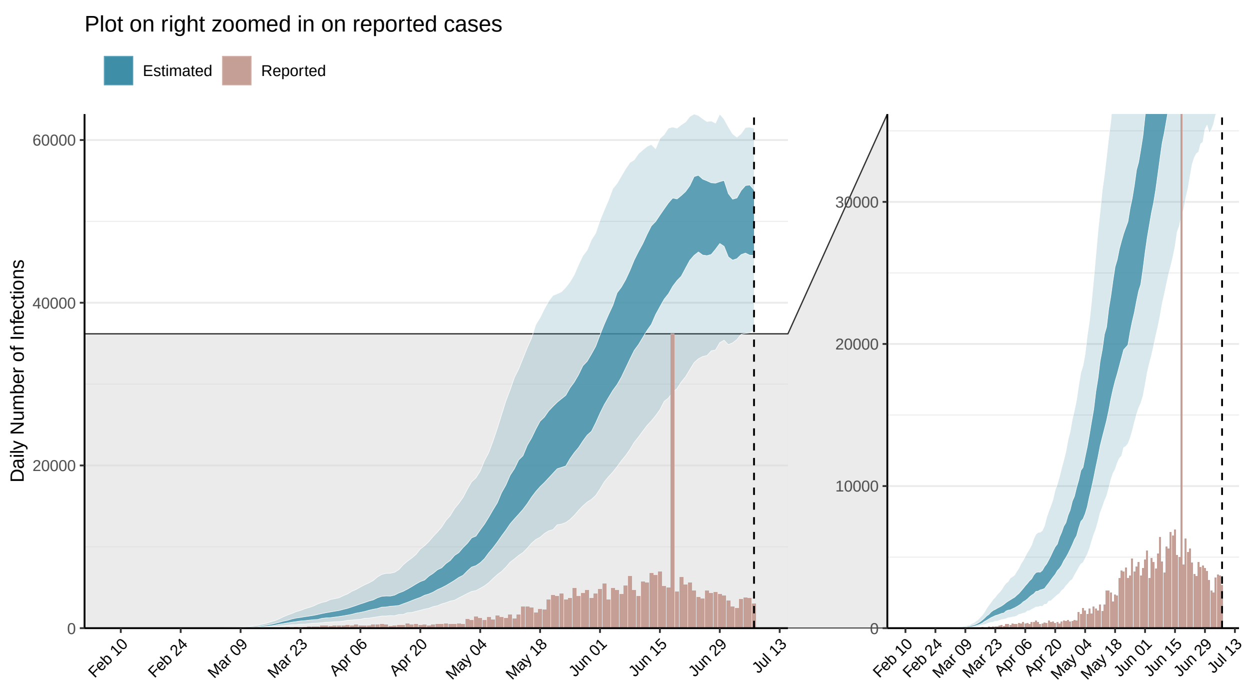

Figure 2: **Daily number of infections estimated by fitting to the current total of deaths.** Reported cases are shown in red. Model estimated infections are shown in blue (dark blue 50% interquartile range, light blue 95% quantile). The dashed line shows the current day.

By fitting to the time series of deaths, we are able to estimate a time-varying reproduction number, R_t. R_t is the the average number of secondary infections caused by a single infected person at a given time. If R_t is above 1, the rate of transmission is increasing and the number of new infections is increasing. R_t is assumed to change in relation to mobility fall in proportion. When fitting our model we assume that 100% of COVID-19 related deaths have been reported (please see our FAQ section for more information about this assumption). We also assume a fixed date at which the impact of mobility on transmission changes from pre-lockdown levels to post-lockdown levels, which may cause large changes in Rt. We are working to refine how this switch occurs and to formally calculate its shape.

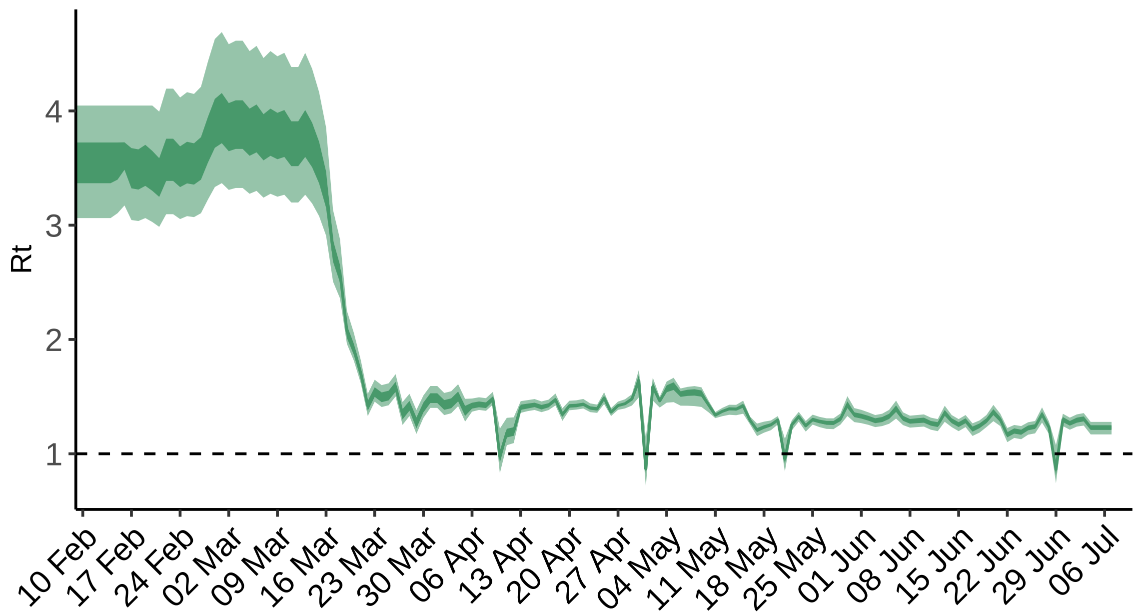

Figure 3: **Time-varying reproduction number, R_t.** R_t is the average number of secondary infections caused by a single infected person at time equal to t. $R_t < 1$ indicates a slowing epidemic in which new infections are not increasing. $R_t > 1$ indicates a growing epidemic in which new infections are increasing over time. Dark green shows the 50% CI and light green shows the 95% CI.

Using the model fit, we can forecast the expected trajectory for cumulative deaths, which is shown in the figure below. This assumes a severity pattern by age that is consistent with that observed in China, Europe and the U.S to date. This projection assumes that transmission is maintained at the current level of transmission as estimated by the final R_t value. **N.B. Chile is forecast to be close to or surpassing our best estimates for healthcare capacity in the next 28 days.** Estimates of deaths in the next 28 days may be inaccurate due to our working assumptions for mortality in individuals who do not receive appropriate treatment. See our methods for more information.

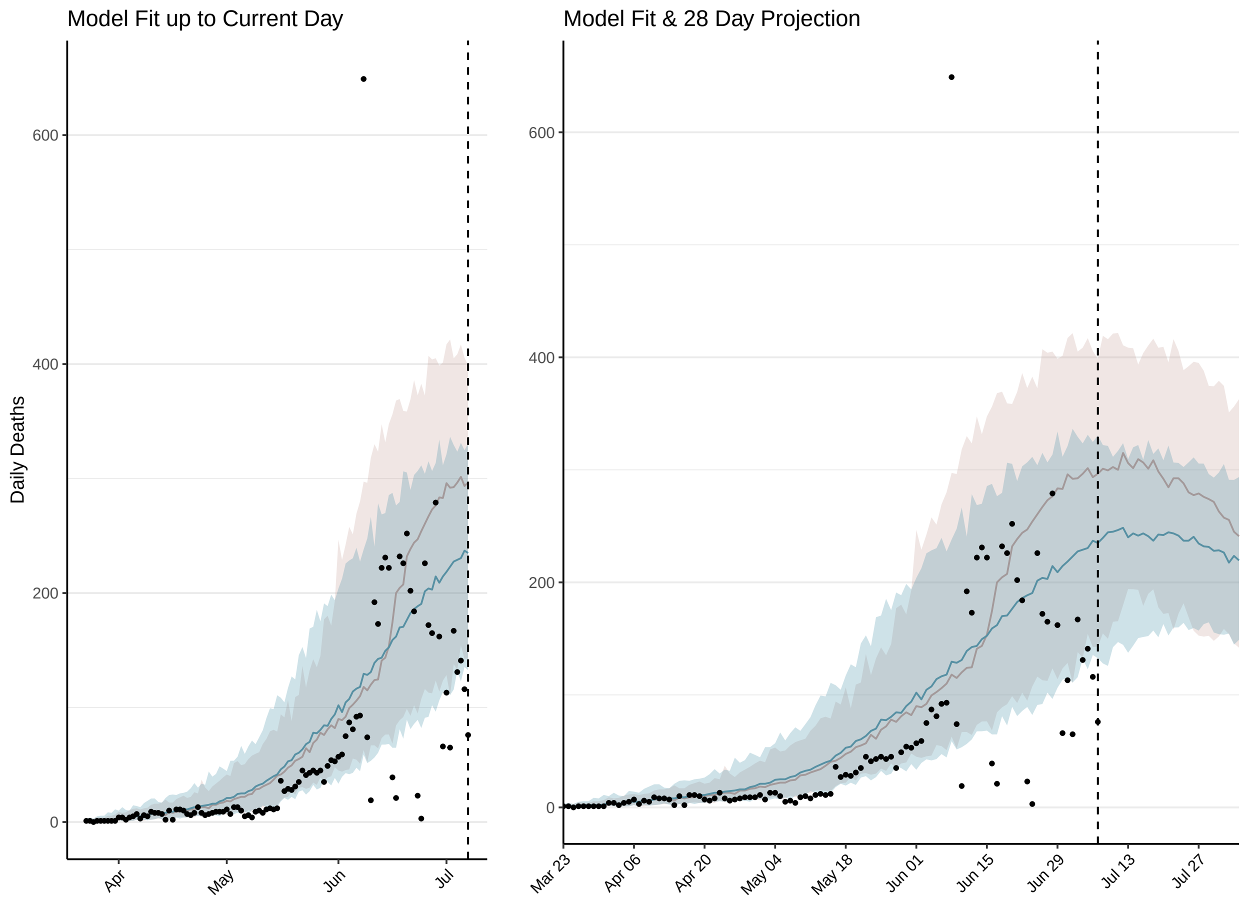

Figure 4: **Estimated daily deaths.** Projected deaths assuming the current level of interventions are maintained are shown in red (median and 95% quantile). Reported deaths are plotted in black. The plot on the left is focussed on the model fit prior to today, while the plot on the right forecasts the next 28 days. The forecasted deaths in blue assumes healthcare capacity has been surged to ensure sufficient supply of ICU and hospital beds. The red curve assumes no surging in healthcare capacity and subsequently projects increased deaths.

Short-term Epidemic Scenarios

We make the following short-term projections of healthcare demand and new infections under the following three scenarios:

- **Scenario 1.** The epidemic continues to grow at the current rate.
- **Scenario 2.** Countries will further scale up interventions (either increasing current strategies or implementing new interventions) leading to a further 50% reduction in transmission.
- **Scenario 3.** Countries will relax current interventions by 50%

N.B. These scenarios currently assume that the impact of mobility on transmission will remain the same in the future as it has in the past. We are working to extend methods to estimate the impact of increases in mobility on transmission as lockdown and interventions are reversed. Consequently, projection are likely to represent an upper estimate of the healthcare demand and case load for each scenario

We estimate that over the next 4 weeks demand for hospital beds will change from 9,327 (95% CI: 8,984-9,669) patients requiring treatment with high-pressure oxygen at the current date to 8,582 (95% CI: 8,265-8,899) hospital beds being required on 2020-08-04 if no further interventions are introduced (Scenario 1). Similarly, we estimate that over the next 4 weeks demand for critical care (ICU) beds will change from 2,335 (95% CI: 2,284-2,386) patients requiring treatment with mechanical ventilation at the current date to 2,268 (95% CI: 2,218-2,317) by 2020-08-04. These projections assume that approximately 5% of all infections will require treatment with high-pressure oxygen and that approximately 30% of hospitalised cases will require treatment with mechanical ventilation (based on analysis of ongoing epidemics in Europe). **N.B. These scenarios are unlikely to show significant differences for the first week since there is a delay of approximately 10 days between infection and hospital admission. Consequently, the effectiveness of a change in policy is likely to be better captured by hospital admission data approximately 2 weeks after the policy change is implemented.**

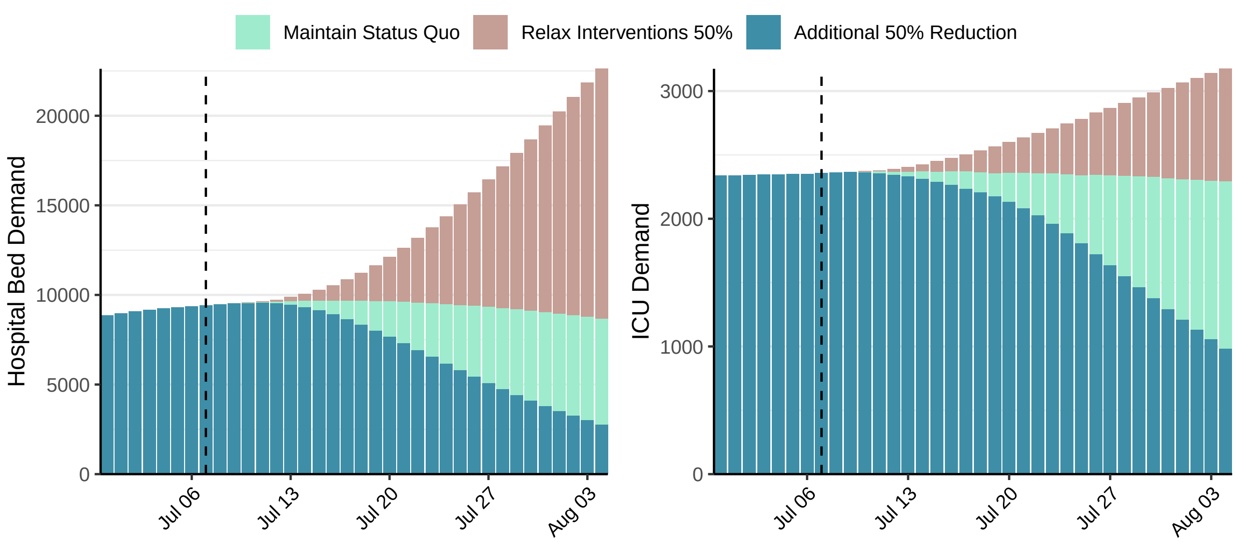

Figure 5: **Healthcare demands in the next 28 days.** Individuals needing an ICU bed are assumed to need mechanical ventilation. Projected demand for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

The impact of each scenario has a more immediate effect on the daily number of infections. The figure below shows the impact of each scenario on the estimated daily incidence of new infections. If interventions are scaled up (Scenario 2), the daily number of infections will change from 49,106 (95% CI: 47,502-50,711) at the current date to 3,501 (95% CI: 3,346-3,657) by 2020-08-04. If current interventions were relaxed by 50%, we estimate the daily number of infections will change from 49,106 (95% CI: 47,502-50,711) at the current date to 137,683 (95% CI: 131,907-143,460) by 2020-08-04.

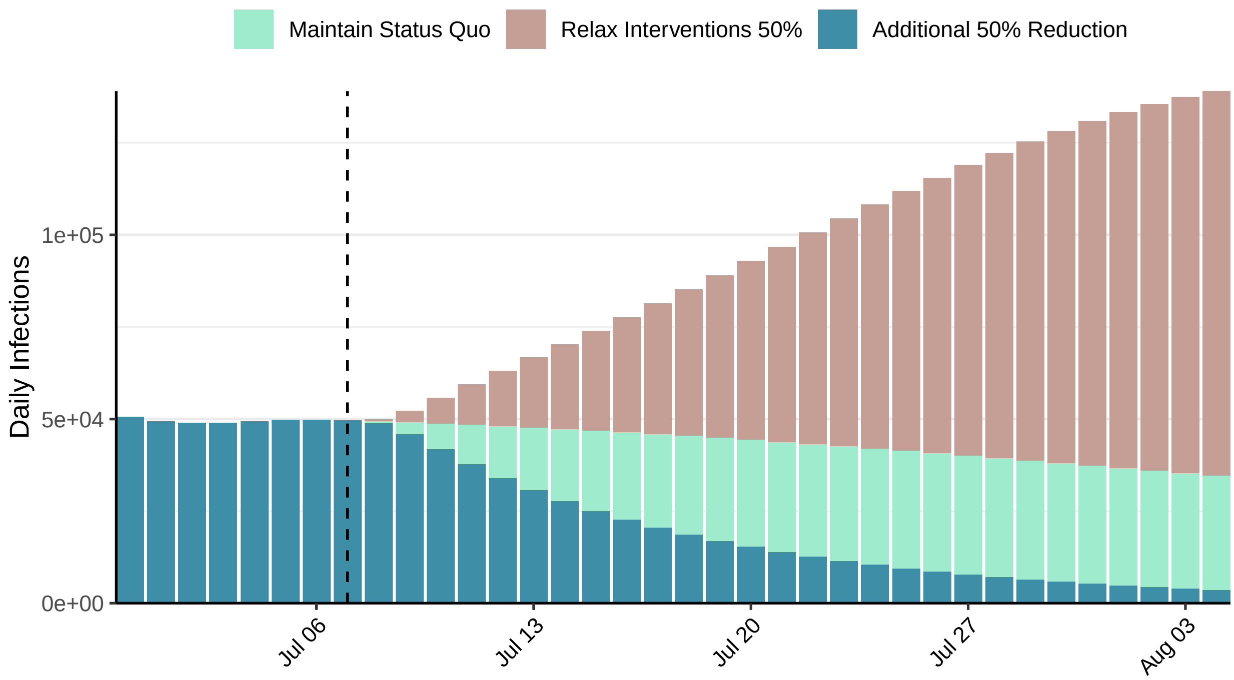

Figure 6: **Daily number of infections estimated by fitting to deaths.** Projected infections for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

To explore different scenarios, we recommend using our COVID-19 Scenario Analysis Tool - https://covidsim.org/, which can be used to simulate different intervention scenarios and explore the long term impact on healthcare demand.

Situation Report for COVID-19: Cote d'Ivoire, 2020-07-07

Download the report for Cote d'Ivoire, 2020-07-07 here. This report uses data from the European Centre for Disease Control. These data are updated daily and whilst there may be a short delay, they are generally consistent with Ministry reports. These data are then used to back-calculate an 'inferred number of COVID-19 infections' using mathematical modelling techniques (see Report 12 for further details) to estimate the number of people that have been infected and to make short-term projections for future healthcare needs.

Epidemiological Situation

Total Reported Cases	New Reported Cases	Total Reported Deaths	New Reported Deaths	Estimated R_t
10,966	194	75	1	1.27 (95% CI: 1.1-1.46)

The figure below shows the cumulative reported deaths as a function of the time since the 10th death was reported. Dashed lines show the expected trajectory for different doubling times of the epidemic. For example, with a doubling time of 3 days, if there are currently a total of 20 deaths reported, we would expect there to be 40 deaths in total reported in 3 days-time, 80 deaths in 6 days-time, 160 deaths in 9 days-time etc. For most epidemics, in the absence of interventions, we expect a doubling time of 3-4 days for this disease.

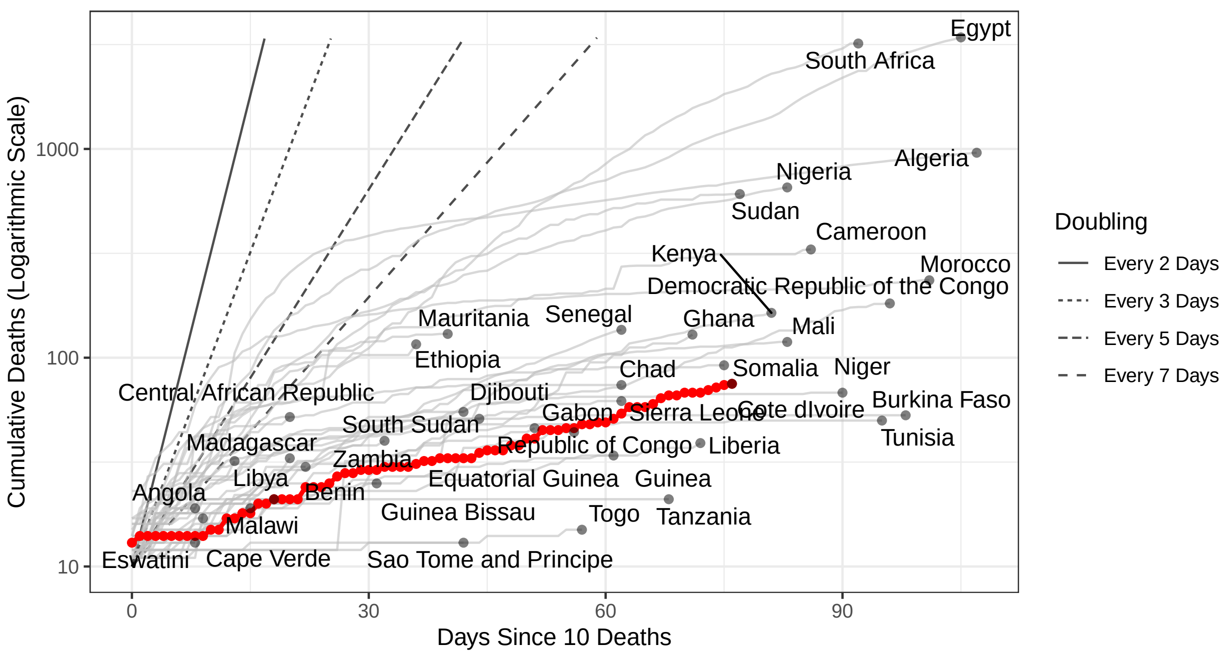

Figure 1: **Cumulative Deaths since 10 deaths.** Country not shown if fewer than 10 deaths.

COVID-19 Transmission Modelling

We assume that the deaths reported to date provide the best indication of the stage of the epidemic, as deaths are more consistently and accurately reported. Our current working estimate is that 1 death indicates that approximately 100 people will have been infected with the other 99 recovering (based on an infection fatality ratio of ~1%). These infections will have happened approximately 21 days previously – capturing a 5-day period from infection to onset of symptoms (the incubation period), 4 days from onset of symptoms to hospitalisation, and 12 days in hospital before death. With a 3-day doubling time, 100 infections that occurred 15 days ago will have generated 200 infections 12 days ago, 400 infections 9 days ago, 800 infections 6 days ago and 1,600 infections 3 days ago resulting in approximately 3,200 infections at the time the first death is observed.

To explore this, we fit our age-structured SEIR model (see Methods) to the time series of deaths in a country, in order to estimate the start date of the epidemic and the baseline R0. We assume that 100% of COVID-19 related deaths have been reported. We have also included the impact of interventions that have been put in place and their effect on human mobility and transmission based on the Google COVID-19 Community Mobility Reports. Using our mathematical model that formalises this approach, we estimate that there has been a total of 36,067 (95% CI: 31,694-40,440) infections over the past 4 weeks.

The figure below shows the estimated number of people infected over the past 4 weeks. The bar charts show, for comparison, the number of reported cases. The right-hand plot shows these data on a different scale as the estimated infections are likely to be much larger than the reported cases. **Importantly**, the estimated infections includes both asymptomatic and mild cases that would not necessarily be identified through surveillance. Consequently, the estimated infections are likely to be significantly higher than the reported cases (see our FAQ for further explanation of these differences and why the reported cases and estimated infections are unlikely to match).

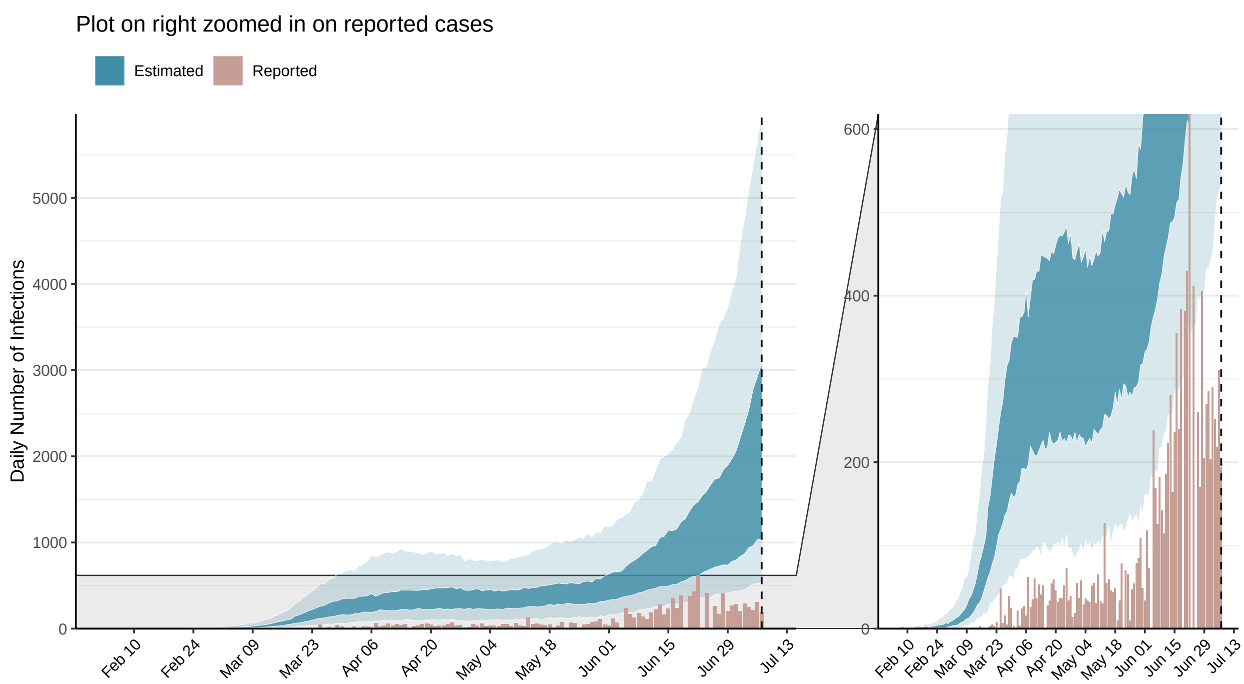

Figure 2: **Daily number of infections estimated by fitting to the current total of deaths.** Reported cases are shown in red. Model estimated infections are shown in blue (dark blue 50% interquartile range, light blue 95% quantile). The dashed line shows the current day.

By fitting to the time series of deaths, we are able to estimate a time-varying reproduction number, R_t. R_t is the the average number of secondary infections caused by a single infected person at a given time. If R_t is above 1, the rate of transmission is increasing and the number of new infections is increasing. R_t is assumed to change in relation to mobility fall in proportion. When fitting our model we assume that 100% of COVID-19 related deaths have been reported (please see our FAQ section for more information about this assumption). We also assume a fixed date at which the impact of mobility on transmission changes from pre-lockdown levels to post-lockdown levels, which may cause large changes in Rt. We are working to refine how this switch occurs and to formally calculate its shape.

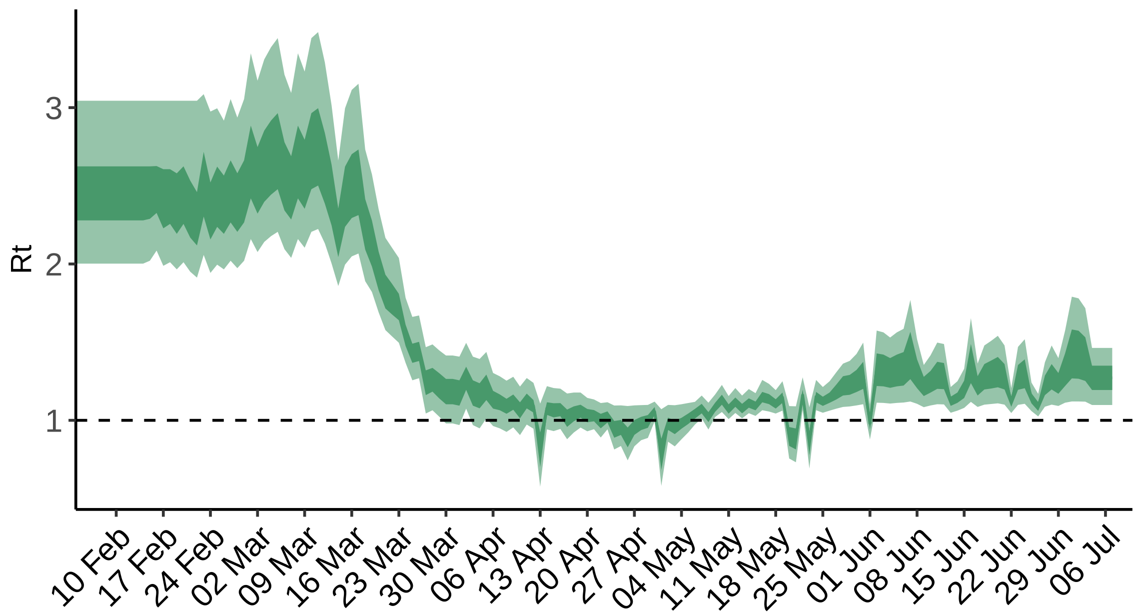

Figure 3: **Time-varying reproduction number, R_t.** R_t is the average number of secondary infections caused by a single infected person at time equal to t. $R_t < 1$ indicates a slowing epidemic in which new infections are not increasing. $R_t > 1$ indicates a growing epidemic in which new infections are increasing over time. Dark green shows the 50% CI and light green shows the 95% CI.

Using the model fit, we can forecast the expected trajectory for cumulative deaths, which is shown in the figure below. This assumes a severity pattern by age that is consistent with that observed in China, Europe and the U.S to date. This projection assumes that transmission is maintained at the current level of transmission as estimated by the final R_t value.

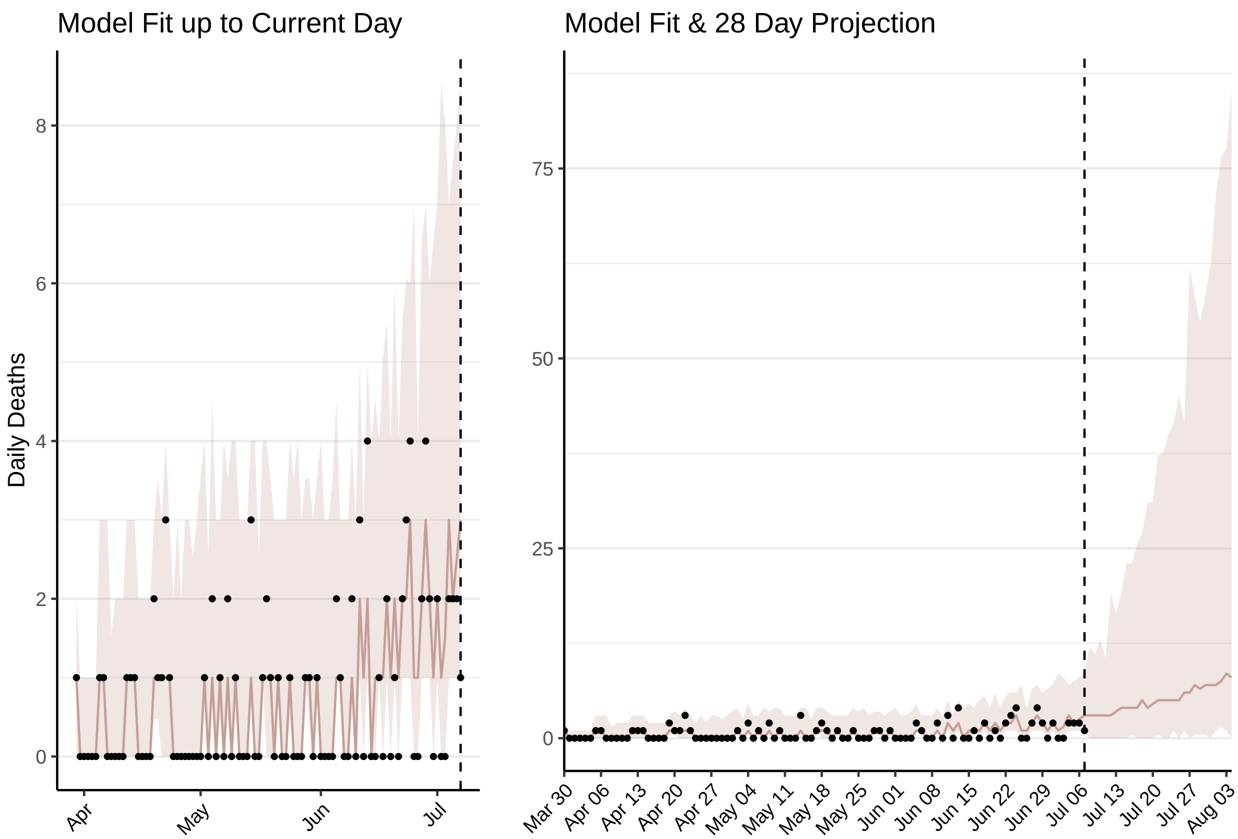

Figure 4: **Estimated daily deaths.** Projected deaths assuming the current level of interventions are maintained are shown in red (median and 95% quantile). Reported deaths are plotted in black. The plot on the left is focussed on the model fit prior to today, while the plot on the right forecasts the next 28 days.

Short-term Epidemic Scenarios

We make the following short-term projections of healthcare demand and new infections under the following three scenarios:

- **Scenario 1.** The epidemic continues to grow at the current rate.
- **Scenario 2.** Countries will further scale up interventions (either increasing current strategies or implementing new interventions) leading to a further 50% reduction in transmission.
- **Scenario 3.** Countries will relax current interventions by 50%

N.B. These scenarios currently assume that the impact of mobility on transmission will remain the same in the future as it has in the past. We are working to extend methods to estimate the impact of increases in mobility on transmission as lockdown and interventions are reversed. Consequently, projection are likely to represent an upper estimate of the healthcare demand and case load for each scenario

We estimate that over the next 4 weeks demand for hospital beds will change from 200 (95% CI: 175-225) patients requiring treatment with high-pressure oxygen at the current date to 689 (95% CI: 568-809) hospital beds being required on 2020-08-04 if no further interventions are introduced (Scenario 1). Similarly, we estimate that over the next 4 weeks demand for critical care (ICU) beds will change from 52 (95% CI: 46-59) patients requiring treatment with mechanical ventilation at the current date to 121 (95% CI: 109-133) by 2020-08-04. These projections assume that approximately 5% of all infections will require treatment with high-pressure oxygen and that approximately 30% of hospitalised cases will require treatment with mechanical ventilation (based on analysis of ongoing epidemics in Europe). **N.B. These scenarios are unlikely to show significant differences for the first week since there is a delay of approximately 10 days between infection and hospital admission. Consequently, the effectiveness of a change in policy is likely to be better captured by hospital admission data approximately 2 weeks after the policy change is implemented.**

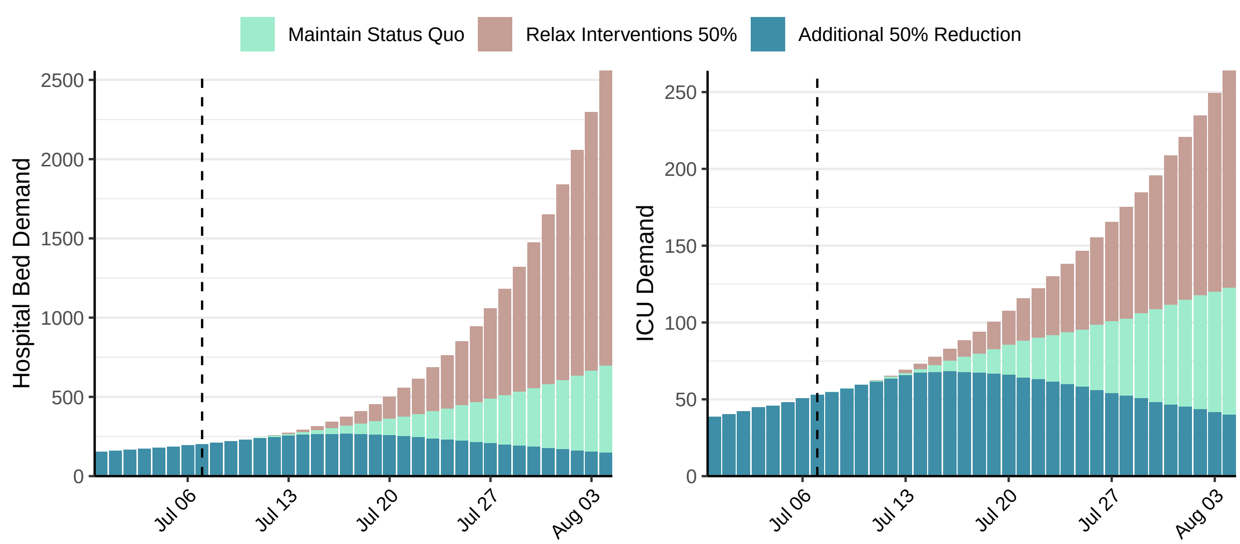

Figure 5: **Healthcare demands in the next 28 days.** Individuals needing an ICU bed are assumed to need mechanical ventilation. Projected demand for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

The impact of each scenario has a more immediate effect on the daily number of infections. The figure below shows the impact of each scenario on the estimated daily incidence of new infections. If interventions are scaled up (Scenario 2), the daily number of infections will change from 2,191 (95% CI: 1,884-2,498) at the current date to 505 (95% CI: 409-600) by 2020-08-04. If current interventions were relaxed by 50%, we estimate the daily number of infections will change from 2,191 (95% CI: 1,884-2,498) at the current date to 49,227 (95% CI: 39,438-59,016) by 2020-08-04.

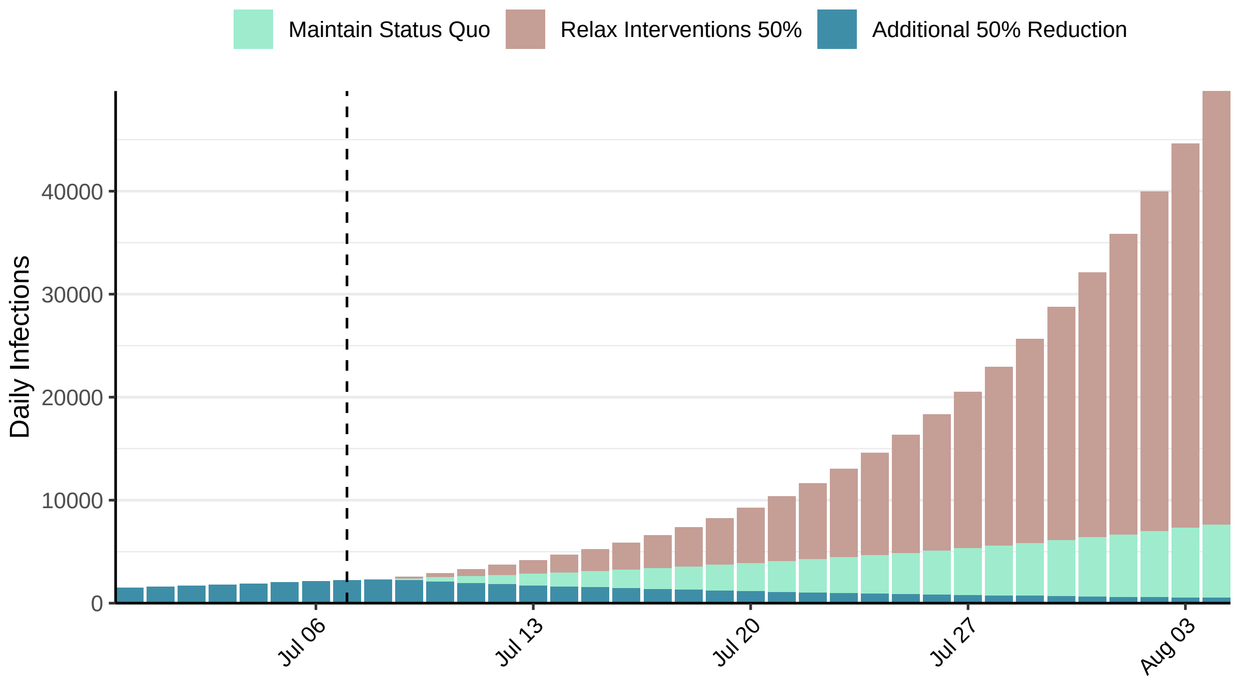

Figure 6: **Daily number of infections estimated by fitting to deaths.** Projected infections for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

To explore different scenarios, we recommend using our COVID-19 Scenario Analysis Tool - https://covidsim.org/, which can be used to simulate different intervention scenarios and explore the long term impact on healthcare demand.

Situation Report for COVID-19: Cameroon, 2020-07-07

Download the report for Cameroon, 2020-07-07 here. This report uses data from the European Centre for Disease Control. These data are updated daily and whilst there may be a short delay, they are generally consistent with Ministry reports. These data are then used to back-calculate an ‘inferred number of COVID-19 infections’ using mathematical modelling techniques (see Report 12 for further details) to estimate the number of people that have been infected and to make short-term projections for future healthcare needs.

Epidemiological Situation

Total Reported Cases	New Reported Cases	Total Reported Deaths	New Reported Deaths	Estimated R_t
14,037	326	330	2	0.98 (95% CI: 0.93-1.05)

The figure below shows the cumulative reported deaths as a function of the time since the 10th death was reported. Dashed lines show the expected trajectory for different doubling times of the epidemic. For example, with a doubling time of 3 days, if there are currently a total of 20 deaths reported, we would expect there to be 40 deaths in total reported in 3 days-time, 80 deaths in 6 days-time, 160 deaths in 9 days-time etc. For most epidemics, in the absence of interventions, we expect a doubling time of 3-4 days for this disease.

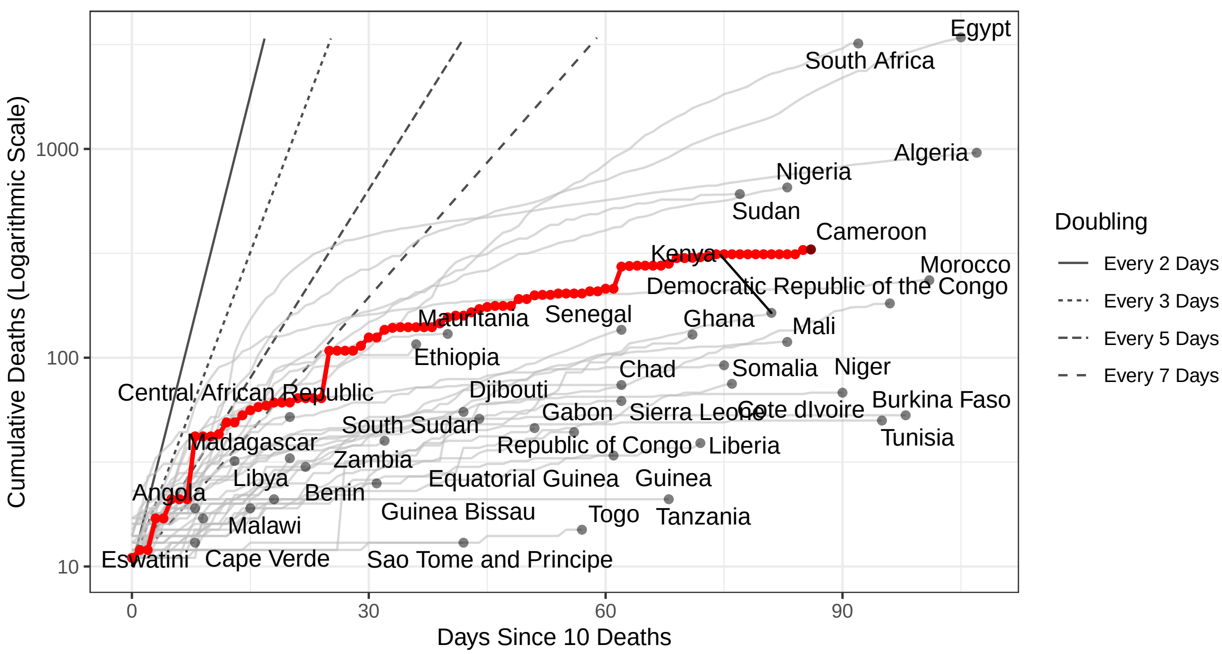

Figure 1: **Cumulative Deaths since 10 deaths.** Country not shown if fewer than 10 deaths.

COVID-19 Transmission Modelling

We assume that the deaths reported to date provide the best indication of the stage of the epidemic, as deaths are more consistently and accurately reported. Our current working estimate is that 1 death indicates that approximately 100 people will have been infected with the other 99 recovering (based on an infection fatality ratio of ~1%). These infections will have happened approximately 21 days previously – capturing a 5-day period from infection to onset of symptoms (the incubation period), 4 days from onset of symptoms to hospitalisation, and 12 days in hospital before death. With a 3-day doubling time, 100 infections that occurred 15 days ago will have generated 200 infections 12 days ago, 400 infections 9 days ago, 800 infections 6 days ago and 1,600 infections 3 days ago resulting in approximately 3,200 infections at the time the first death is observed.

To explore this, we fit our age-structured SEIR model (see Methods) to the time series of deaths in a country, in order to estimate the start date of the epidemic and the baseline R0. We assume that 100% of COVID-19 related deaths have been reported. We have also included the impact of interventions that have been put in place and their effect on human mobility and transmission based on the Google COVID-19 Community Mobility Reports. Using our mathematical model that formalises this approach, we estimate that there has been a total of 52,574 (95% CI: 47,713-57,435) infections over the past 4 weeks.

The figure below shows the estimated number of people infected over the past 4 weeks. The bar charts show, for comparison, the number of reported cases. The right-hand plot shows these data on a different scale as the estimated infections are likely to be much larger than the reported cases. **Importantly**, the estimated infections includes both asymptomatic and mild cases that would not necessarily be identified through surveillance. Consequently, the estimated infections are likely to be significantly higher than the reported cases (see our FAQ for further explanation of these differences and why the reported cases and estimated infections are unlikely to match).

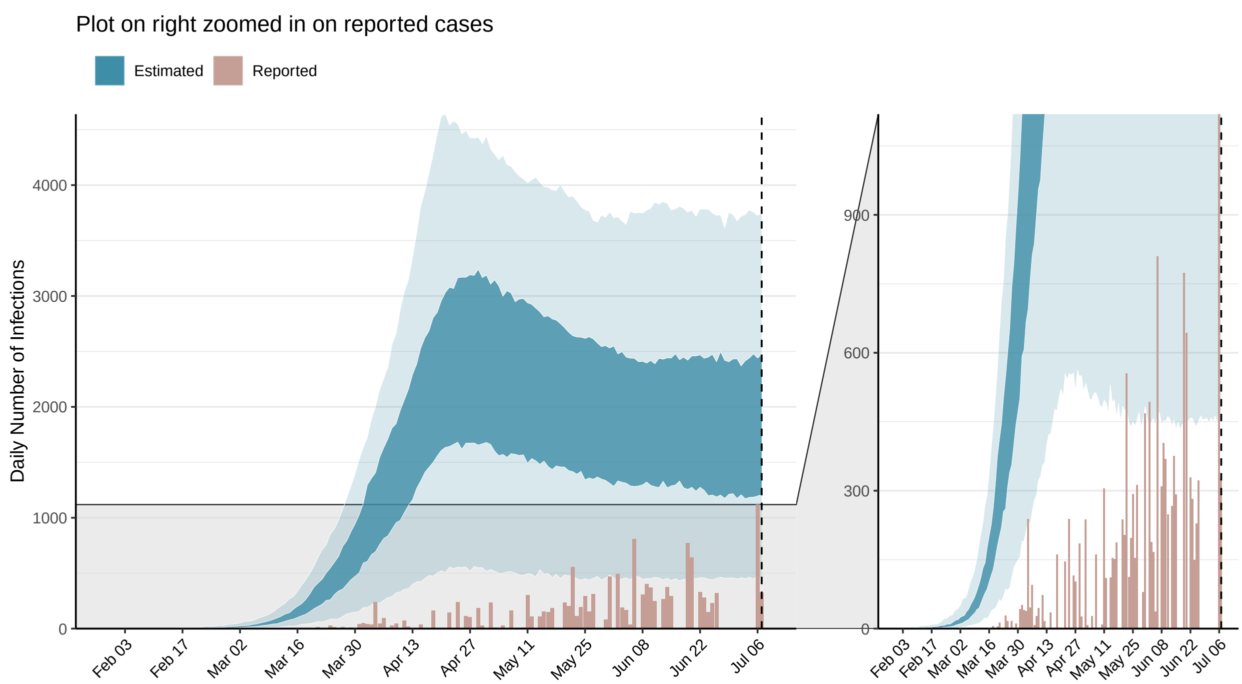

Figure 2: **Daily number of infections estimated by fitting to the current total of deaths.** Reported cases are shown in red. Model estimated infections are shown in blue (dark blue 50% interquartile range, light blue 95% quantile). The dashed line shows the current day.

By fitting to the time series of deaths, we are able to estimate a time-varying reproduction number, R_t. R_t is the the average number of secondary infections caused by a single infected person at a given time. If R_t is above 1, the rate of transmission is increasing and the number of new infections is increasing. R_t is assumed to change in relation to mobility fall in proportion. When fitting our model we assume that 100% of COVID-19 related deaths have been reported (please see our FAQ section for more information about this assumption). We also assume a fixed date at which the impact of mobility on transmission changes from pre-lockdown levels to post-lockdown levels, which may cause large changes in Rt. We are working to refine how this switch occurs and to formally calculate its shape.

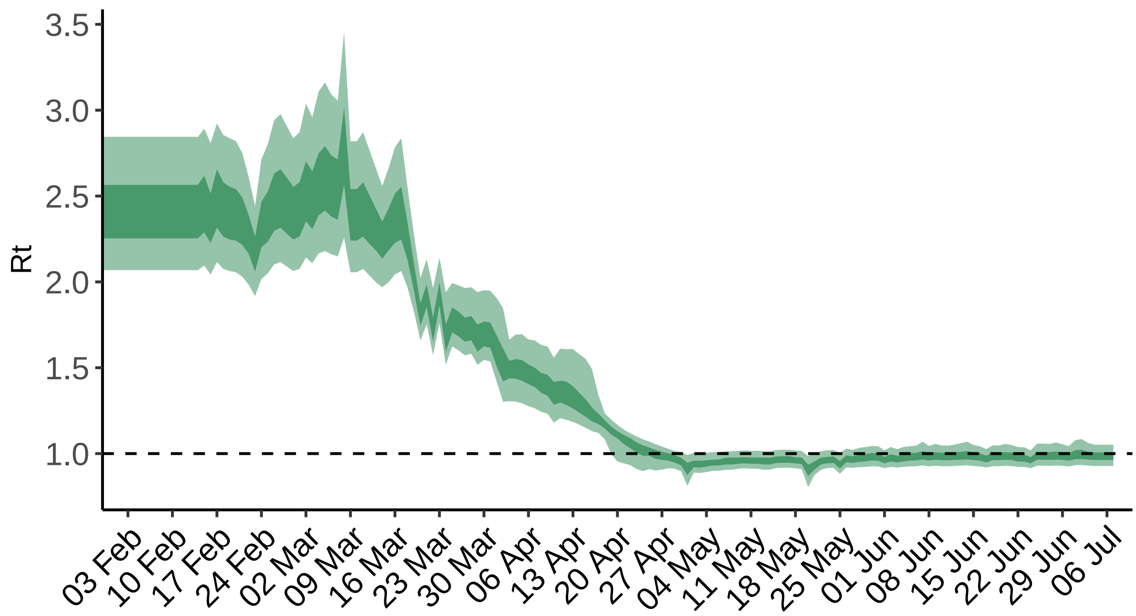

Figure 3: **Time-varying reproduction number, R_t.** R_t is the average number of secondary infections caused by a single infected person at time equal to t. $R_t < 1$ indicates a slowing epidemic in which new infections are not increasing. $R_t > 1$ indicates a growing epidemic in which new infections are increasing over time. Dark green shows the 50% CI and light green shows the 95% CI.

Using the model fit, we can forecast the expected trajectory for cumulative deaths, which is shown in the figure below. This assumes a severity pattern by age that is consistent with that observed in China, Europe and the U.S to date. This projection assumes that transmission is maintained at the current level of transmission as estimated by the final R_t value.

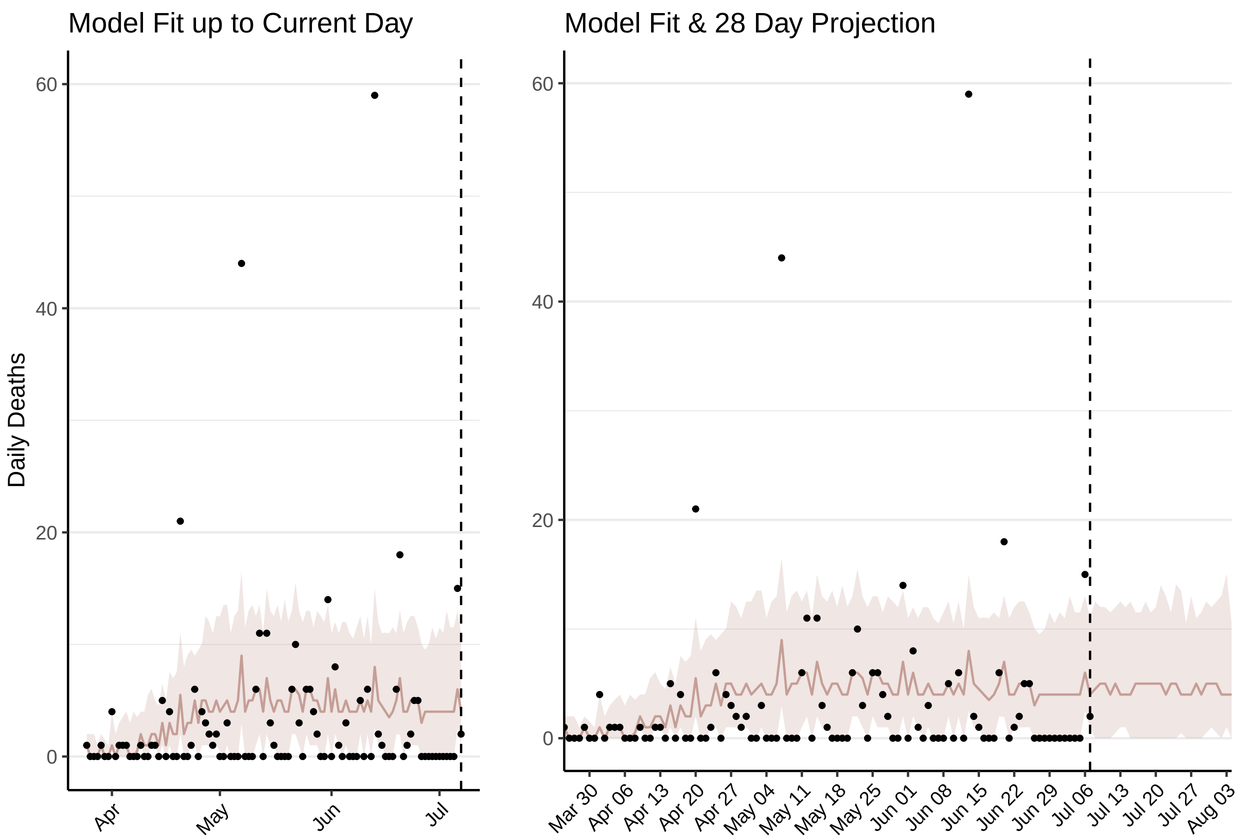

Figure 4: **Estimated daily deaths.** Projected deaths assuming the current level of interventions are maintained are shown in red (median and 95% quantile). Reported deaths are plotted in black. The plot on the left is focussed on the model fit prior to today, while the plot on the right forecasts the next 28 days.

Short-term Epidemic Scenarios

We make the following short-term projections of healthcare demand and new infections under the following three scenarios:

- **Scenario 1.** The epidemic continues to grow at the current rate.
- **Scenario 2.** Countries will further scale up interventions (either increasing current strategies or implementing new interventions) leading to a further 50% reduction in transmission.
- **Scenario 3.** Countries will relax current interventions by 50%

N.B. These scenarios currently assume that the impact of mobility on transmission will remain the same in the future as it has in the past. We are working to extend methods to estimate the impact of increases in mobility on transmission as lockdown and interventions are reversed. Consequently, projection are likely to represent an upper estimate of the healthcare demand and case load for each scenario

We estimate that over the next 4 weeks demand for hospital beds will change from 269 (95% CI: 244-295) patients requiring treatment with high-pressure oxygen at the current date to 262 (95% CI: 234-290) hospital beds being required on 2020-08-04 if no further interventions are introduced (Scenario 1). Similarly, we estimate that over the next 4 weeks demand for critical care (ICU) beds will change from 72 (95% CI: 66-79) patients requiring treatment with mechanical ventilation at the current date to 71 (95% CI: 63-78) by 2020-08-04. These projections assume that approximately 5% of all infections will require treatment with high-pressure oxygen and that approximately 30% of hospitalised cases will require treatment with mechanical ventilation (based on analysis of ongoing epidemics in Europe). **N.B. These scenarios are unlikely to show significant differences for the first week since there is a delay of approximately 10 days between infection and hospital admission. Consequently, the effectiveness of a change in policy is likely to be better captured by hospital admission data approximately 2 weeks after the policy change is implemented.**

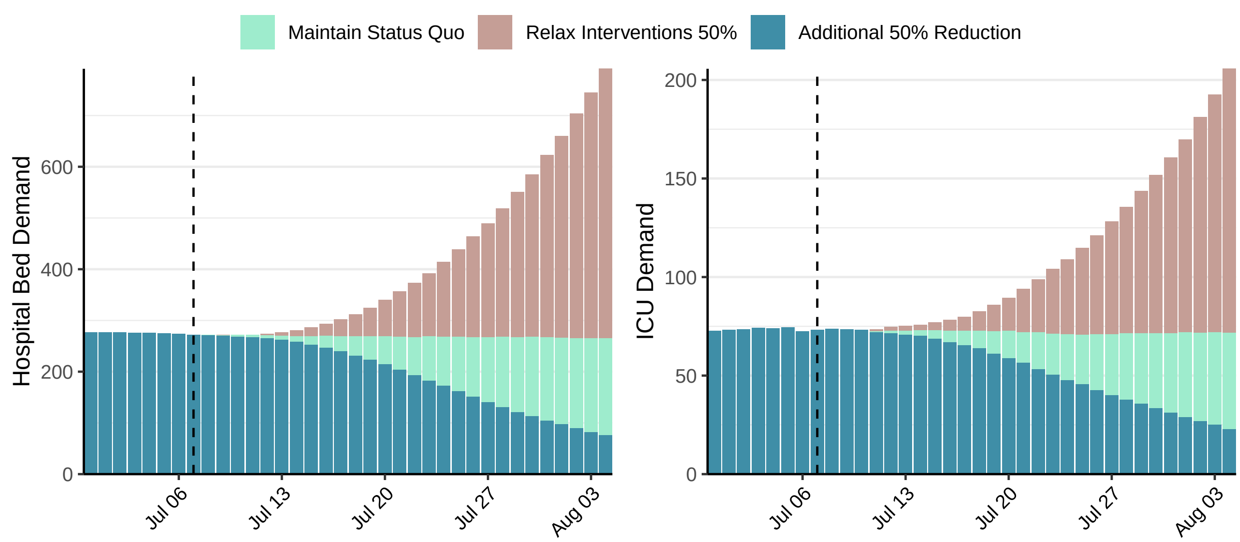

Figure 5: **Healthcare demands in the next 28 days.** Individuals needing an ICU bed are assumed to need mechanical ventilation. Projected demand for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

The impact of each scenario has a more immediate effect on the daily number of infections. The figure below shows the impact of each scenario on the estimated daily incidence of new infections. If interventions are scaled up (Scenario 2), the daily number of infections will change from 1,846 (95% CI: 1,668-2,024) at the current date to 155 (95% CI: 138-171) by 2020-08-04. If current interventions were relaxed by 50%, we estimate the daily number of infections will change from 1,846 (95% CI: 1,668-2,024) at the current date to 10,053 (95% CI: 8,901-11,206) by 2020-08-04.

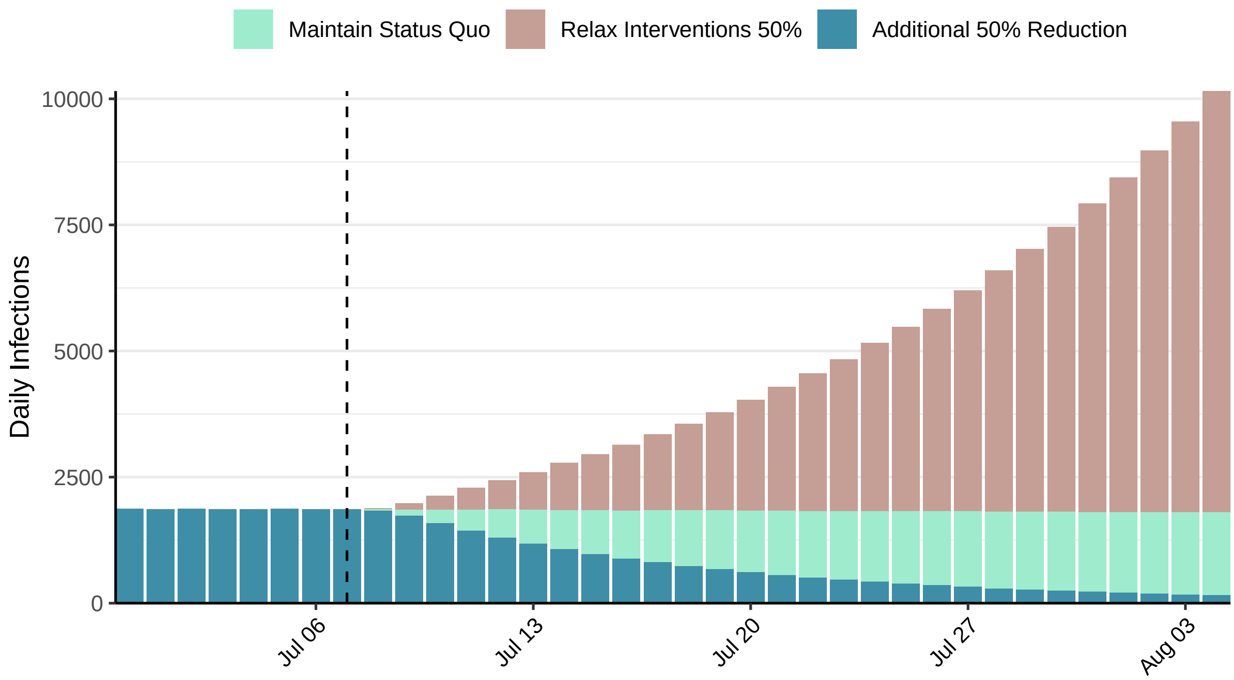

Figure 6: **Daily number of infections estimated by fitting to deaths.** Projected infections for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

To explore different scenarios, we recommend using our COVID-19 Scenario Analysis Tool - https://covidsim.org/, which can be used to simulate different intervention scenarios and explore the long term impact on healthcare demand.

Situation Report for COVID-19: Democratic Republic of Congo, 2020-07-07

Download the report for Democratic Republic of Congo, 2020-07-07 here. This report uses data from the European Centre for Disease Control. These data are updated daily and whilst there may be a short delay, they are generally consistent with Ministry reports. These data are then used to back-calculate an 'inferred number of COVID-19 infections' using mathematical modelling techniques (see Report 12 for further details) to estimate the number of people that have been infected and to make short-term projections for future healthcare needs.

Epidemiological Situation

Total Reported Cases	New Reported Cases	Total Reported Deaths	New Reported Deaths	Estimated R_t
7,432	22	182	1	1.15 (95% CI: 1.1-1.19)

The figure below shows the cumulative reported deaths as a function of the time since the 10th death was reported. Dashed lines show the expected trajectory for different doubling times of the epidemic. For example, with a doubling time of 3 days, if there are currently a total of 20 deaths reported, we would expect there to be 40 deaths in total reported in 3 days-time, 80 deaths in 6 days-time, 160 deaths in 9 days-time etc. For most epidemics, in the absence of interventions, we expect a doubling time of 3-4 days for this disease.

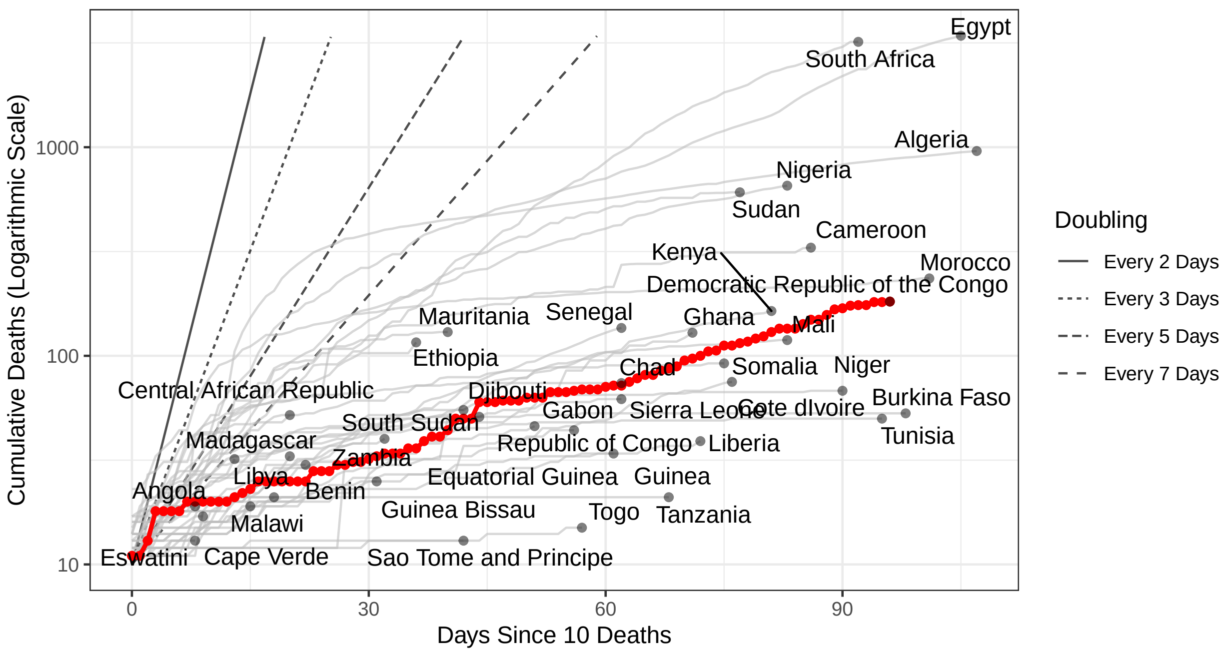

Figure 1: **Cumulative Deaths since 10 deaths.** Country not shown if fewer than 10 deaths.

COVID-19 Transmission Modelling

We assume that the deaths reported to date provide the best indication of the stage of the epidemic, as deaths are more consistently and accurately reported. Our current working estimate is that 1 death indicates that approximately 100 people will have been infected with the other 99 recovering (based on an infection fatality ratio of ~1%). These infections will have happened approximately 21 days previously – capturing a 5-day period from infection to onset of symptoms (the incubation period), 4 days from onset of symptoms to hospitalisation, and 12 days in hospital before death. With a 3-day doubling time, 100 infections that occurred 15 days ago will have generated 200 infections 12 days ago, 400 infections 9 days ago, 800 infections 6 days ago and 1,600 infections 3 days ago resulting in approximately 3,200 infections at the time the first death is observed.

To explore this, we fit our age-structured SEIR model (see Methods) to the time series of deaths in a country, in order to estimate the start date of the epidemic and the baseline R0. We assume that 100% of COVID-19 related deaths have been reported. We have also included the impact of interventions that have been put in place and their effect on human mobility and transmission based on the Google COVID-19 Community Mobility Reports. Using our mathematical model that formalises this approach, we estimate that there has been a total of 74,360 (95% CI: 66,603-82,117) infections over the past 4 weeks.

The figure below shows the estimated number of people infected over the past 4 weeks. The bar charts show, for comparison, the number of reported cases. The right-hand plot shows these data on a different scale as the estimated infections are likely to be much larger than the reported cases. **Importantly**, the estimated infections includes both asymptomatic and mild cases that would not necessarily be identified through surveillance. Consequently, the estimated infections are likely to be significantly higher than the reported cases (see our FAQ for further explanation of these differences and why the reported cases and estimated infections are unlikely to match).

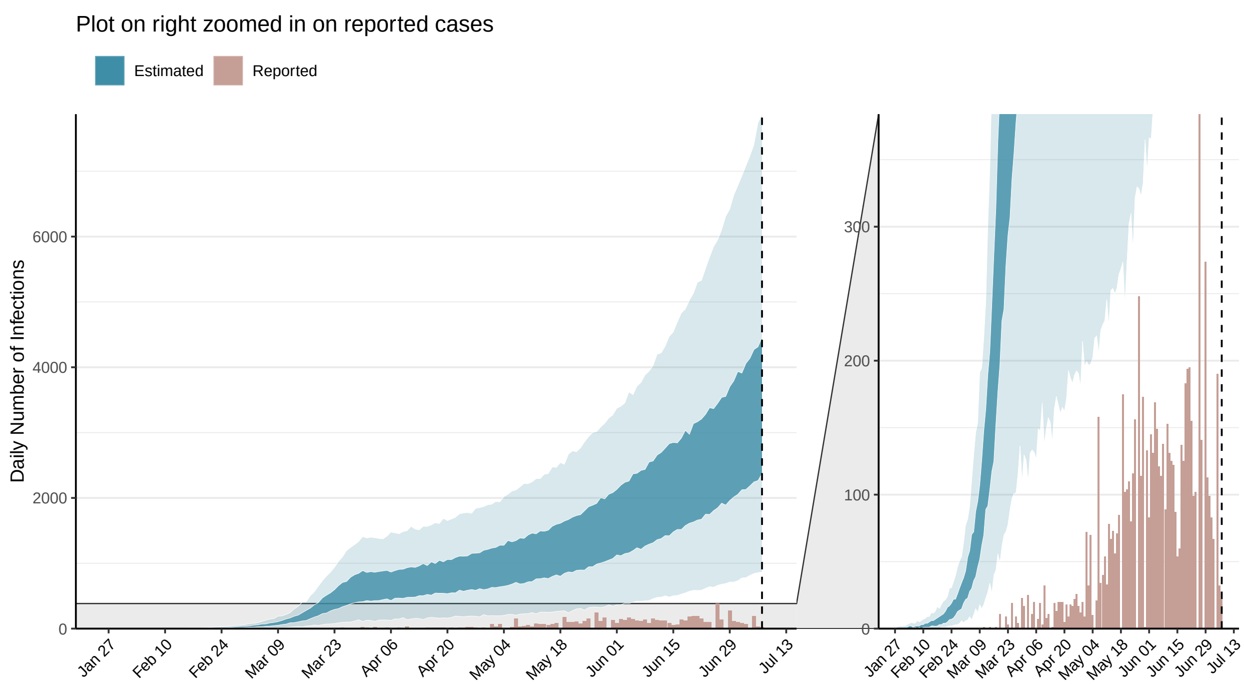

Figure 2: **Daily number of infections estimated by fitting to the current total of deaths.** Reported cases are shown in red. Model estimated infections are shown in blue (dark blue 50% interquartile range, light blue 95% quantile). The dashed line shows the current day.

By fitting to the time series of deaths, we are able to estimate a time-varying reproduction number, R_t. R_t is the the average number of secondary infections caused by a single infected person at a given time. If R_t is above 1, the rate of transmission is increasing and the number of new infections is increasing. R_t is assumed to change in relation to mobility fall in proportion. When fitting our model we assume that 100% of COVID-19 related deaths have been reported (please see our FAQ section for more information about this assumption). We also assume a fixed date at which the impact of mobility on transmission changes from pre-lockdown levels to post-lockdown levels, which may cause large changes in Rt. We are working to refine how this switch occurs and to formally calculate its shape.

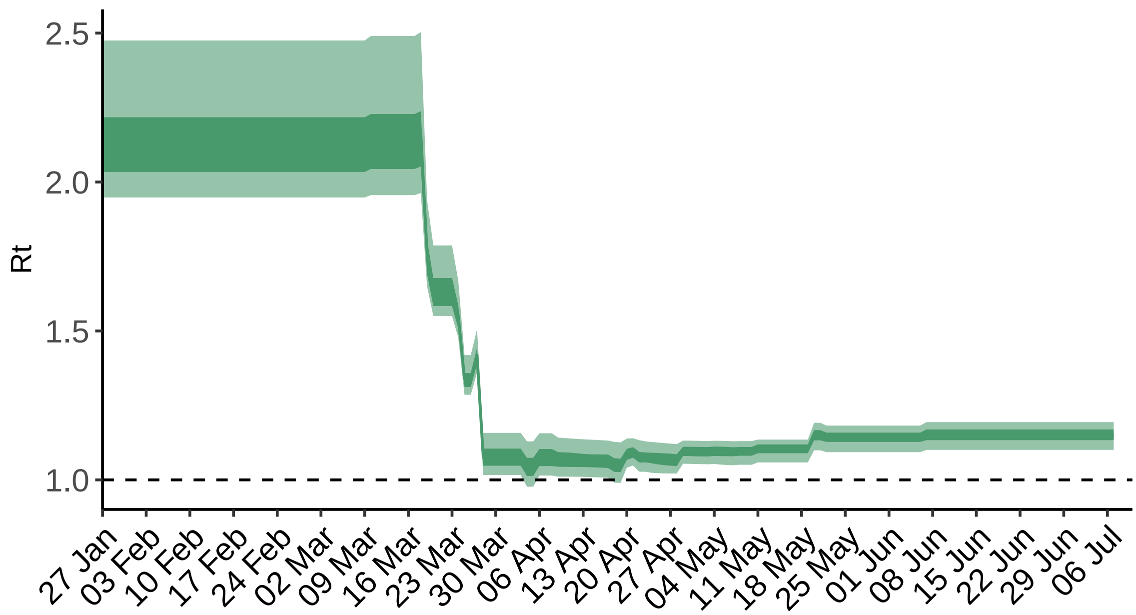

Figure 3: **Time-varying reproduction number, R_t.** R_t is the average number of secondary infections caused by a single infected person at time equal to t. $R_t < 1$ indicates a slowing epidemic in which new infections are not increasing. $R_t > 1$ indicates a growing epidemic in which new infections are increasing over time. Dark green shows the 50% CI and light green shows the 95% CI.

Using the model fit, we can forecast the expected trajectory for cumulative deaths, which is shown in the figure below. This assumes a severity pattern by age that is consistent with that observed in China, Europe and the U.S to date. This projection assumes that transmission is maintained at the current level of transmission as estimated by the final R_t value.

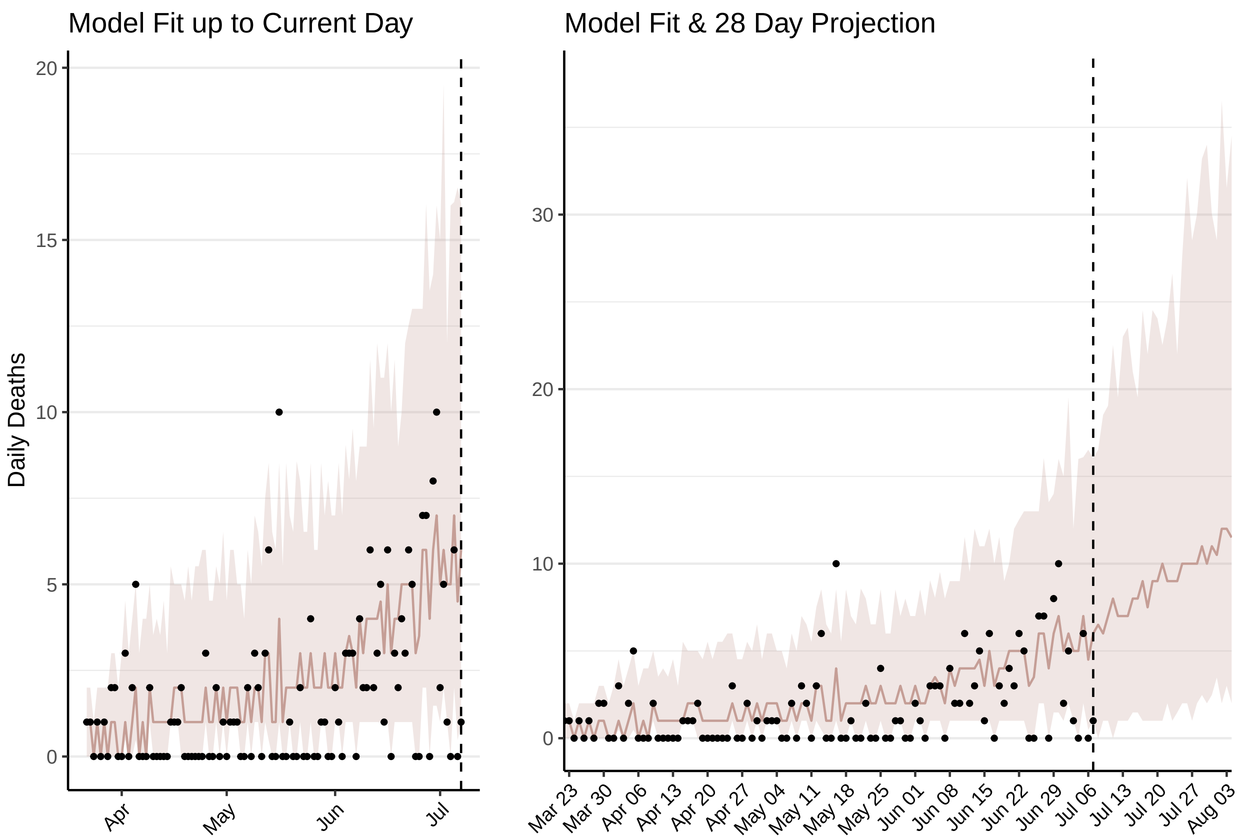

Figure 4: **Estimated daily deaths.** Projected deaths assuming the current level of interventions are maintained are shown in red (median and 95% quantile). Reported deaths are plotted in black. The plot on the left is focussed on the model fit prior to today, while the plot on the right forecasts the next 28 days.

Short-term Epidemic Scenarios

We make the following short-term projections of healthcare demand and new infections under the following three scenarios:

- **Scenario 1.** The epidemic continues to grow at the current rate.
- **Scenario 2.** Countries will further scale up interventions (either increasing current strategies or implementing new interventions) leading to a further 50% reduction in transmission.
- **Scenario 3.** Countries will relax current interventions by 50%

N.B. These scenarios currently assume that the impact of mobility on transmission will remain the same in the future as it has in the past. We are working to extend methods to estimate the impact of increases in mobility on transmission as lockdown and interventions are reversed. Consequently, projection are likely to represent an upper estimate of the healthcare demand and case load for each scenario

We estimate that over the next 4 weeks demand for hospital beds will change from 396 (95% CI: 355-438) patients requiring treatment with high-pressure oxygen at the current date to 752 (95% CI: 666-837) hospital beds being required on 2020-08-04 if no further interventions are introduced (Scenario 1). Similarly, we estimate that over the next 4 weeks demand for critical care (ICU) beds will change from 112 (95% CI: 99-124) patients requiring treatment with mechanical ventilation at the current date to 205 (95% CI: 181-229) by 2020-08-04. These projections assume that approximately 5% of all infections will require treatment with high-pressure oxygen and that approximately 30% of hospitalised cases will require treatment with mechanical ventilation (based on analysis of ongoing epidemics in Europe). **N.B. These scenarios are unlikely to show significant differences for the first week since there is a delay of approximately 10 days between infection and hospital admission. Consequently, the effectiveness of a change in policy is likely to be better captured by hospital admission data approximately 2 weeks after the policy change is implemented.**

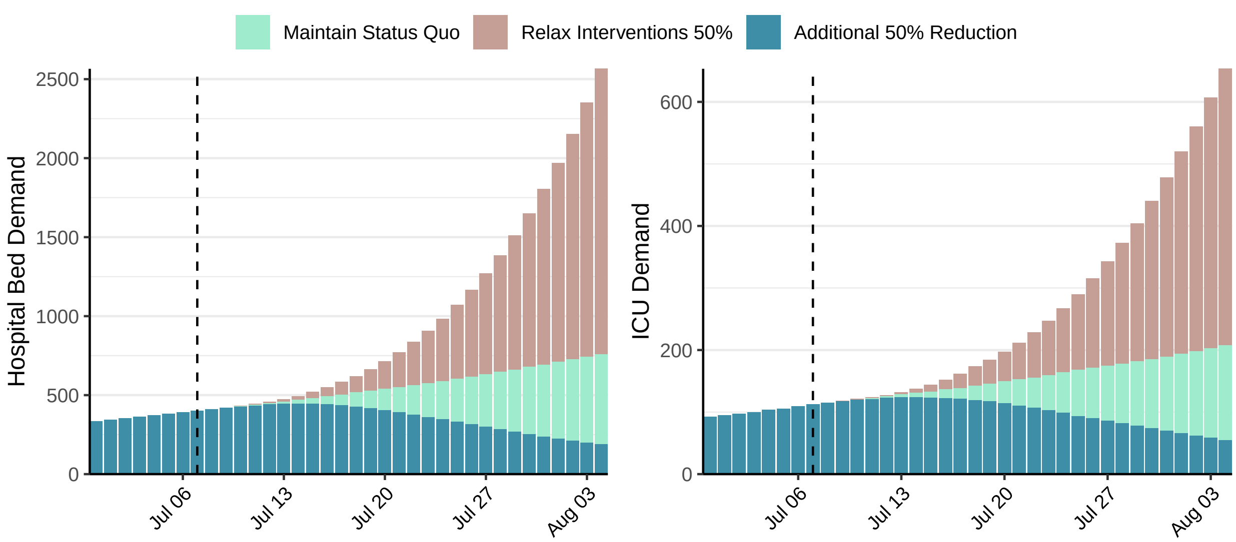

Figure 5: **Healthcare demands in the next 28 days.** Individuals needing an ICU bed are assumed to need mechanical ventilation. Projected demand for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

The impact of each scenario has a more immediate effect on the daily number of infections. The figure below shows the impact of each scenario on the estimated daily incidence of new infections. If interventions are scaled up (Scenario 2), the daily number of infections will change from 3,545 (95% CI: 3,162-3,928) at the current date to 503 (95% CI: 444-562) by 2020-08-04. If current interventions were relaxed by 50%, we estimate the daily number of infections will change from 3,545 (95% CI: 3,162-3,928) at the current date to 41,636 (95% CI: 36,675-46,596) by 2020-08-04.

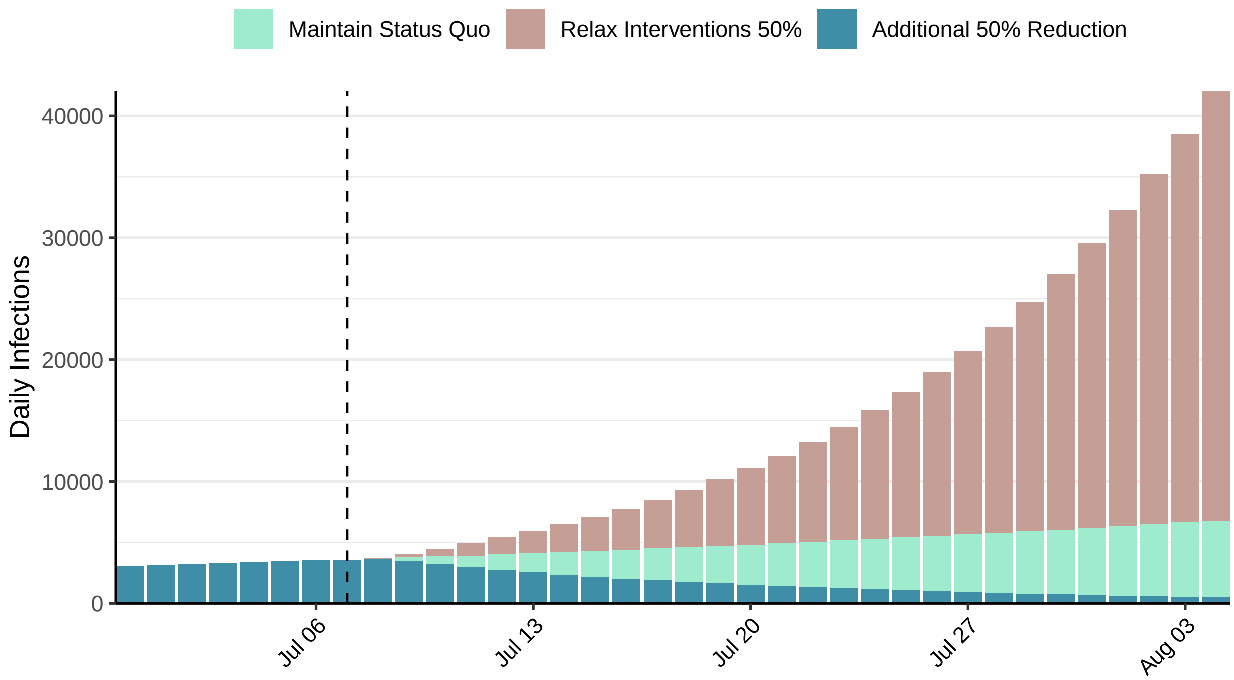

Figure 6: **Daily number of infections estimated by fitting to deaths.** Projected infections for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

To explore different scenarios, we recommend using our COVID-19 Scenario Analysis Tool - https://covidsim.org/, which can be used to simulate different intervention scenarios and explore the long term impact on healthcare demand.

Situation Report for COVID-19: Republic of the Congo, 2020-07-07

Download the report for Republic of the Congo, 2020-07-07 here. This report uses data from the European Centre for Disease Control. These data are updated daily and whilst there may be a short delay, they are generally consistent with Ministry reports. These data are then used to back-calculate an 'inferred number of COVID-19 infections' using mathematical modelling techniques (see Report 12 for further details) to estimate the number of people that have been infected and to make short-term projections for future healthcare needs.

Epidemiological Situation

Total Reported Cases	New Reported Cases	Total Reported Deaths	New Reported Deaths	Estimated R_t
1,557	0	44	0	1.16 (95% CI: 1.06-1.29)

The figure below shows the cumulative reported deaths as a function of the time since the 10th death was reported. Dashed lines show the expected trajectory for different doubling times of the epidemic. For example, with a doubling time of 3 days, if there are currently a total of 20 deaths reported, we would expect there to be 40 deaths in total reported in 3 days-time, 80 deaths in 6 days-time, 160 deaths in 9 days-time etc. For most epidemics, in the absence of interventions, we expect a doubling time of 3-4 days for this disease.

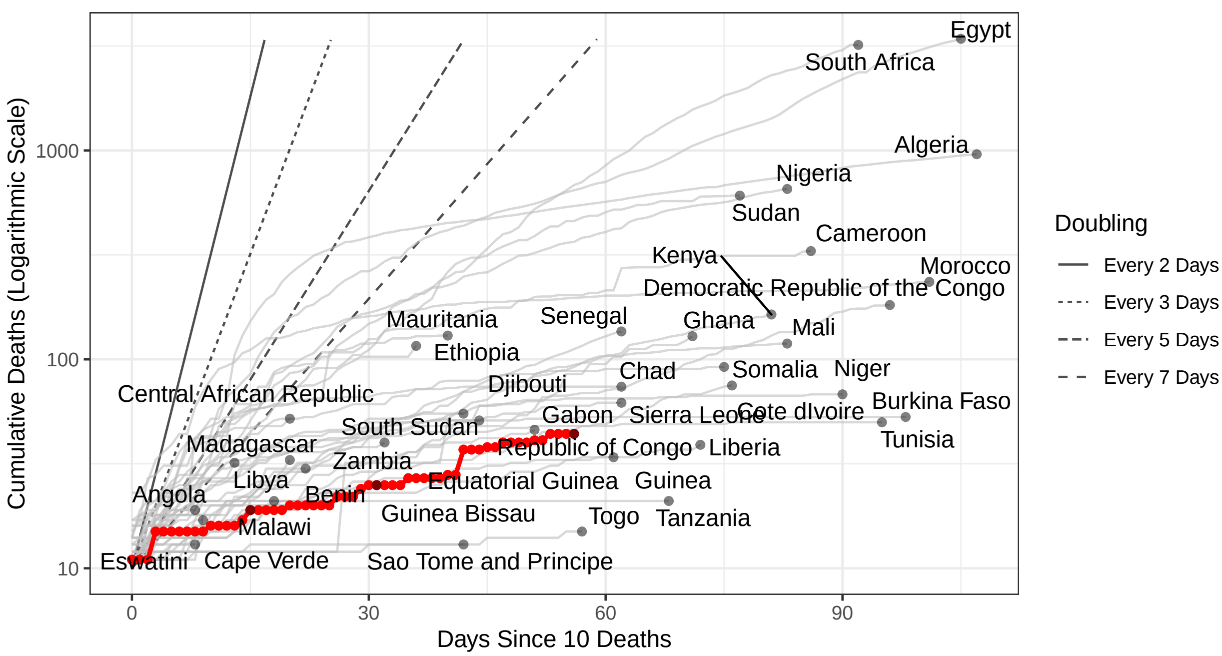

Figure 1: **Cumulative Deaths since 10 deaths.** Country not shown if fewer than 10 deaths.

COVID-19 Transmission Modelling

We assume that the deaths reported to date provide the best indication of the stage of the epidemic, as deaths are more consistently and accurately reported. Our current working estimate is that 1 death indicates that approximately 100 people will have been infected with the other 99 recovering (based on an infection fatality ratio of ~1%). These infections will have happened approximately 21 days previously – capturing a 5-day period from infection to onset of symptoms (the incubation period), 4 days from onset of symptoms to hospitalisation, and 12 days in hospital before death. With a 3-day doubling time, 100 infections that occurred 15 days ago will have generated 200 infections 12 days ago, 400 infections 9 days ago, 800 infections 6 days ago and 1,600 infections 3 days ago resulting in approximately 3,200 infections at the time the first death is observed.

To explore this, we fit our age-structured SEIR model (see Methods) to the time series of deaths in a country, in order to estimate the start date of the epidemic and the baseline R0. We assume that 100% of COVID-19 related deaths have been reported. We have also included the impact of interventions that have been put in place and their effect on human mobility and transmission based on the Google COVID-19 Community Mobility Reports. Using our mathematical model that formalises this approach, we estimate that there has been a total of 15,579 (95% CI: 13,753-17,405) infections over the past 4 weeks.

The figure below shows the estimated number of people infected over the past 4 weeks. The bar charts show, for comparison, the number of reported cases. The right-hand plot shows these data on a different scale as the estimated infections are likely to be much larger than the reported cases. **Importantly**, the estimated infections includes both asymptomatic and mild cases that would not necessarily be identified through surveillance. Consequently, the estimated infections are likely to be significantly higher than the reported cases (see our FAQ for further explanation of these differences and why the reported cases and estimated infections are unlikely to match).

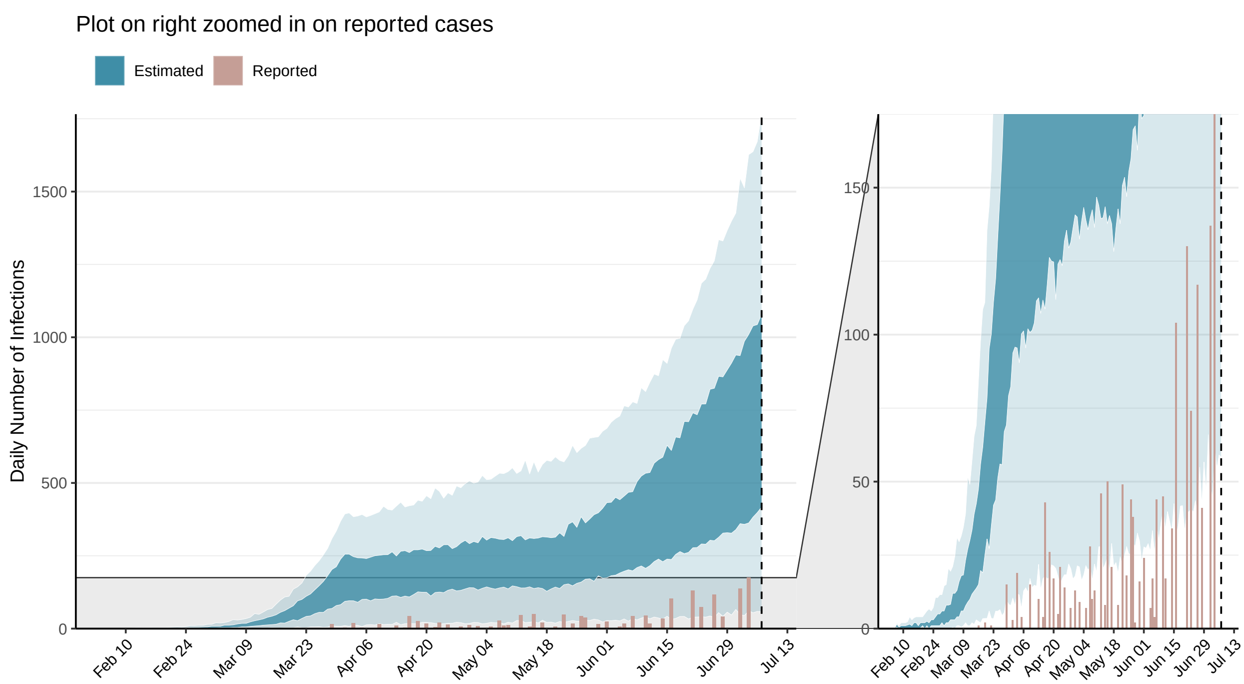

Figure 2: **Daily number of infections estimated by fitting to the current total of deaths.** Reported cases are shown in red. Model estimated infections are shown in blue (dark blue 50% interquartile range, light blue 95% quantile). The dashed line shows the current day.

By fitting to the time series of deaths, we are able to estimate a time-varying reproduction number, R_t. R_t is the the average number of secondary infections caused by a single infected person at a given time. If R_t is above 1, the rate of transmission is increasing and the number of new infections is increasing. R_t is assumed to change in relation to mobility fall in proportion. When fitting our model we assume that 100% of COVID-19 related deaths have been reported (please see our FAQ section for more information about this assumption). We also assume a fixed date at which the impact of mobility on transmission changes from pre-lockdown levels to post-lockdown levels, which may cause large changes in Rt. We are working to refine how this switch occurs and to formally calculate its shape.

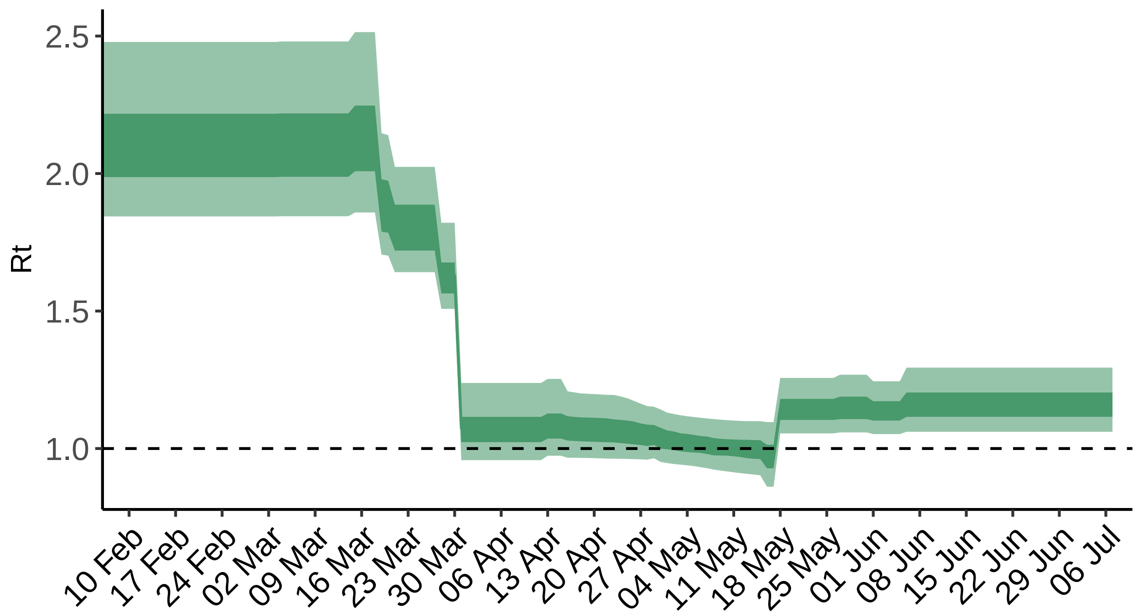

Figure 3: **Time-varying reproduction number, R_t.** R_t is the average number of secondary infections caused by a single infected person at time equal to t. $R_t < 1$ indicates a slowing epidemic in which new infections are not increasing. $R_t > 1$ indicates a growing epidemic in which new infections are increasing over time. Dark green shows the 50% CI and light green shows the 95% CI.

Using the model fit, we can forecast the expected trajectory for cumulative deaths, which is shown in the figure below. This assumes a severity pattern by age that is consistent with that observed in China, Europe and the U.S to date. This projection assumes that transmission is maintained at the current level of transmission as estimated by the final R_t value.

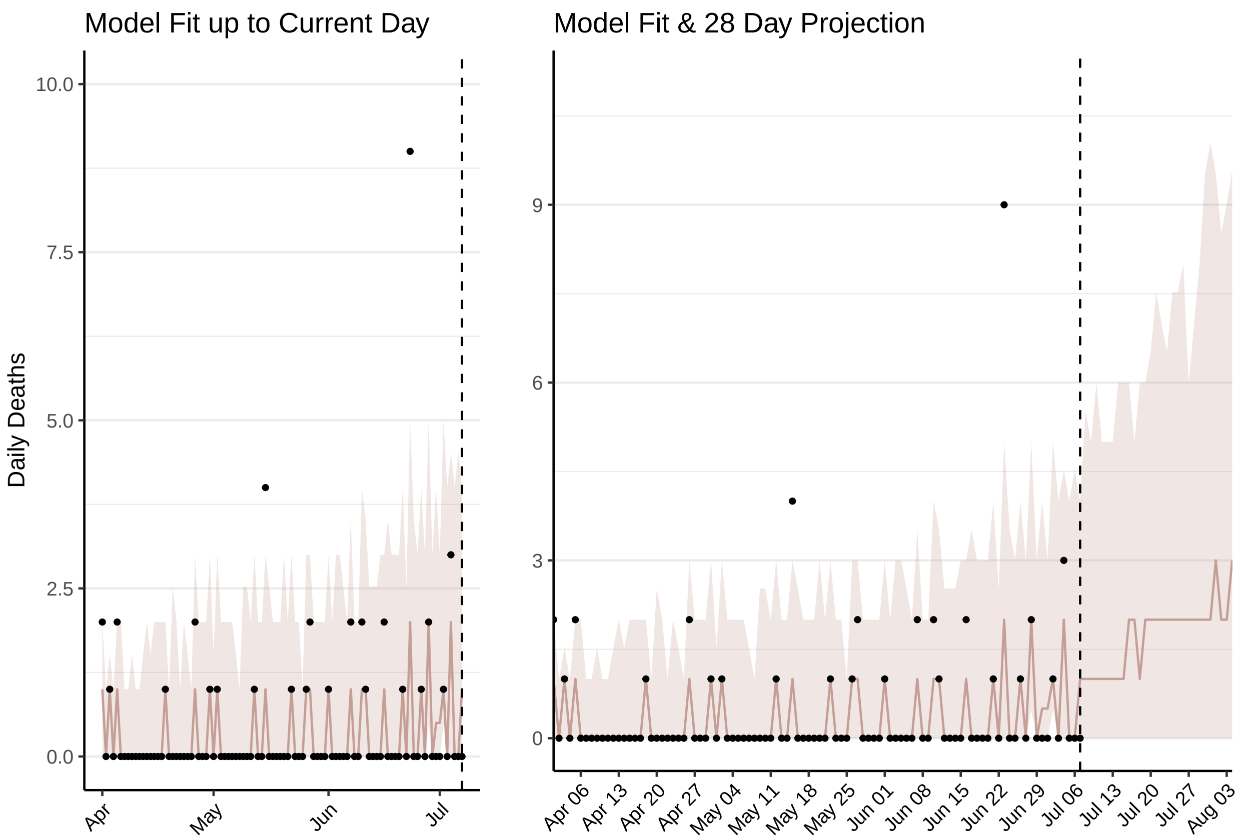

Figure 4: **Estimated daily deaths.** Projected deaths assuming the current level of interventions are maintained are shown in red (median and 95% quantile). Reported deaths are plotted in black. The plot on the left is focussed on the model fit prior to today, while the plot on the right forecasts the next 28 days.

Short-term Epidemic Scenarios

We make the following short-term projections of healthcare demand and new infections under the following three scenarios:

- **Scenario 1.** The epidemic continues to grow at the current rate.
- **Scenario 2.** Countries will further scale up interventions (either increasing current strategies or implementing new interventions) leading to a further 50% reduction in transmission.
- **Scenario 3.** Countries will relax current interventions by 50%

N.B. These scenarios currently assume that the impact of mobility on transmission will remain the same in the future as it has in the past. We are working to extend methods to estimate the impact of increases in mobility on transmission as lockdown and interventions are reversed. Consequently, projection are likely to represent an upper estimate of the healthcare demand and case load for each scenario

We estimate that over the next 4 weeks demand for hospital beds will change from 88 (95% CI: 78-99) patients requiring treatment with high-pressure oxygen at the current date to 180 (95% CI: 154-205) hospital beds being required on 2020-08-04 if no further interventions are introduced (Scenario 1). Similarly, we estimate that over the next 4 weeks demand for critical care (ICU) beds will change from 23 (95% CI: 20-26) patients requiring treatment with mechanical ventilation at the current date to 45 (95% CI: 38-51) by 2020-08-04. These projections assume that approximately 5% of all infections will require treatment with high-pressure oxygen and that approximately 30% of hospitalised cases will require treatment with mechanical ventilation (based on analysis of ongoing epidemics in Europe). **N.B. These scenarios are unlikely to show significant differences for the first week since there is a delay of approximately 10 days between infection and hospital admission. Consequently, the effectiveness of a change in policy is likely to be better captured by hospital admission data approximately 2 weeks after the policy change is implemented.**

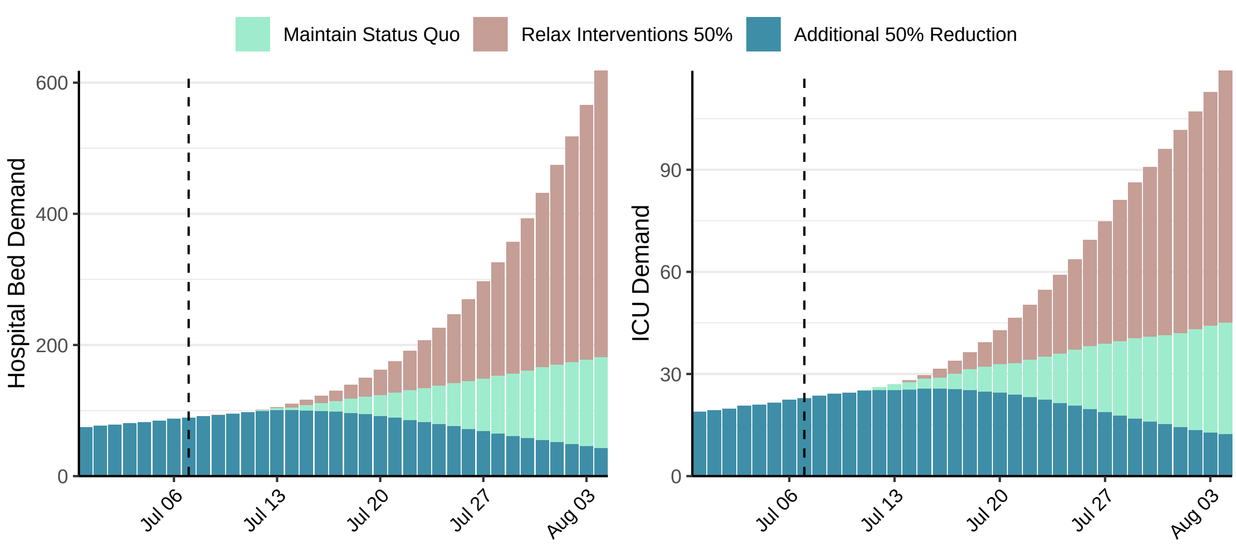

Figure 5: **Healthcare demands in the next 28 days.** Individuals needing an ICU bed are assumed to need mechanical ventilation. Projected demand for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

The impact of each scenario has a more immediate effect on the daily number of infections. The figure below shows the impact of each scenario on the estimated daily incidence of new infections. If interventions are scaled up (Scenario 2), the daily number of infections will change from 763 (95% CI: 669-856) at the current date to 117 (95% CI: 100-134) by 2020-08-04. If current interventions were relaxed by 50%, we estimate the daily number of infections will change from 763 (95% CI: 669-856) at the current date to 9,579 (95% CI: 8,144-11,014) by 2020-08-04.

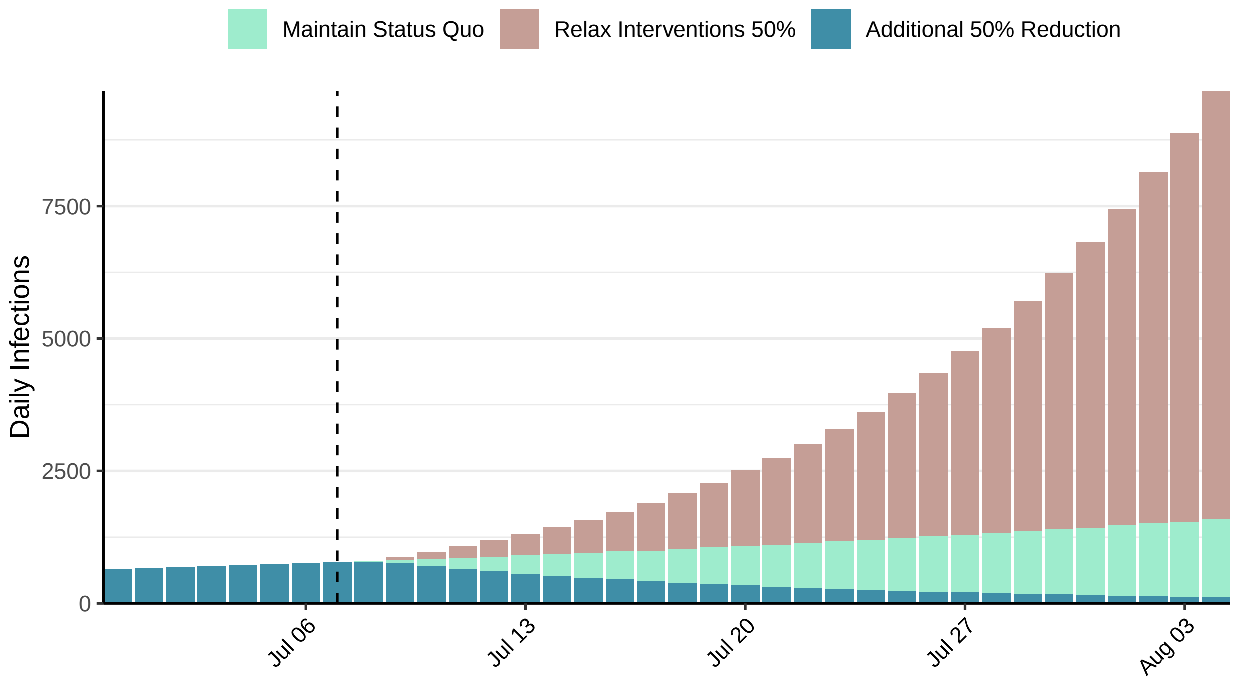

Figure 6: **Daily number of infections estimated by fitting to deaths.** Projected infections for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

To explore different scenarios, we recommend using our COVID-19 Scenario Analysis Tool - https://covidsim.org/, which can be used to simulate different intervention scenarios and explore the long term impact on healthcare demand.

Situation Report for COVID-19: Colombia, 2020-07-07

Download the report for Colombia, 2020-07-07 here. This report uses data from the European Centre for Disease Control. These data are updated daily and whilst there may be a short delay, they are generally consistent with Ministry reports. These data are then used to back-calculate an 'inferred number of COVID-19 infections' using mathematical modelling techniques (see Report 12 for further details) to estimate the number of people that have been infected and to make short-term projections for future healthcare needs.

Epidemiological Situation

Total Reported Cases	New Reported Cases	Total Reported Deaths	New Reported Deaths	Estimated R_t
120,281	3,171	4,210	146	1.39 (95% CI: 1.29-1.48)

The figure below shows the cumulative reported deaths as a function of the time since the 10th death was reported. Dashed lines show the expected trajectory for different doubling times of the epidemic. For example, with a doubling time of 3 days, if there are currently a total of 20 deaths reported, we would expect there to be 40 deaths in total reported in 3 days-time, 80 deaths in 6 days-time, 160 deaths in 9 days-time etc. For most epidemics, in the absence of interventions, we expect a doubling time of 3-4 days for this disease.

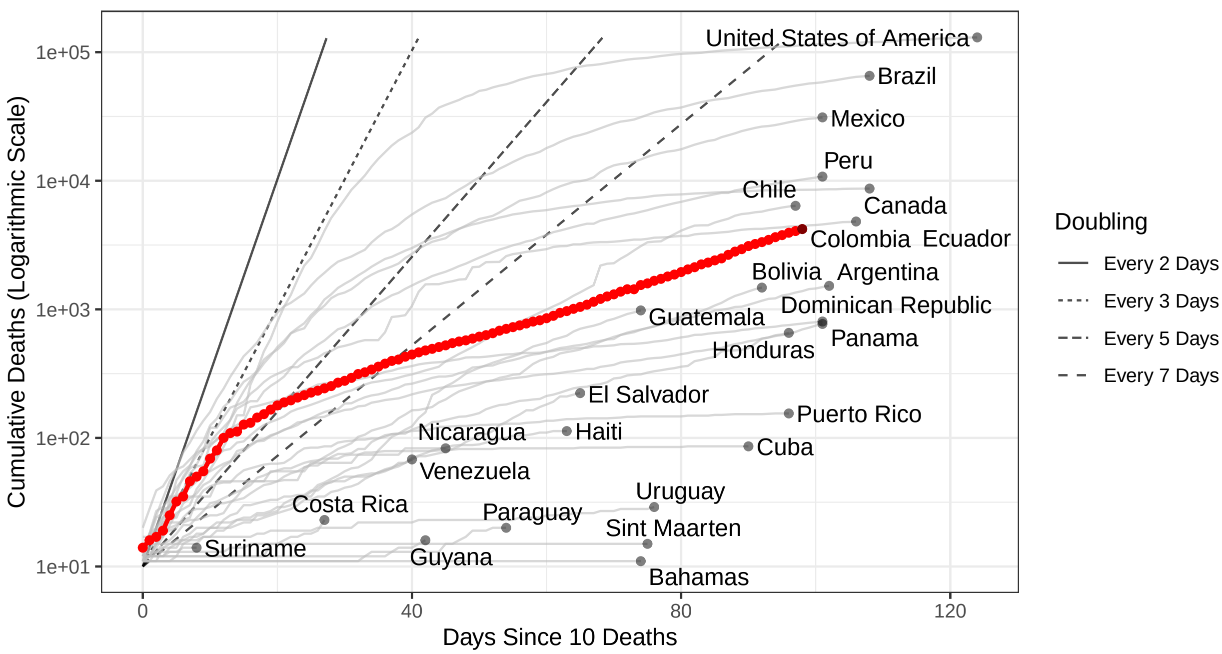

Figure 1: **Cumulative Deaths since 10 deaths.** Country not shown if fewer than 10 deaths.

COVID-19 Transmission Modelling

We assume that the deaths reported to date provide the best indication of the stage of the epidemic, as deaths are more consistently and accurately reported. Our current working estimate is that 1 death indicates that approximately 100 people will have been infected with the other 99 recovering (based on an infection fatality ratio of ~1%). These infections will have happened approximately 21 days previously – capturing a 5-day period from infection to onset of symptoms (the incubation period), 4 days from onset of symptoms to hospitalisation, and 12 days in hospital before death. With a 3-day doubling time, 100 infections that occurred 15 days ago will have generated 200 infections 12 days ago, 400 infections 9 days ago, 800 infections 6 days ago and 1,600 infections 3 days ago resulting in approximately 3,200 infections at the time the first death is observed.

To explore this, we fit our age-structured SEIR model (see Methods) to the time series of deaths in a country, in order to estimate the start date of the epidemic and the baseline R0. We assume that 100% of COVID-19 related deaths have been reported. We have also included the impact of interventions that have been put in place and their effect on human mobility and transmission based on the Google COVID-19 Community Mobility Reports. Using our mathematical model that formalises this approach, we estimate that there has been a total of 1,641,510 (95% CI: 1,536,842-1,746,178) infections over the past 4 weeks.

The figure below shows the estimated number of people infected over the past 4 weeks. The bar charts show, for comparison, the number of reported cases. The right-hand plot shows these data on a different scale as the estimated infections are likely to be much larger than the reported cases. **Importantly**, the estimated infections includes both asymptomatic and mild cases that would not necessarily be identified through surveillance. Consequently, the estimated infections are likely to be significantly higher than the reported cases (see our FAQ for further explanation of these differences and why the reported cases and estimated infections are unlikely to match).

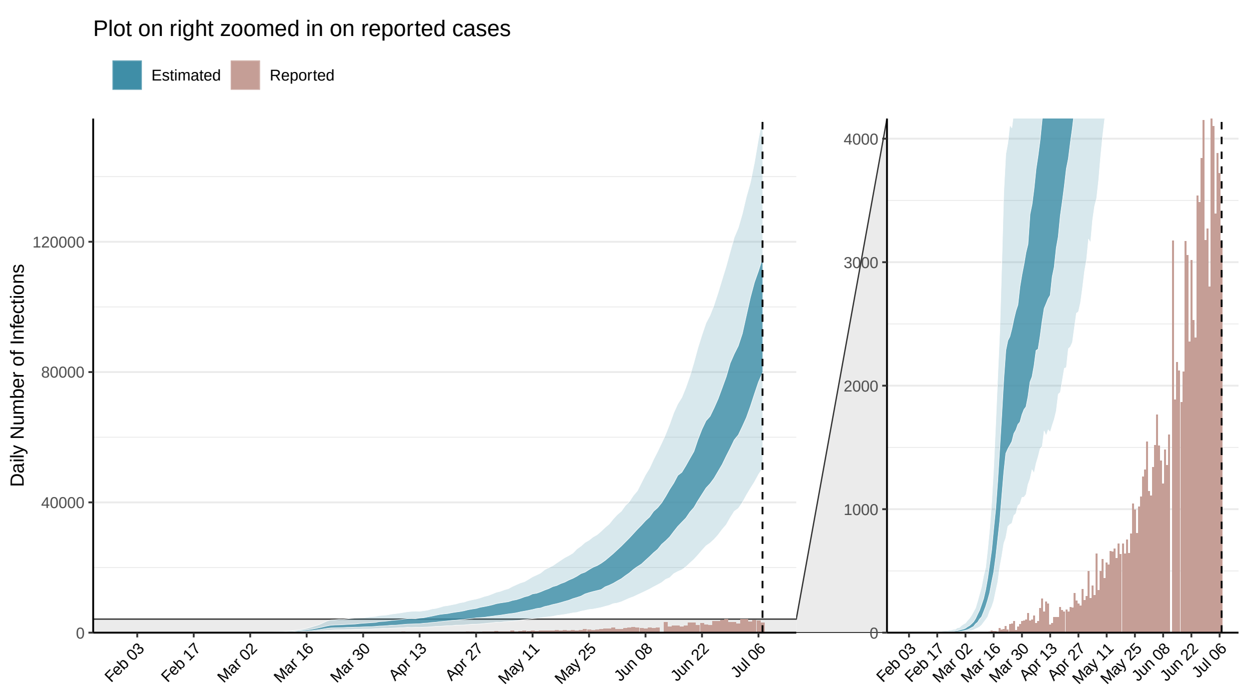

Figure 2: **Daily number of infections estimated by fitting to the current total of deaths.** Reported cases are shown in red. Model estimated infections are shown in blue (dark blue 50% interquartile range, light blue 95% quantile). The dashed line shows the current day.

By fitting to the time series of deaths, we are able to estimate a time-varying reproduction number, R_t. R_t is the the average number of secondary infections caused by a single infected person at a given time. If R_t is above 1, the rate of transmission is increasing and the number of new infections is increasing. R_t is assumed to change in relation to mobility fall in proportion. When fitting our model we assume that 100% of COVID-19 related deaths have been reported (please see our FAQ section for more information about this assumption). We also assume a fixed date at which the impact of mobility on transmission changes from pre-lockdown levels to post-lockdown levels, which may cause large changes in Rt. We are working to refine how this switch occurs and to formally calculate its shape.

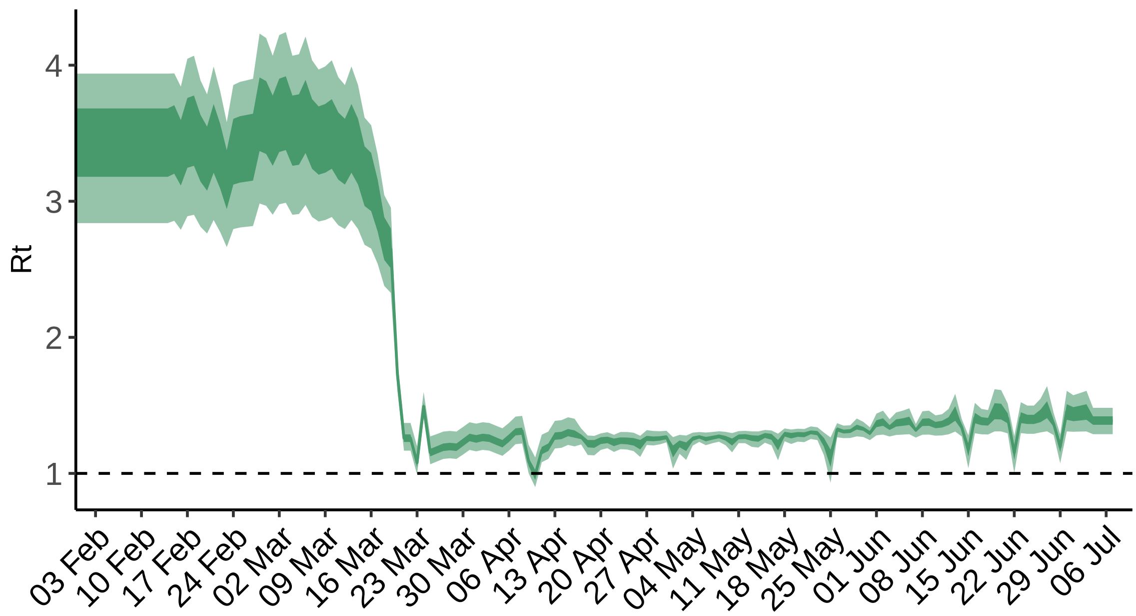

Figure 3: **Time-varying reproduction number, R_t.** R_t is the average number of secondary infections caused by a single infected person at time equal to t. $R_t < 1$ indicates a slowing epidemic in which new infections are not increasing. $R_t > 1$ indicates a growing epidemic in which new infections are increasing over time. Dark green shows the 50% CI and light green shows the 95% CI.

Using the model fit, we can forecast the expected trajectory for cumulative deaths, which is shown in the figure below. This assumes a severity pattern by age that is consistent with that observed in China, Europe and the U.S to date. This projection assumes that transmission is maintained at the current level of transmission as estimated by the final R_t value. **N.B. Colombia is forecast to be close to or surpassing our best estimates for healthcare capacity in the next 28 days.** Estimates of deaths in the next 28 days may be inaccurate due to our working assumptions for mortality in individuals who do not receive appropriate treatment. See our methods for more information.

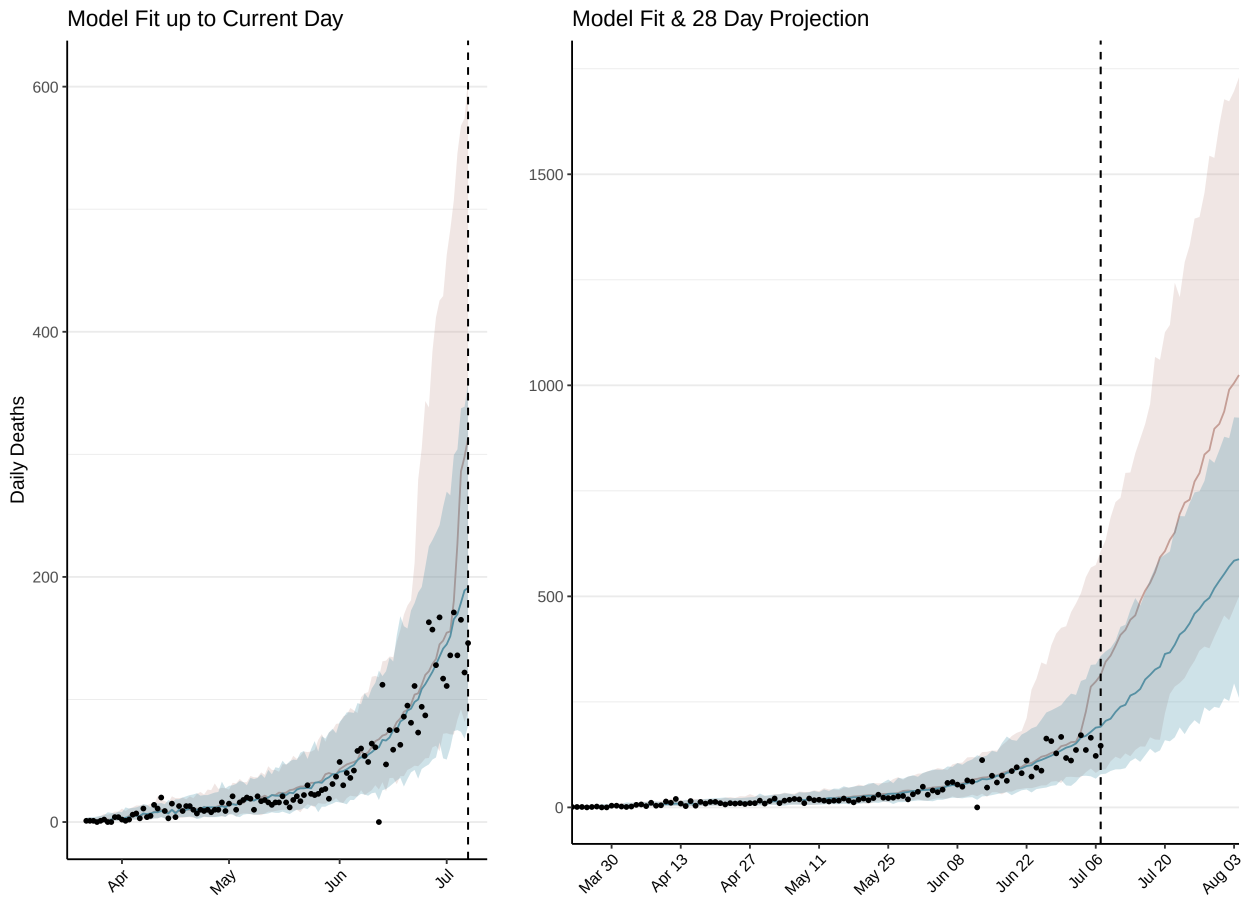

Figure 4: **Estimated daily deaths.** Projected deaths assuming the current level of interventions are maintained are shown in red (median and 95% quantile). Reported deaths are plotted in black. The plot on the left is focussed on the model fit prior to today, while the plot on the right forecasts the next 28 days. The forecasted deaths in blue assumes healthcare capacity has been surged to ensure sufficient supply of ICU and hospital beds. The red curve assumes no surging in healthcare capacity and subsequently projects increased deaths.

Short-term Epidemic Scenarios

We make the following short-term projections of healthcare demand and new infections under the following three scenarios:

- **Scenario 1.** The epidemic continues to grow at the current rate.
- **Scenario 2.** Countries will further scale up interventions (either increasing current strategies or implementing new interventions) leading to a further 50% reduction in transmission.
- **Scenario 3.** Countries will relax current interventions by 50%

N.B. These scenarios currently assume that the impact of mobility on transmission will remain the same in the future as it has in the past. We are working to extend methods to estimate the impact of increases in mobility on transmission as lockdown and interventions are reversed. Consequently, projection are likely to represent an upper estimate of the healthcare demand and case load for each scenario

We estimate that over the next 4 weeks demand for hospital beds will change from 10,203 (95% CI: 9,545-10,861) patients requiring treatment with high-pressure oxygen at the current date to 27,770 (95% CI: 26,122-29,418) hospital beds being required on 2020-08-04 if no further interventions are introduced (Scenario 1). Similarly, we estimate that over the next 4 weeks demand for critical care (ICU) beds will change from 2,648 (95% CI: 2,540-2,756) patients requiring treatment with mechanical ventilation at the current date to 3,597 (95% CI: 3,496-3,698) by 2020-08-04. These projections assume that approximately 5% of all infections will require treatment with high-pressure oxygen and that approximately 30% of hospitalised cases will require treatment with mechanical ventilation (based on analysis of ongoing epidemics in Europe). **N.B. These scenarios are unlikely to show significant differences for the first week since there is a delay of approximately 10 days between infection and hospital admission. Consequently, the effectiveness of a change in policy is likely to be better captured by hospital admission data approximately 2 weeks after the policy change is implemented.**

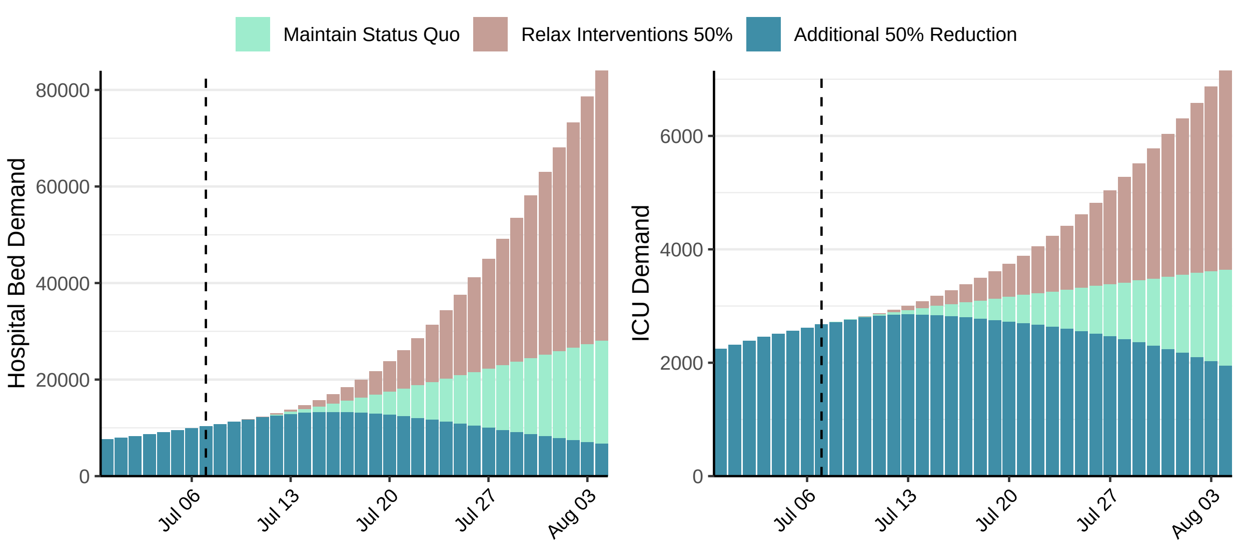

Figure 5: **Healthcare demands in the next 28 days.** Individuals needing an ICU bed are assumed to need mechanical ventilation. Projected demand for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

The impact of each scenario has a more immediate effect on the daily number of infections. The figure below shows the impact of each scenario on the estimated daily incidence of new infections. If interventions are scaled up (Scenario 2), the daily number of infections will change from 98,126 (95% CI: 91,951-104,300) at the current date to 17,717 (95% CI: 16,652-18,782) by 2020-08-04. If current interventions were relaxed by 50%, we estimate the daily number of infections will change from 98,126 (95% CI: 91,951-104,300) at the current date to 782,517 (95% CI: 755,866-809,168) by 2020-08-04.

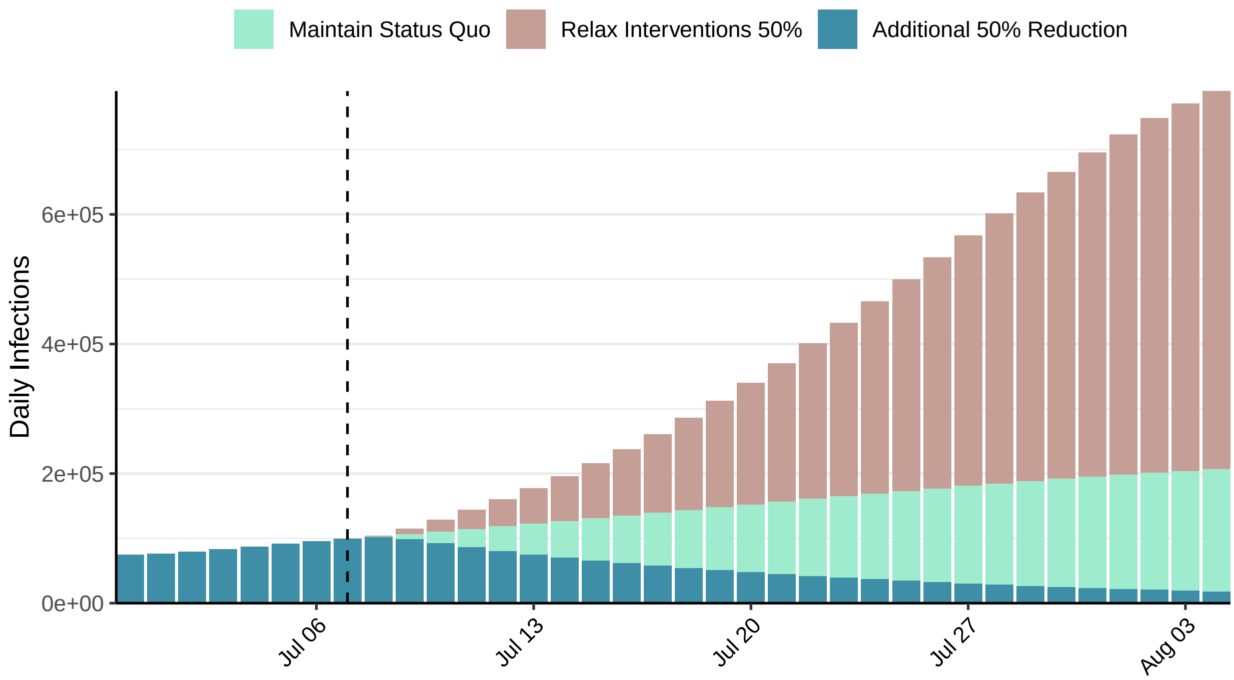

Figure 6: **Daily number of infections estimated by fitting to deaths.** Projected infections for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

To explore different scenarios, we recommend using our COVID-19 Scenario Analysis Tool - https://covidsim.org/, which can be used to simulate different intervention scenarios and explore the long term impact on healthcare demand.

Situation Report for COVID-19: Comoros, 2020-07-07

Download the report for Comoros, 2020-07-07 here. This report uses data from the European Centre for Disease Control. These data are updated daily and whilst there may be a short delay, they are generally consistent with Ministry reports. These data are then used to back-calculate an 'inferred number of COVID-19 infections' using mathematical modelling techniques (see Report 12 for further details) to estimate the number of people that have been infected and to make short-term projections for future healthcare needs.

Epidemiological Situation

Total Reported Cases	New Reported Cases	Total Reported Deaths	New Reported Deaths	Estimated R_t
311	0	7	0	1.2 (95% CI: 0.89-1.5)

The figure below shows the cumulative reported deaths as a function of the time since the 10th death was reported. Dashed lines show the expected trajectory for different doubling times of the epidemic. For example, with a doubling time of 3 days, if there are currently a total of 20 deaths reported, we would expect there to be 40 deaths in total reported in 3 days-time, 80 deaths in 6 days-time, 160 deaths in 9 days-time etc. For most epidemics, in the absence of interventions, we expect a doubling time of 3-4 days for this disease. **N.B. Comoros is not shown in the following plot as only 7 deaths have been reported to date**

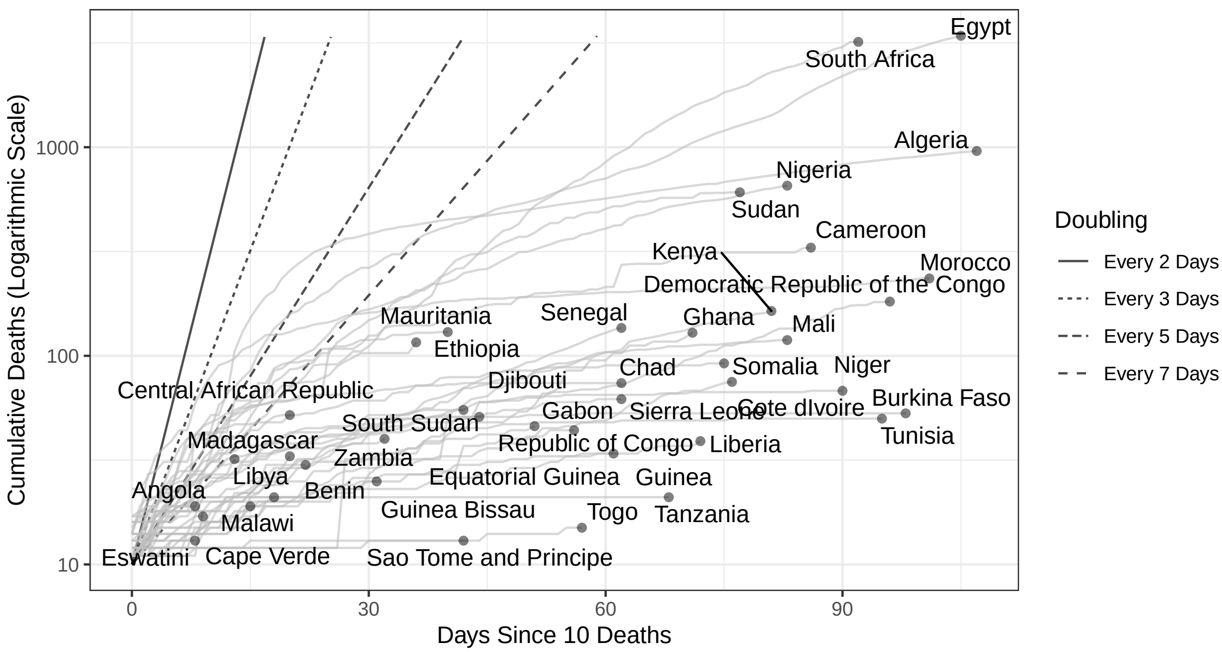

Figure 1: **Cumulative Deaths since 10 deaths.** Country not shown if fewer than 10 deaths.

COVID-19 Transmission Modelling

We assume that the deaths reported to date provide the best indication of the stage of the epidemic, as deaths are more consistently and accurately reported. Our current working estimate is that 1 death indicates that approximately 100 people will have been infected with the other 99 recovering (based on an infection fatality ratio of ~1%). These infections will have happened approximately 21 days previously – capturing a 5-day period from infection to onset of symptoms (the incubation period), 4 days from onset of symptoms to hospitalisation, and 12 days in hospital before death. With a 3-day doubling time, 100 infections that occurred 15 days ago will have generated 200 infections 12 days ago, 400 infections 9 days ago, 800 infections 6 days ago and 1,600 infections 3 days ago resulting in approximately 3,200 infections at the time the first death is observed.

To explore this, we fit our age-structured SEIR model (see Methods) to the time series of deaths in a country, in order to estimate the start date of the epidemic and the baseline R0. We assume that 100% of COVID-19 related deaths have been reported. We have also included the impact of interventions that have been put in place and their effect on human mobility and transmission based on the Google COVID-19 Community Mobility Reports. Using our mathematical model that formalises this approach, we estimate that there has been a total of 2,457 (95% CI: 2,034-2,881) infections over the past 4 weeks.

The figure below shows the estimated number of people infected over the past 4 weeks. The bar charts show, for comparison, the number of reported cases. The right-hand plot shows these data on a different scale as the estimated infections are likely to be much larger than the reported cases. **Importantly**, the estimated infections includes both asymptomatic and mild cases that would not necessarily be identified through surveillance. Consequently, the estimated infections are likely to be significantly higher than the reported cases (see our FAQ for further explanation of these differences and why the reported cases and estimated infections are unlikely to match).

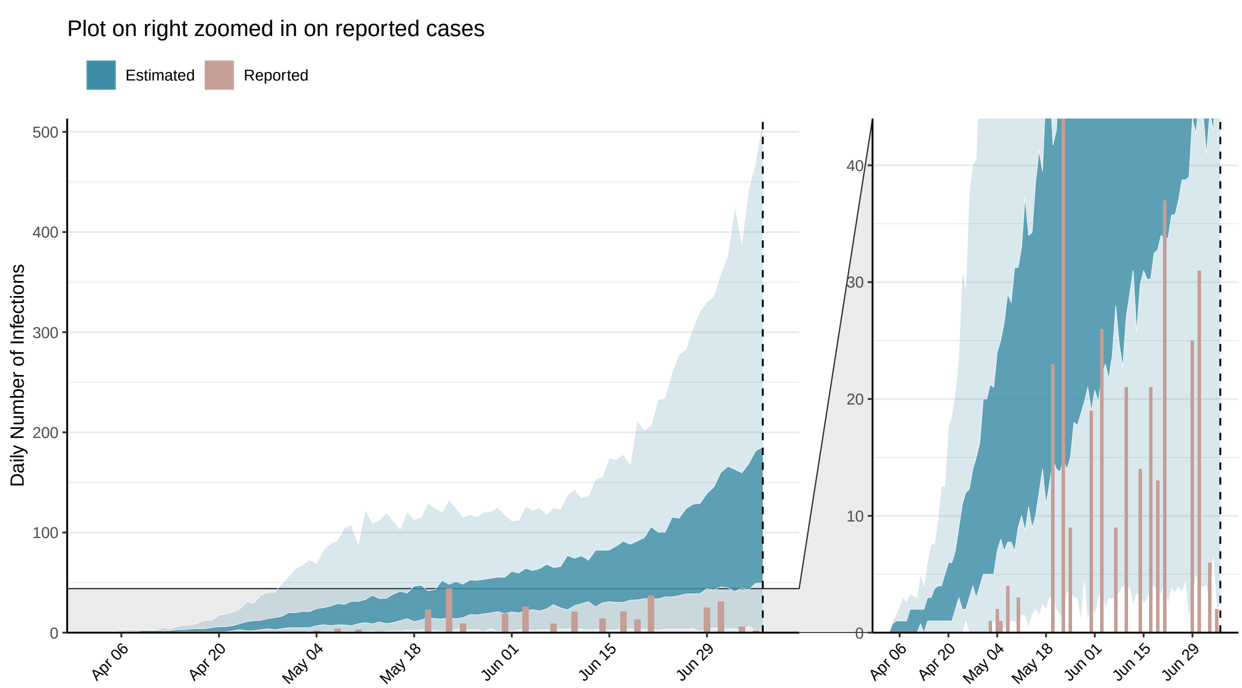

Figure 2: **Daily number of infections estimated by fitting to the current total of deaths.** Reported cases are shown in red. Model estimated infections are shown in blue (dark blue 50% interquartile range, light blue 95% quantile). The dashed line shows the current day.

By fitting to the time series of deaths, we are able to estimate a time-varying reproduction number, R_t. R_t is the the average number of secondary infections caused by a single infected person at a given time. If R_t is above 1, the rate of transmission is increasing and the number of new infections is increasing. R_t is assumed to change in relation to mobility fall in proportion. When fitting our model we assume that 100% of COVID-19 related deaths have been reported (please see our FAQ section for more information about this assumption). We also assume a fixed date at which the impact of mobility on transmission changes from pre-lockdown levels to post-lockdown levels, which may cause large changes in Rt. We are working to refine how this switch occurs and to formally calculate its shape.

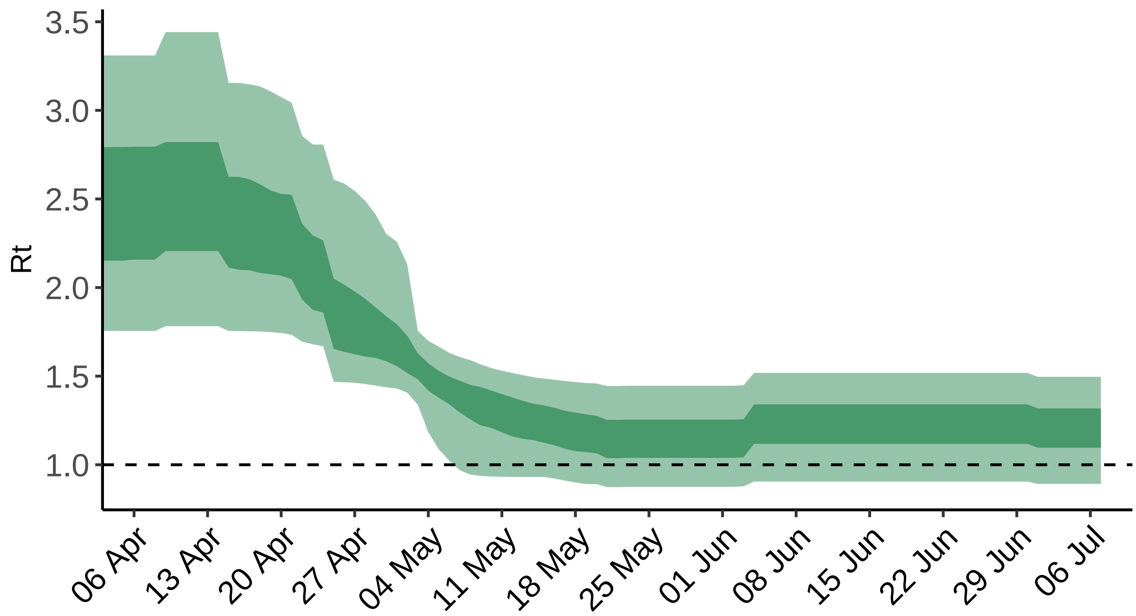

Figure 3: **Time-varying reproduction number, R_t.** R_t is the average number of secondary infections caused by a single infected person at time equal to t. $R_t < 1$ indicates a slowing epidemic in which new infections are not increasing. $R_t > 1$ indicates a growing epidemic in which new infections are increasing over time. Dark green shows the 50% CI and light green shows the 95% CI.

Using the model fit, we can forecast the expected trajectory for cumulative deaths, which is shown in the figure below. This assumes a severity pattern by age that is consistent with that observed in China, Europe and the U.S to date. This projection assumes that transmission is maintained at the current level of transmission as estimated by the final R_t value.

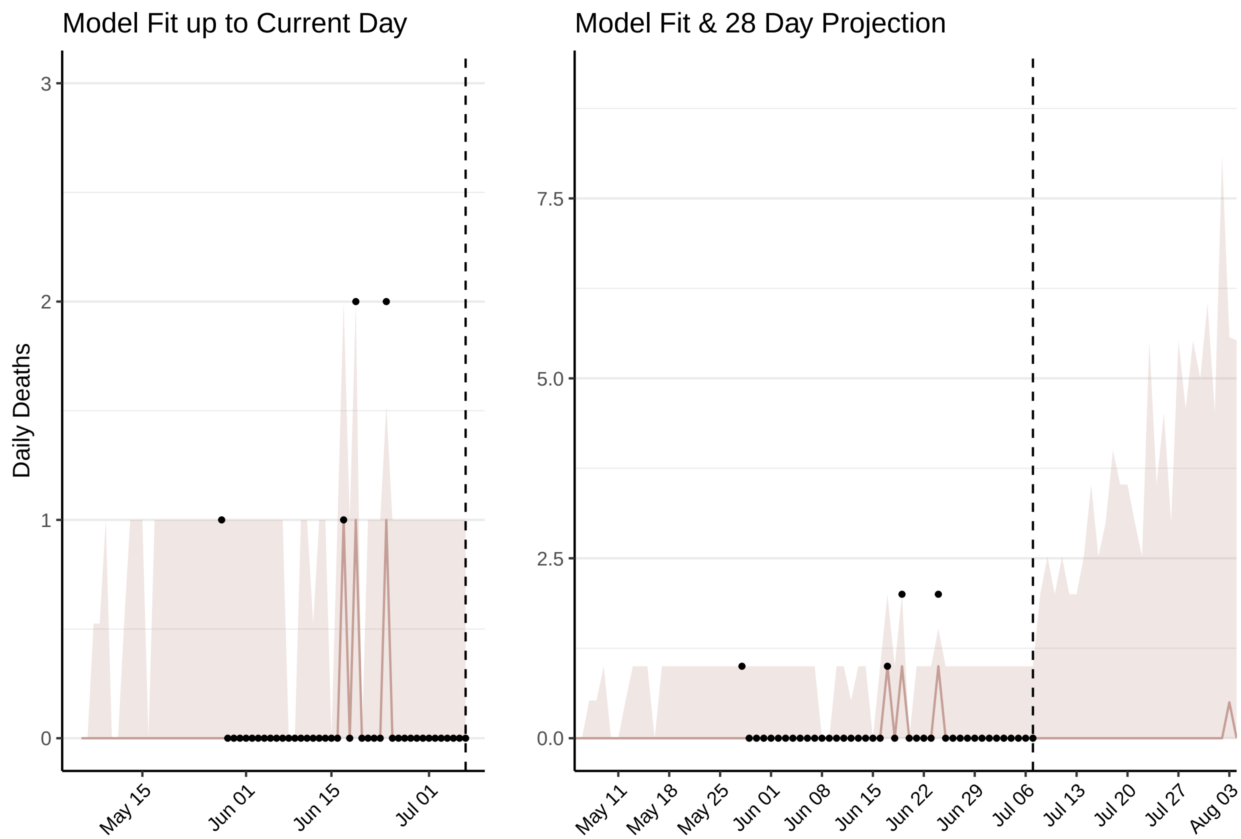

Figure 4: **Estimated daily deaths.** Projected deaths assuming the current level of interventions are maintained are shown in red (median and 95% quantile). Reported deaths are plotted in black. The plot on the left is focussed on the model fit prior to today, while the plot on the right forecasts the next 28 days.

Short-term Epidemic Scenarios

We make the following short-term projections of healthcare demand and new infections under the following three scenarios:

- **Scenario 1.** The epidemic continues to grow at the current rate.
- **Scenario 2.** Countries will further scale up interventions (either increasing current strategies or implementing new interventions) leading to a further 50% reduction in transmission.
- **Scenario 3.** Countries will relax current interventions by 50%

N.B. These scenarios currently assume that the impact of mobility on transmission will remain the same in the future as it has in the past. We are working to extend methods to estimate the impact of increases in mobility on transmission as lockdown and interventions are reversed. Consequently, projection are likely to represent an upper estimate of the healthcare demand and case load for each scenario

We estimate that over the next 4 weeks demand for hospital beds will change from 15 (95% CI: 12-17) patients requiring treatment with high-pressure oxygen at the current date to 43 (95% CI: 30-57) hospital beds being required on 2020-08-04 if no further interventions are introduced (Scenario 1). Similarly, we estimate that over the next 4 weeks demand for critical care (ICU) beds will change from 4 (95% CI: 3-5) patients requiring treatment with mechanical ventilation at the current date to 8 (95% CI: 7-9) by 2020-08-04. These projections assume that approximately 5% of all infections will require treatment with high-pressure oxygen and that approximately 30% of hospitalised cases will require treatment with mechanical ventilation (based on analysis of ongoing epidemics in Europe). **N.B. These scenarios are unlikely to show significant differences for the first week since there is a delay of approximately 10 days between infection and hospital admission. Consequently, the effectiveness of a change in policy is likely to be better captured by hospital admission data approximately 2 weeks after the policy change is implemented.**

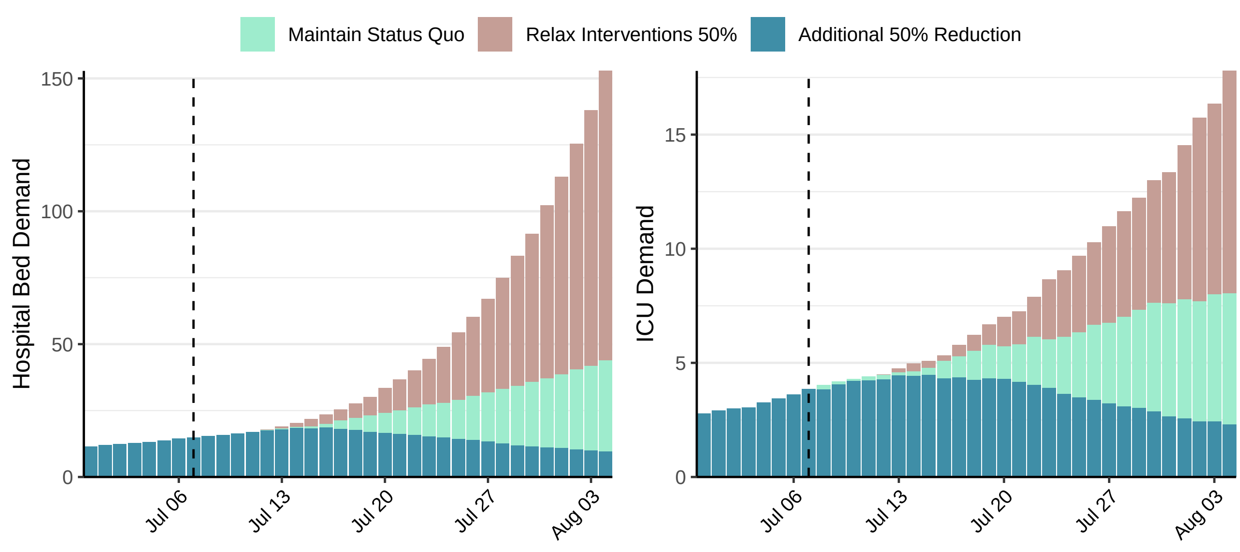

Figure 5: **Healthcare demands in the next 28 days.** Individuals needing an ICU bed are assumed to need mechanical ventilation. Projected demand for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

The impact of each scenario has a more immediate effect on the daily number of infections. The figure below shows the impact of each scenario on the estimated daily incidence of new infections. If interventions are scaled up (Scenario 2), the daily number of infections will change from 139 (95% CI: 110-169) at the current date to 31 (95% CI: 21-41) by 2020-08-04. If current interventions were relaxed by 50%, we estimate the daily number of infections will change from 139 (95% CI: 110-169) at the current date to 2,604 (95% CI: 1,840-3,368) by 2020-08-04.

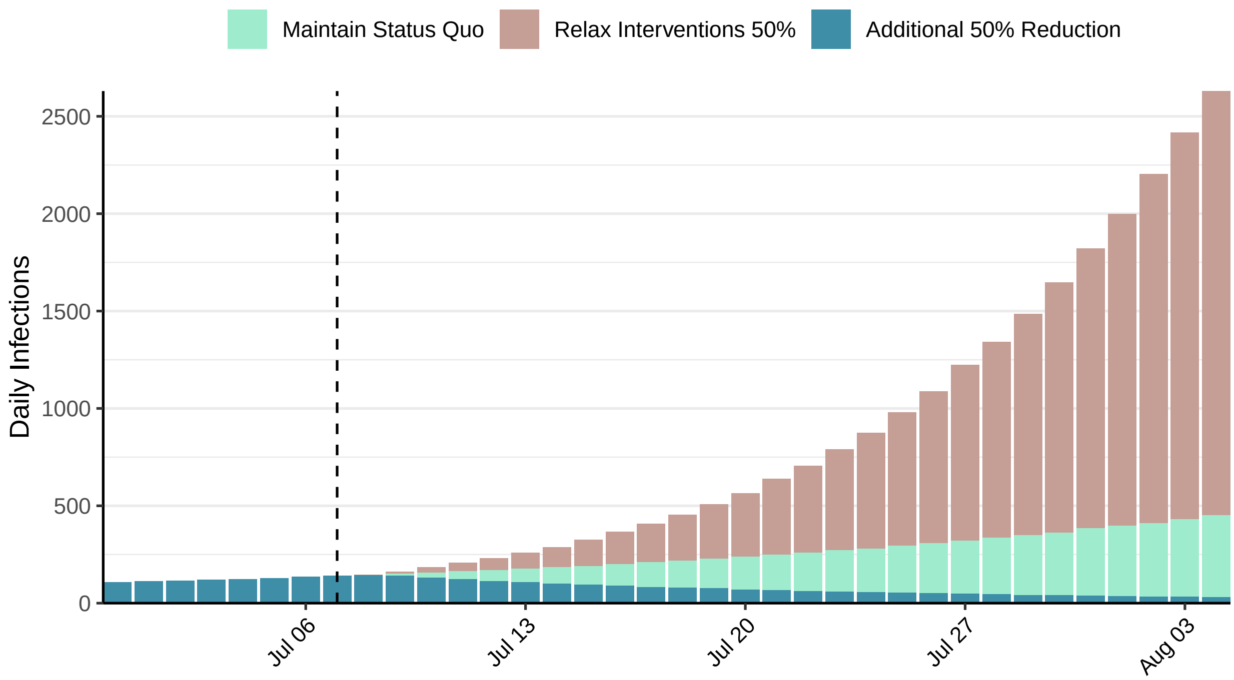

Figure 6: **Daily number of infections estimated by fitting to deaths.** Projected infections for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

To explore different scenarios, we recommend using our COVID-19 Scenario Analysis Tool - https://covidsim.org/, which can be used to simulate different intervention scenarios and explore the long term impact on healthcare demand.

Situation Report for COVID-19: Cabo Verde, 2020-07-07

Download the report for Cabo Verde, 2020-07-07 here. This report uses data from the European Centre for Disease Control. These data are updated daily and whilst there may be a short delay, they are generally consistent with Ministry reports. These data are then used to back-calculate an 'inferred number of COVID-19 infections' using mathematical modelling techniques (see Report 12 for further details) to estimate the number of people that have been infected and to make short-term projections for future healthcare needs.

Epidemiological Situation

Total Reported Cases	New Reported Cases	Total Reported Deaths	New Reported Deaths	Estimated R_t
1,463	12	17	0	1.38 (95% CI: 1.22-1.59)

The figure below shows the cumulative reported deaths as a function of the time since the 10th death was reported. Dashed lines show the expected trajectory for different doubling times of the epidemic. For example, with a doubling time of 3 days, if there are currently a total of 20 deaths reported, we would expect there to be 40 deaths in total reported in 3 days-time, 80 deaths in 6 days-time, 160 deaths in 9 days-time etc. For most epidemics, in the absence of interventions, we expect a doubling time of 3-4 days for this disease.

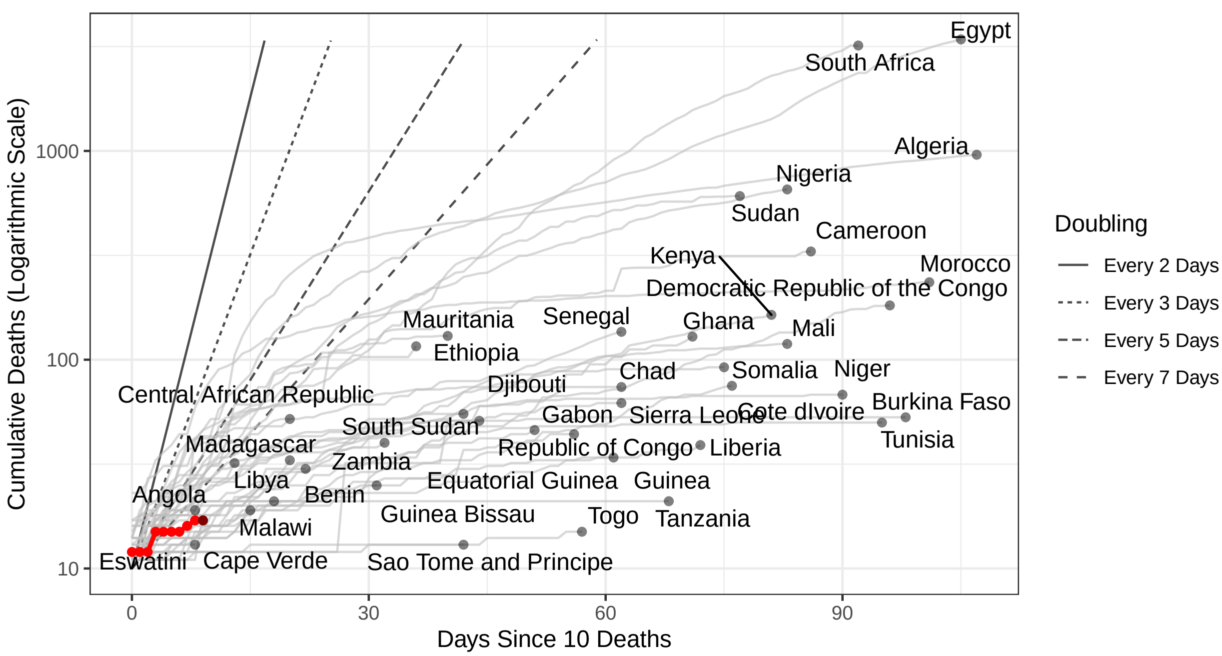

Figure 1: **Cumulative Deaths since 10 deaths.** Country not shown if fewer than 10 deaths.

COVID-19 Transmission Modelling

We assume that the deaths reported to date provide the best indication of the stage of the epidemic, as deaths are more consistently and accurately reported. Our current working estimate is that 1 death indicates that approximately 100 people will have been infected with the other 99 recovering (based on an infection fatality ratio of ~1%). These infections will have happened approximately 21 days previously – capturing a 5-day period from infection to onset of symptoms (the incubation period), 4 days from onset of symptoms to hospitalisation, and 12 days in hospital before death. With a 3-day doubling time, 100 infections that occurred 15 days ago will have generated 200 infections 12 days ago, 400 infections 9 days ago, 800 infections 6 days ago and 1,600 infections 3 days ago resulting in approximately 3,200 infections at the time the first death is observed.

To explore this, we fit our age-structured SEIR model (see Methods) to the time series of deaths in a country, in order to estimate the start date of the epidemic and the baseline R0. We assume that 100% of COVID-19 related deaths have been reported. We have also included the impact of interventions that have been put in place and their effect on human mobility and transmission based on the Google COVID-19 Community Mobility Reports. Using our mathematical model that formalises this approach, we estimate that there has been a total of 7,659 (95% CI: 6,587-8,731) infections over the past 4 weeks.

The figure below shows the estimated number of people infected over the past 4 weeks. The bar charts show, for comparison, the number of reported cases. The right-hand plot shows these data on a different scale as the estimated infections are likely to be much larger than the reported cases. **Importantly**, the estimated infections includes both asymptomatic and mild cases that would not necessarily be identified through surveillance. Consequently, the estimated infections are likely to be significantly higher than the reported cases (see our FAQ for further explanation of these differences and why the reported cases and estimated infections are unlikely to match).

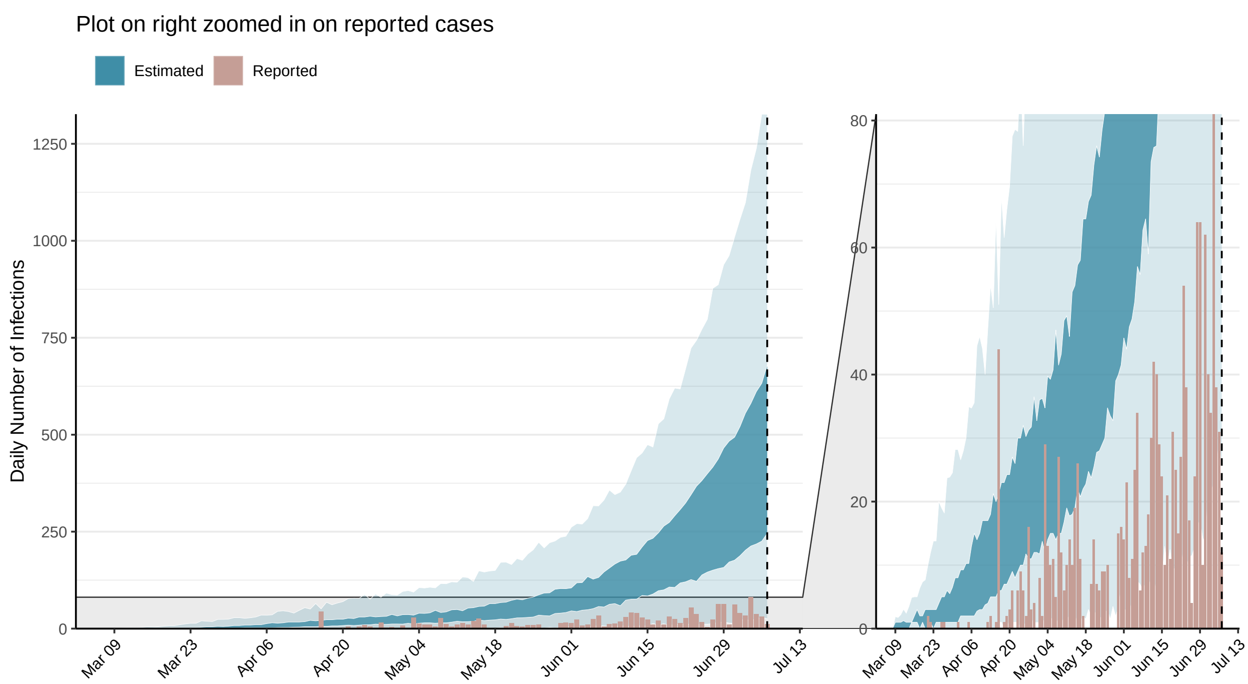

Figure 2: **Daily number of infections estimated by fitting to the current total of deaths.** Reported cases are shown in red. Model estimated infections are shown in blue (dark blue 50% interquartile range, light blue 95% quantile). The dashed line shows the current day.

By fitting to the time series of deaths, we are able to estimate a time-varying reproduction number, R_t. R_t is the the average number of secondary infections caused by a single infected person at a given time. If R_t is above 1, the rate of transmission is increasing and the number of new infections is increasing. R_t is assumed to change in relation to mobility fall in proportion. When fitting our model we assume that 100% of COVID-19 related deaths have been reported (please see our FAQ section for more information about this assumption). We also assume a fixed date at which the impact of mobility on transmission changes from pre-lockdown levels to post-lockdown levels, which may cause large changes in Rt. We are working to refine how this switch occurs and to formally calculate its shape.

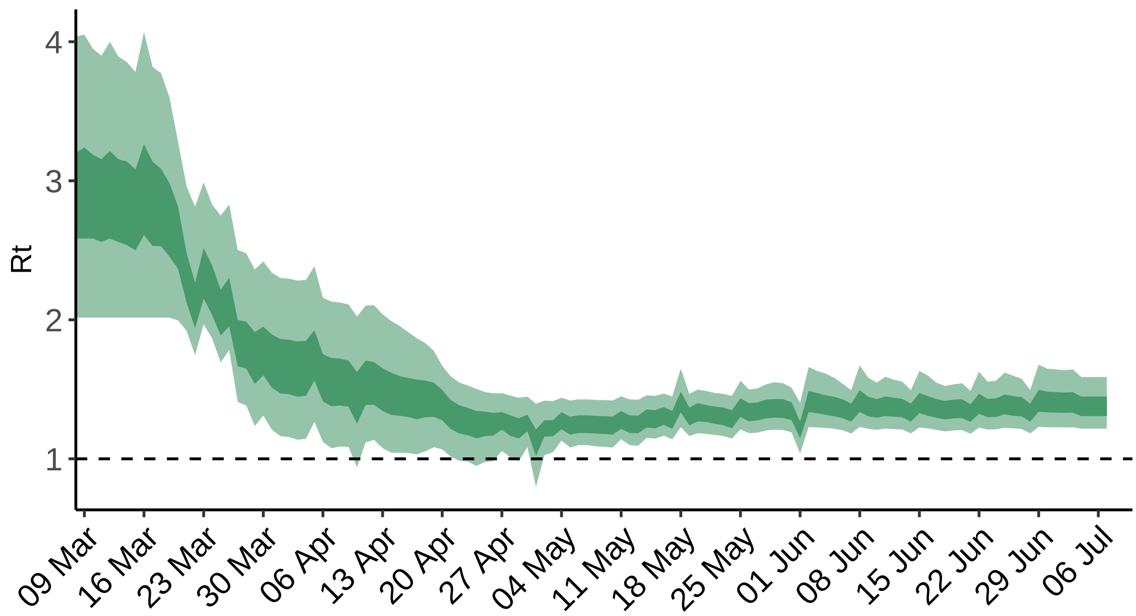

Figure 3: **Time-varying reproduction number, R_t.** R_t is the average number of secondary infections caused by a single infected person at time equal to t. $R_t < 1$ indicates a slowing epidemic in which new infections are not increasing. $R_t > 1$ indicates a growing epidemic in which new infections are increasing over time. Dark green shows the 50% CI and light green shows the 95% CI.

Using the model fit, we can forecast the expected trajectory for cumulative deaths, which is shown in the figure below. This assumes a severity pattern by age that is consistent with that observed in China, Europe and the U.S to date. This projection assumes that transmission is maintained at the current level of transmission as estimated by the final R_t value. **N.B. Cabo Verde is forecast to be close to or surpassing our best estimates for healthcare capacity in the next 28 days.** Estimates of deaths in the next 28 days may be inaccurate due to our working assumptions for mortality in individuals who do not receive appropriate treatment. See our methods for more information.

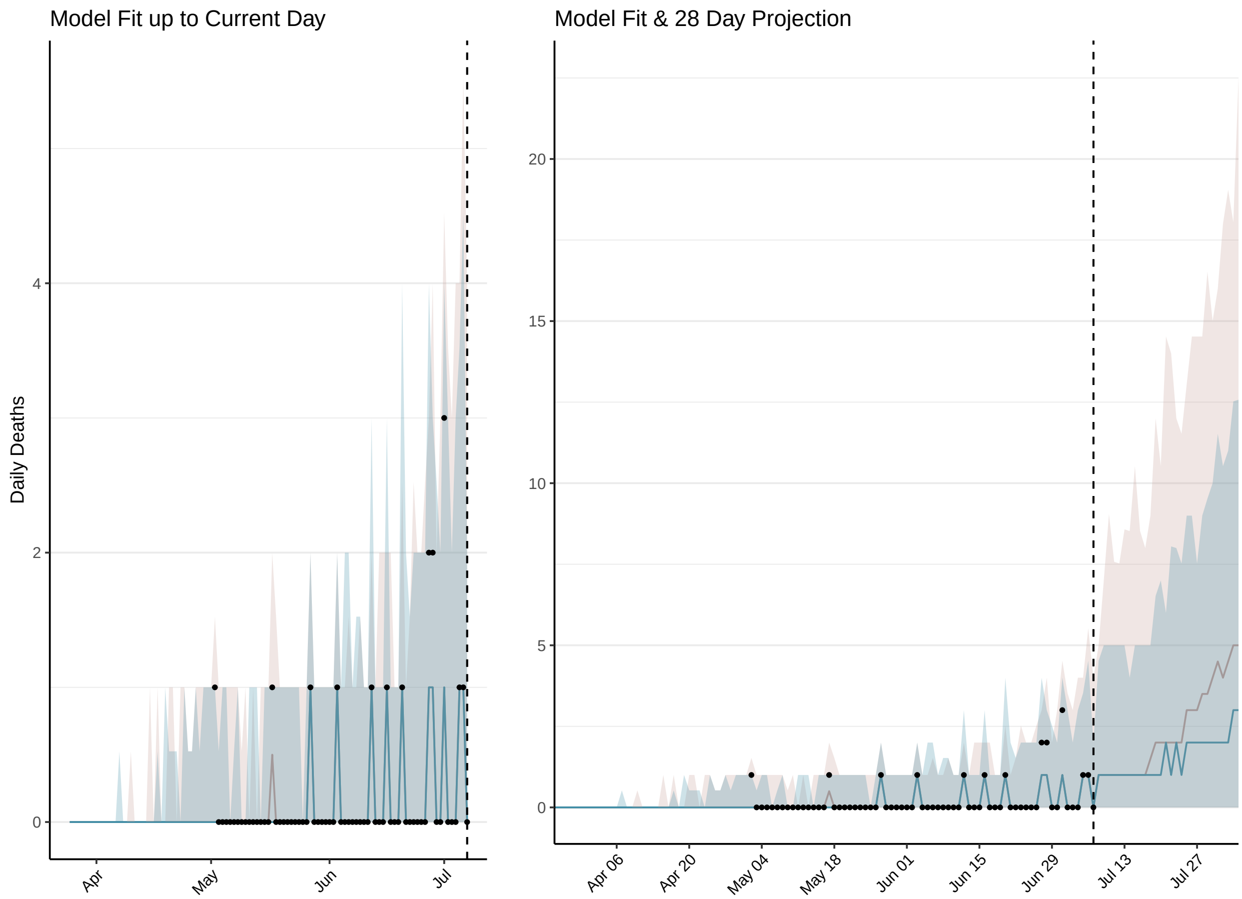

Figure 4: **Estimated daily deaths.** Projected deaths assuming the current level of interventions are maintained are shown in red (median and 95% quantile). Reported deaths are plotted in black. The plot on the left is focussed on the model fit prior to today, while the plot on the right forecasts the next 28 days. The forecasted deaths in blue assumes healthcare capacity has been surged to ensure sufficient supply of ICU and hospital beds. The red curve assumes no surging in healthcare capacity and subsequently projects increased deaths.

Short-term Epidemic Scenarios

We make the following short-term projections of healthcare demand and new infections under the following three scenarios:

- **Scenario 1.** The epidemic continues to grow at the current rate.
- **Scenario 2.** Countries will further scale up interventions (either increasing current strategies or implementing new interventions) leading to a further 50% reduction in transmission.
- **Scenario 3.** Countries will relax current interventions by 50%

N.B. These scenarios currently assume that the impact of mobility on transmission will remain the same in the future as it has in the past. We are working to extend methods to estimate the impact of increases in mobility on transmission as lockdown and interventions are reversed. Consequently, projection are likely to represent an upper estimate of the healthcare demand and case load for each scenario

We estimate that over the next 4 weeks demand for hospital beds will change from 53 (95% CI: 45-60) patients requiring treatment with high-pressure oxygen at the current date to 190 (95% CI: 162-217) hospital beds being required on 2020-08-04 if no further interventions are introduced (Scenario 1). Similarly, we estimate that over the next 4 weeks demand for critical care (ICU) beds will change from 13 (95% CI: 12-15) patients requiring treatment with mechanical ventilation at the current date to 28 (95% CI: 26-30) by 2020-08-04. These projections assume that approximately 5% of all infections will require treatment with high-pressure oxygen and that approximately 30% of hospitalised cases will require treatment with mechanical ventilation (based on analysis of ongoing epidemics in Europe). **N.B. These scenarios are unlikely to show significant differences for the first week since there is a delay of approximately 10 days between infection and hospital admission. Consequently, the effectiveness of a change in policy is likely to be better captured by hospital admission data approximately 2 weeks after the policy change is implemented.**

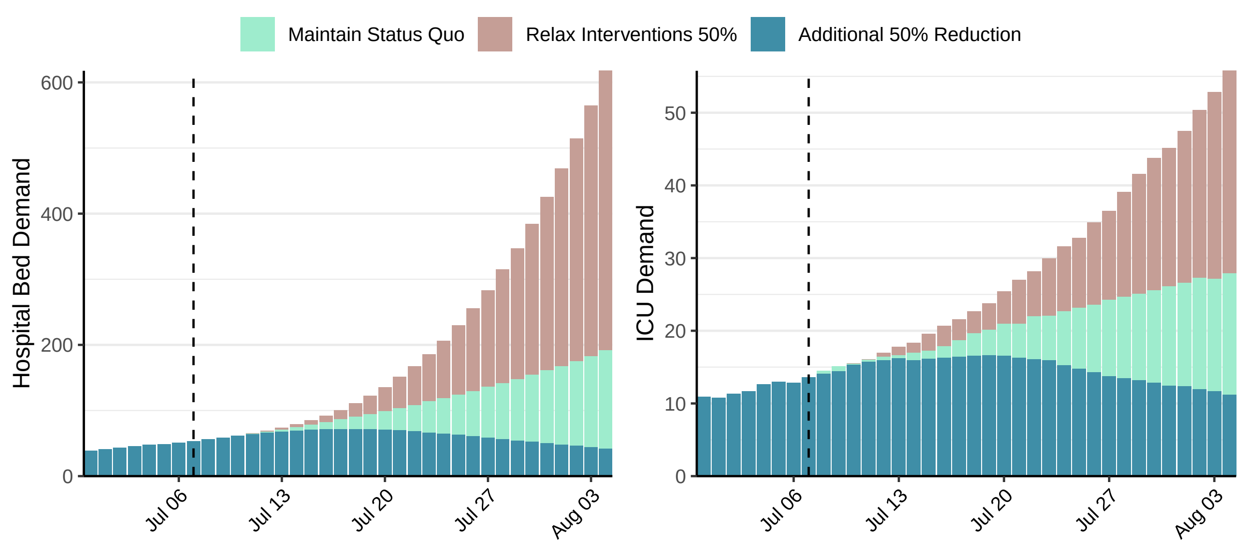

Figure 5: **Healthcare demands in the next 28 days.** Individuals needing an ICU bed are assumed to need mechanical ventilation. Projected demand for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

The impact of each scenario has a more immediate effect on the daily number of infections. The figure below shows the impact of each scenario on the estimated daily incidence of new infections. If interventions are scaled up (Scenario 2), the daily number of infections will change from 489 (95% CI: 420-558) at the current date to 118 (95% CI: 100-135) by 2020-08-04. If current interventions were relaxed by 50%, we estimate the daily number of infections will change from 489 (95% CI: 420-558) at the current date to 7,517 (95% CI: 6,712-8,322) by 2020-08-04.

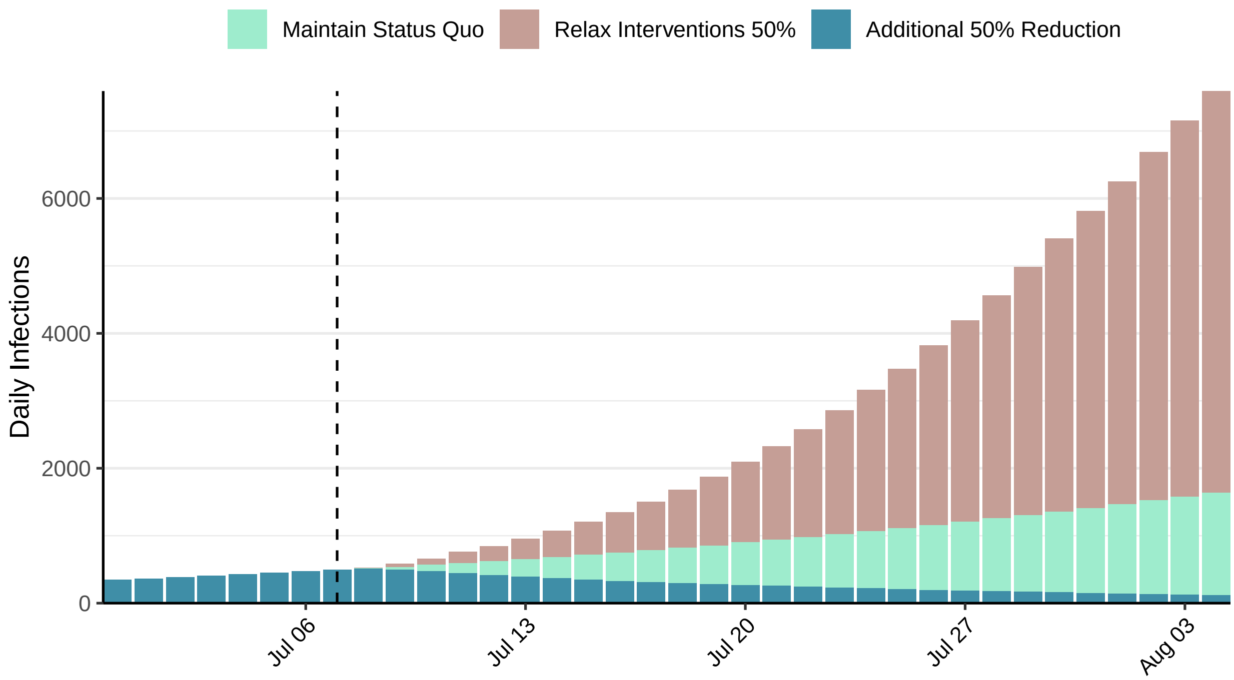

Figure 6: **Daily number of infections estimated by fitting to deaths.** Projected infections for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

To explore different scenarios, we recommend using our COVID-19 Scenario Analysis Tool - https://covidsim.org/, which can be used to simulate different intervention scenarios and explore the long term impact on healthcare demand.

Situation Report for COVID-19: Costa Rica, 2020-07-07

Download the report for Costa Rica, 2020-07-07 here. This report uses data from the European Centre for Disease Control. These data are updated daily and whilst there may be a short delay, they are generally consistent with Ministry reports. These data are then used to back-calculate an 'inferred number of COVID-19 infections' using mathematical modelling techniques (see Report 12 for further details) to estimate the number of people that have been infected and to make short-term projections for future healthcare needs.

Epidemiological Situation

Total Reported Cases	New Reported Cases	Total Reported Deaths	New Reported Deaths	Estimated R_t
5,241	245	23	4	1.13 (95% CI: 1.06-1.22)

The figure below shows the cumulative reported deaths as a function of the time since the 10th death was reported. Dashed lines show the expected trajectory for different doubling times of the epidemic. For example, with a doubling time of 3 days, if there are currently a total of 20 deaths reported, we would expect there to be 40 deaths in total reported in 3 days-time, 80 deaths in 6 days-time, 160 deaths in 9 days-time etc. For most epidemics, in the absence of interventions, we expect a doubling time of 3-4 days for this disease.

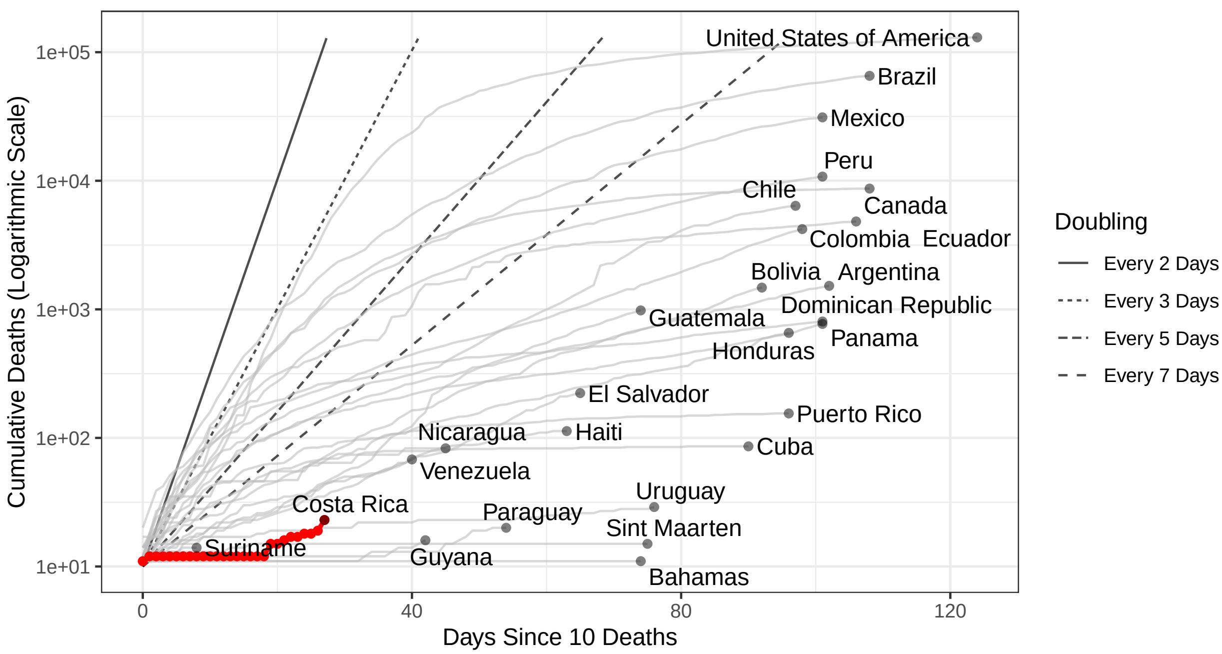

Figure 1: **Cumulative Deaths since 10 deaths.** Country not shown if fewer than 10 deaths.

COVID-19 Transmission Modelling

We assume that the deaths reported to date provide the best indication of the stage of the epidemic, as deaths are more consistently and accurately reported. Our current working estimate is that 1 death indicates that approximately 100 people will have been infected with the other 99 recovering (based on an infection fatality ratio of ~1%). These infections will have happened approximately 21 days previously – capturing a 5-day period from infection to onset of symptoms (the incubation period), 4 days from onset of symptoms to hospitalisation, and 12 days in hospital before death. With a 3-day doubling time, 100 infections that occurred 15 days ago will have generated 200 infections 12 days ago, 400 infections 9 days ago, 800 infections 6 days ago and 1,600 infections 3 days ago resulting in approximately 3,200 infections at the time the first death is observed.

To explore this, we fit our age-structured SEIR model (see Methods) to the time series of deaths in a country, in order to estimate the start date of the epidemic and the baseline R0. We assume that 100% of COVID-19 related deaths have been reported. We have also included the impact of interventions that have been put in place and their effect on human mobility and transmission based on the Google COVID-19 Community Mobility Reports. Using our mathematical model that formalises this approach, we estimate that there has been a total of 5,321 (95% CI: 4,224-6,418) infections over the past 4 weeks.

The figure below shows the estimated number of people infected over the past 4 weeks. The bar charts show, for comparison, the number of reported cases. The right-hand plot shows these data on a different scale as the estimated infections are likely to be much larger than the reported cases. **Importantly**, the estimated infections includes both asymptomatic and mild cases that would not necessarily be identified through surveillance. Consequently, the estimated infections are likely to be significantly higher than the reported cases (see our FAQ for further explanation of these differences and why the reported cases and estimated infections are unlikely to match).

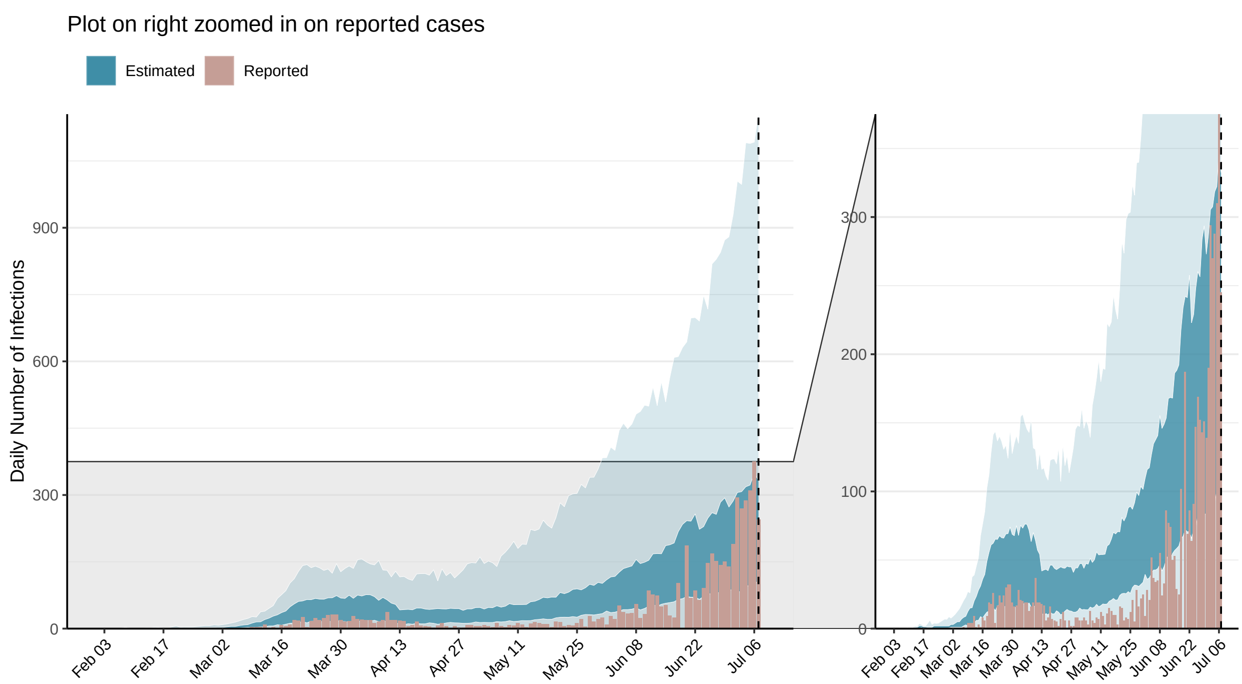

Figure 2: **Daily number of infections estimated by fitting to the current total of deaths.** Reported cases are shown in red. Model estimated infections are shown in blue (dark blue 50% interquartile range, light blue 95% quantile). The dashed line shows the current day.

By fitting to the time series of deaths, we are able to estimate a time-varying reproduction number, R_t. R_t is the the average number of secondary infections caused by a single infected person at a given time. If R_t is above 1, the rate of transmission is increasing and the number of new infections is increasing. R_t is assumed to change in relation to mobility fall in proportion. When fitting our model we assume that 100% of COVID-19 related deaths have been reported (please see our FAQ section for more information about this assumption). We also assume a fixed date at which the impact of mobility on transmission changes from pre-lockdown levels to post-lockdown levels, which may cause large changes in Rt. We are working to refine how this switch occurs and to formally calculate its shape.

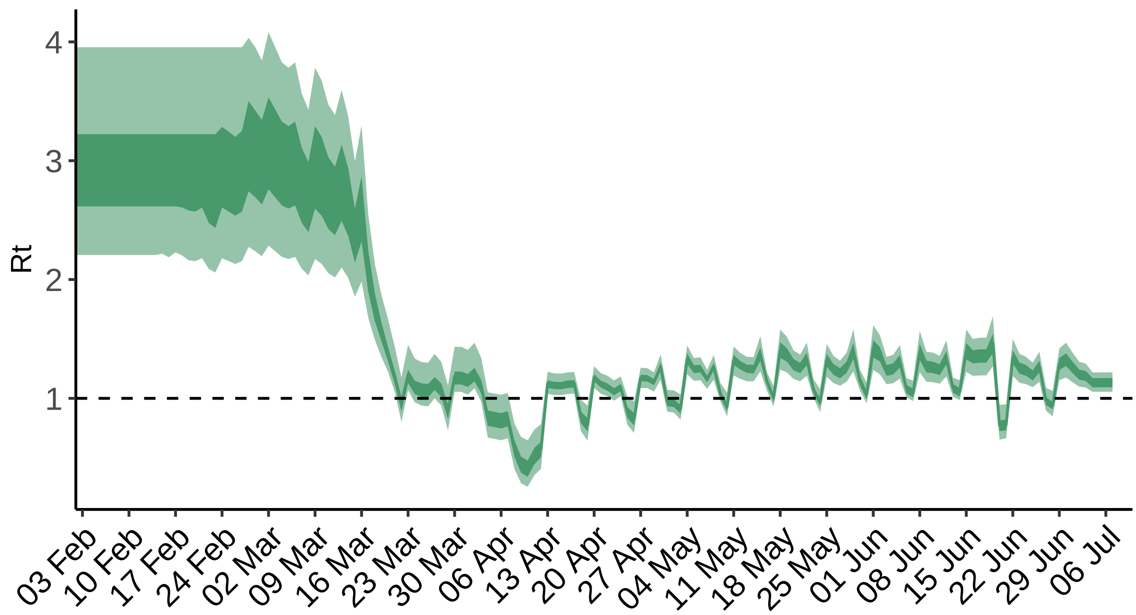

Figure 3: **Time-varying reproduction number,** R_t**.** R_t is the average number of secondary infections caused by a single infected person at time equal to t. $R_t < 1$ indicates a slowing epidemic in which new infections are not increasing. $R_t > 1$ indicates a growing epidemic in which new infections are increasing over time. Dark green shows the 50% CI and light green shows the 95% CI.

Using the model fit, we can forecast the expected trajectory for cumulative deaths, which is shown in the figure below. This assumes a severity pattern by age that is consistent with that observed in China, Europe and the U.S to date. This projection assumes that transmission is maintained at the current level of transmission as estimated by the final R_t value.

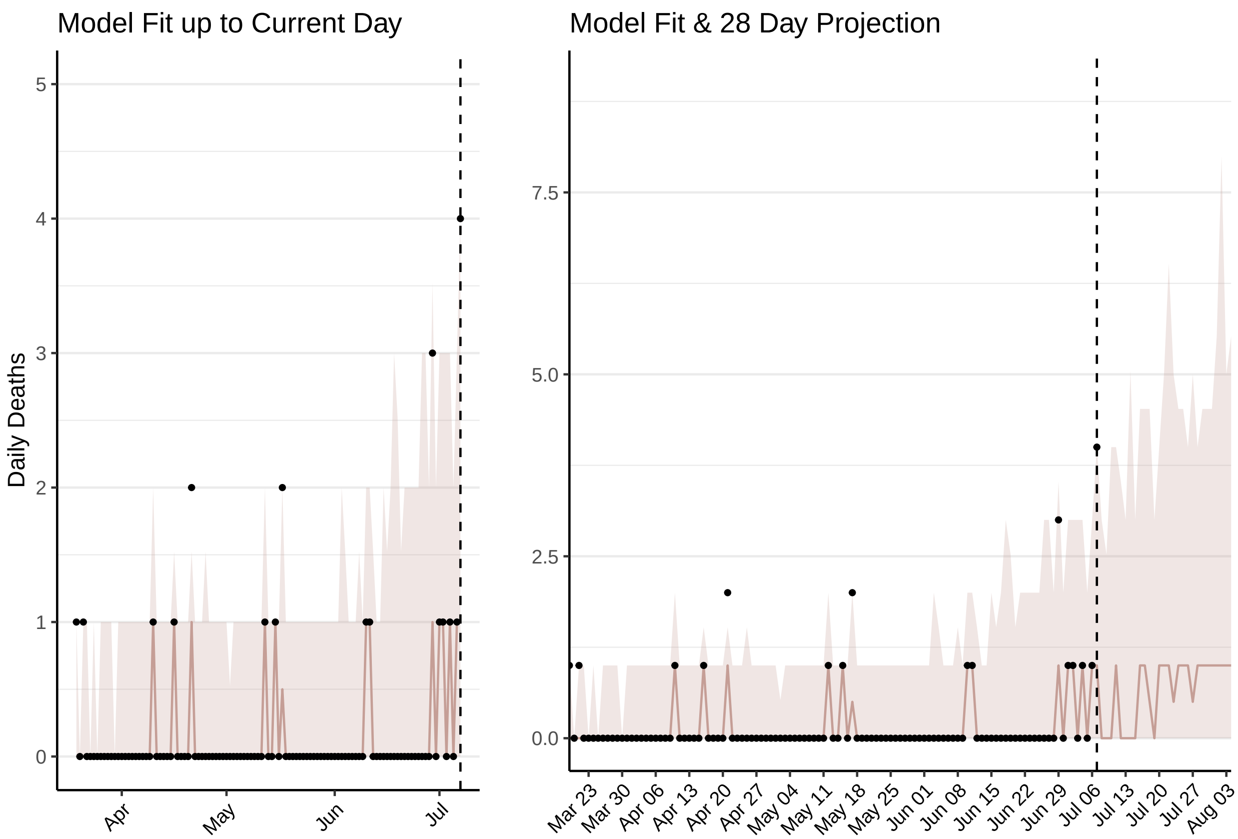

Figure 4: **Estimated daily deaths.** Projected deaths assuming the current level of interventions are maintained are shown in red (median and 95% quantile). Reported deaths are plotted in black. The plot on the left is focussed on the model fit prior to today, while the plot on the right forecasts the next 28 days.

Short-term Epidemic Scenarios

We make the following short-term projections of healthcare demand and new infections under the following three scenarios:

- **Scenario 1.** The epidemic continues to grow at the current rate.
- **Scenario 2.** Countries will further scale up interventions (either increasing current strategies or implementing new interventions) leading to a further 50% reduction in transmission.
- **Scenario 3.** Countries will relax current interventions by 50%

N.B. These scenarios currently assume that the impact of mobility on transmission will remain the same in the future as it has in the past. We are working to extend methods to estimate the impact of increases in mobility on transmission as lockdown and interventions are reversed. Consequently, projection are likely to represent an upper estimate of the healthcare demand and case load for each scenario

We estimate that over the next 4 weeks demand for hospital beds will change from 34 (95% CI: 27-41) patients requiring treatment with high-pressure oxygen at the current date to 64 (95% CI: 50-78) hospital beds being required on 2020-08-04 if no further interventions are introduced (Scenario 1). Similarly, we estimate that over the next 4 weeks demand for critical care (ICU) beds will change from 10 (95% CI: 8-13) patients requiring treatment with mechanical ventilation at the current date to 21 (95% CI: 16-26) by 2020-08-04. These projections assume that approximately 5% of all infections will require treatment with high-pressure oxygen and that approximately 30% of hospitalised cases will require treatment with mechanical ventilation (based on analysis of ongoing epidemics in Europe). **N.B. These scenarios are unlikely to show significant differences for the first week since there is a delay of approximately 10 days between infection and hospital admission. Consequently, the effectiveness of a change in policy is likely to be better captured by hospital admission data approximately 2 weeks after the policy change is implemented.**

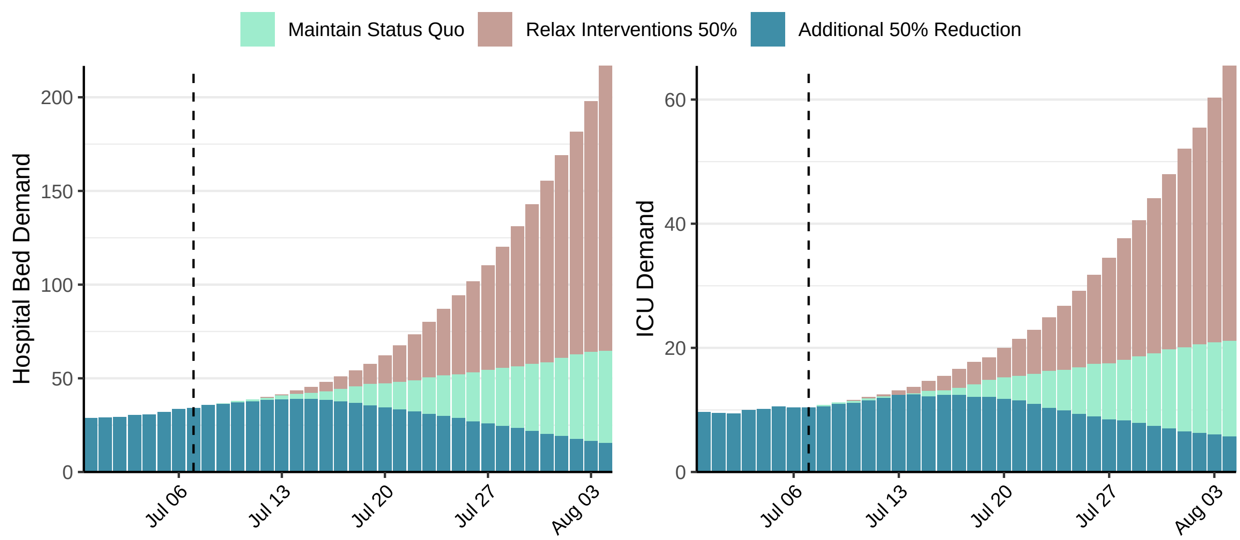

Figure 5: **Healthcare demands in the next 28 days.** Individuals needing an ICU bed are assumed to need mechanical ventilation. Projected demand for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

The impact of each scenario has a more immediate effect on the daily number of infections. The figure below shows the impact of each scenario on the estimated daily incidence of new infections. If interventions are scaled up (Scenario 2), the daily number of infections will change from 266 (95% CI: 210-322) at the current date to 36 (95% CI: 27-45) by 2020-08-04. If current interventions were relaxed by 50%, we estimate the daily number of infections will change from 266 (95% CI: 210-322) at the current date to 2,899 (95% CI: 2,264-3,533) by 2020-08-04.

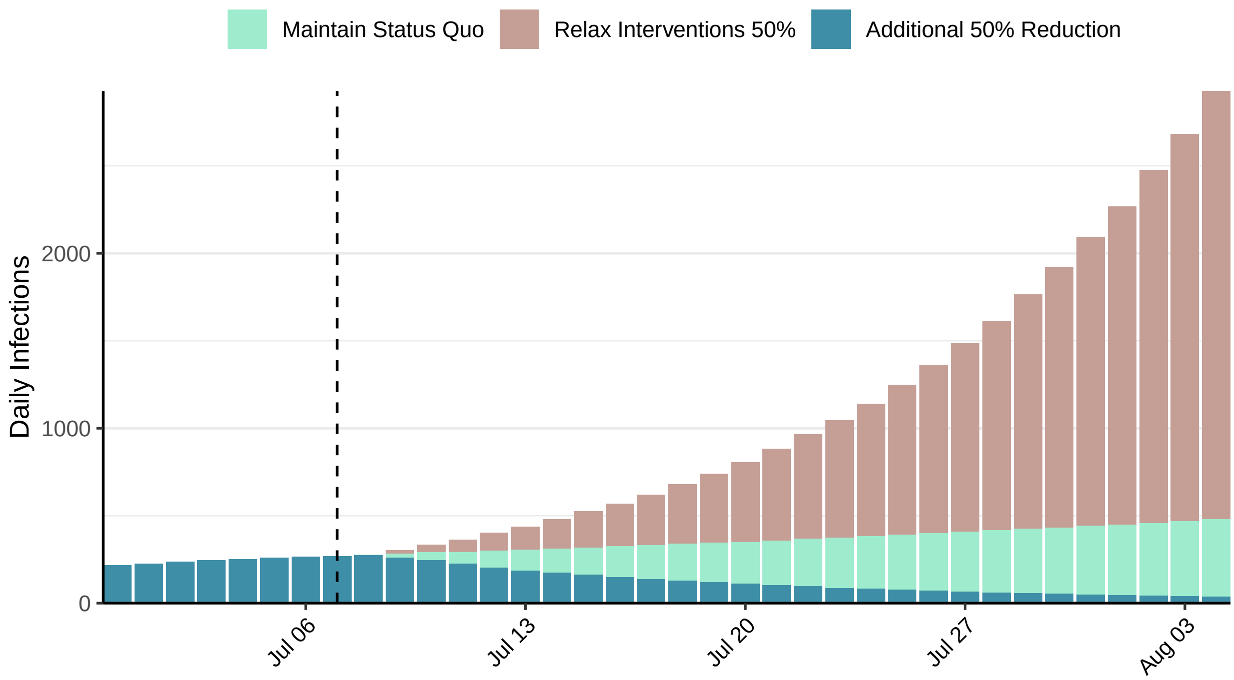

Figure 6: **Daily number of infections estimated by fitting to deaths.** Projected infections for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

To explore different scenarios, we recommend using our COVID-19 Scenario Analysis Tool - https://covidsim.org/, which can be used to simulate different intervention scenarios and explore the long term impact on healthcare demand.

Situation Report for COVID-19: Cuba, 2020-07-07

Download the report for Cuba, 2020-07-07 here. This report uses data from the European Centre for Disease Control. These data are updated daily and whilst there may be a short delay, they are generally consistent with Ministry reports. These data are then used to back-calculate an 'inferred number of COVID-19 infections' using mathematical modelling techniques (see Report 12 for further details) to estimate the number of people that have been infected and to make short-term projections for future healthcare needs.

Epidemiological Situation

Total Reported Cases	New Reported Cases	Total Reported Deaths	New Reported Deaths	Estimated R_t
2,380	8	86	0	0.82 (95% CI: 0.51-1.24)

The figure below shows the cumulative reported deaths as a function of the time since the 10th death was reported. Dashed lines show the expected trajectory for different doubling times of the epidemic. For example, with a doubling time of 3 days, if there are currently a total of 20 deaths reported, we would expect there to be 40 deaths in total reported in 3 days-time, 80 deaths in 6 days-time, 160 deaths in 9 days-time etc. For most epidemics, in the absence of interventions, we expect a doubling time of 3-4 days for this disease.

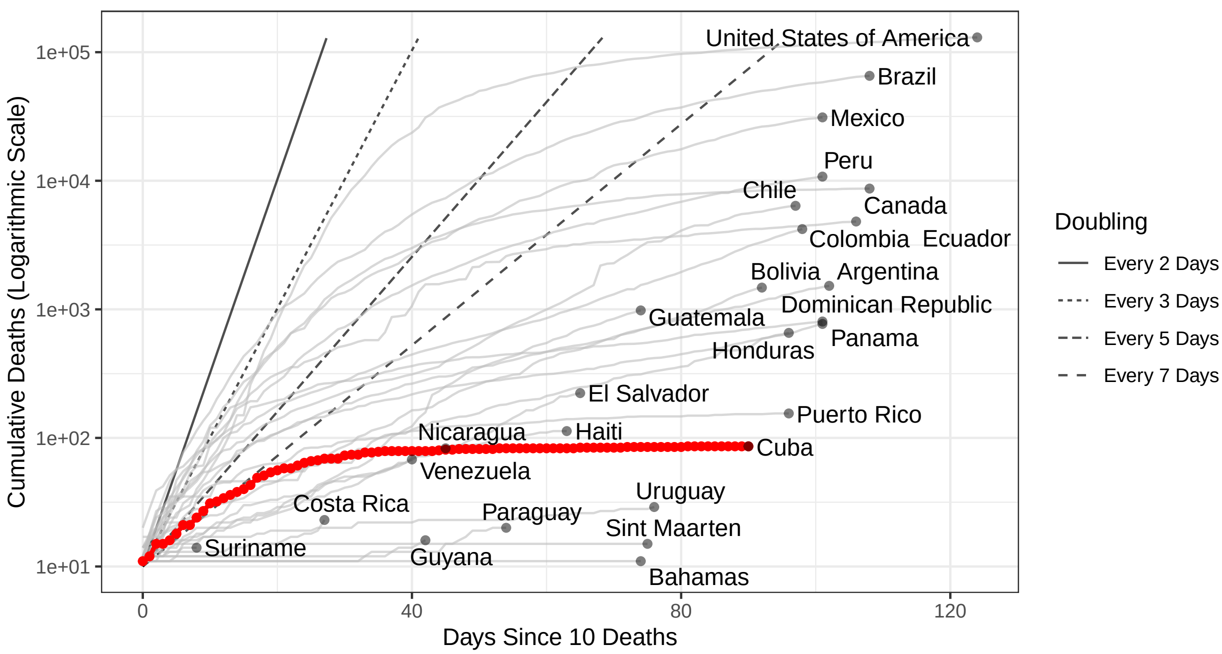

Figure 1: **Cumulative Deaths since 10 deaths.** Country not shown if fewer than 10 deaths.

COVID-19 Transmission Modelling

We assume that the deaths reported to date provide the best indication of the stage of the epidemic, as deaths are more consistently and accurately reported. Our current working estimate is that 1 death indicates that approximately 100 people will have been infected with the other 99 recovering (based on an infection fatality ratio of ~1%). These infections will have happened approximately 21 days previously – capturing a 5-day period from infection to onset of symptoms (the incubation period), 4 days from onset of symptoms to hospitalisation, and 12 days in hospital before death. With a 3-day doubling time, 100 infections that occurred 15 days ago will have generated 200 infections 12 days ago, 400 infections 9 days ago, 800 infections 6 days ago and 1,600 infections 3 days ago resulting in approximately 3,200 infections at the time the first death is observed.

To explore this, we fit our age-structured SEIR model (see Methods) to the time series of deaths in a country, in order to estimate the start date of the epidemic and the baseline R0. We assume that 100% of COVID-19 related deaths have been reported. We have also included the impact of interventions that have been put in place and their effect on human mobility and transmission based on the Google COVID-19 Community Mobility Reports. Using our mathematical model that formalises this approach, we estimate that there has been a total of 165 (95% CI: 125-204) infections over the past 4 weeks.

The figure below shows the estimated number of people infected over the past 4 weeks. The bar charts show, for comparison, the number of reported cases. The right-hand plot shows these data on a different scale as the estimated infections are likely to be much larger than the reported cases. **Importantly**, the estimated infections includes both asymptomatic and mild cases that would not necessarily be identified through surveillance. Consequently, the estimated infections are likely to be significantly higher than the reported cases (see our FAQ for further explanation of these differences and why the reported cases and estimated infections are unlikely to match).

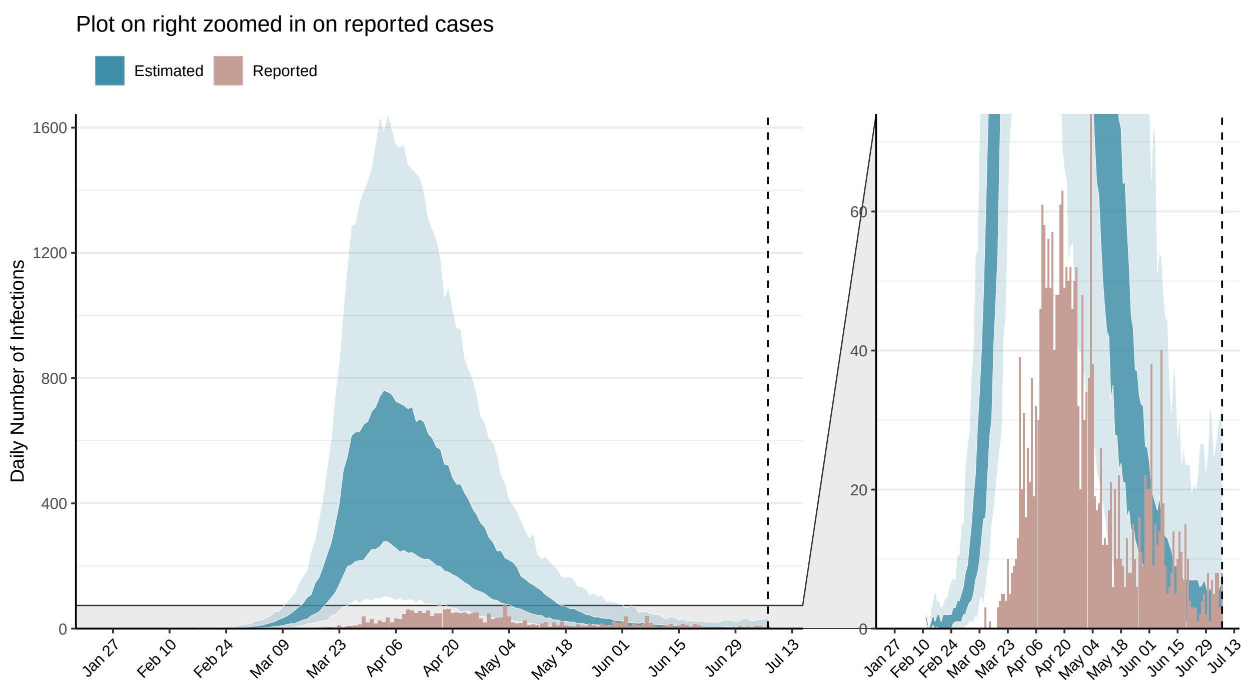

Figure 2: **Daily number of infections estimated by fitting to the current total of deaths.** Reported cases are shown in red. Model estimated infections are shown in blue (dark blue 50% interquartile range, light blue 95% quantile). The dashed line shows the current day.

By fitting to the time series of deaths, we are able to estimate a time-varying reproduction number, R_t. R_t is the the average number of secondary infections caused by a single infected person at a given time. If R_t is above 1, the rate of transmission is increasing and the number of new infections is increasing. R_t is assumed to change in relation to mobility fall in proportion. When fitting our model we assume that 100% of COVID-19 related deaths have been reported (please see our FAQ section for more information about this assumption). We also assume a fixed date at which the impact of mobility on transmission changes from pre-lockdown levels to post-lockdown levels, which may cause large changes in Rt. We are working to refine how this switch occurs and to formally calculate its shape.

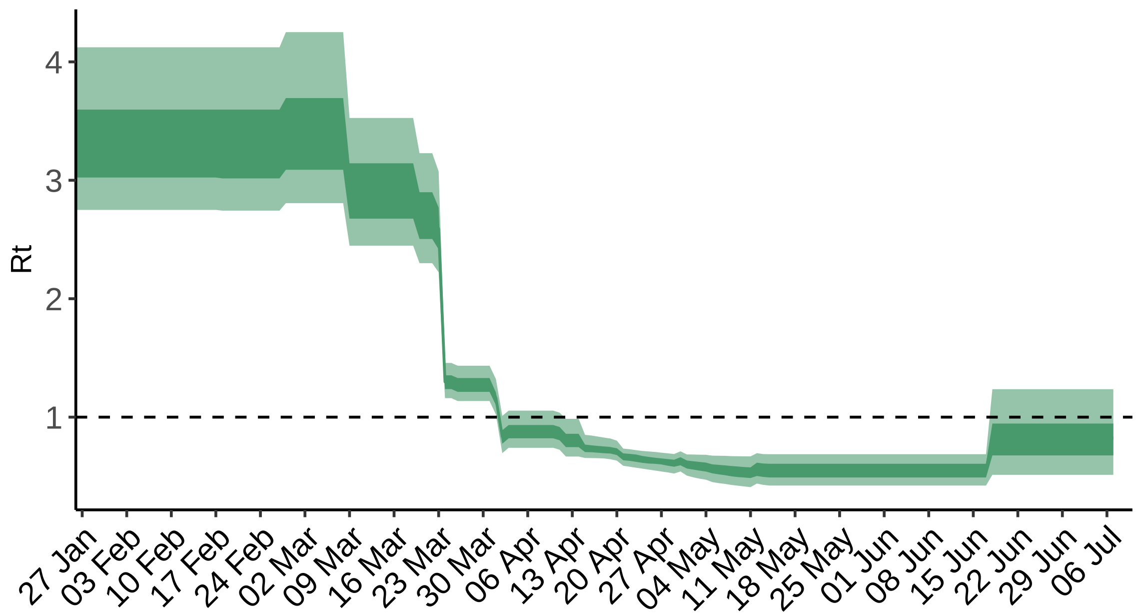

Figure 3: **Time-varying reproduction number, R_t.** R_t is the average number of secondary infections caused by a single infected person at time equal to t. $R_t < 1$ indicates a slowing epidemic in which new infections are not increasing. $R_t > 1$ indicates a growing epidemic in which new infections are increasing over time. Dark green shows the 50% CI and light green shows the 95% CI.

Using the model fit, we can forecast the expected trajectory for cumulative deaths, which is shown in the figure below. This assumes a severity pattern by age that is consistent with that observed in China, Europe and the U.S to date. This projection assumes that transmission is maintained at the current level of transmission as estimated by the final R_t value.

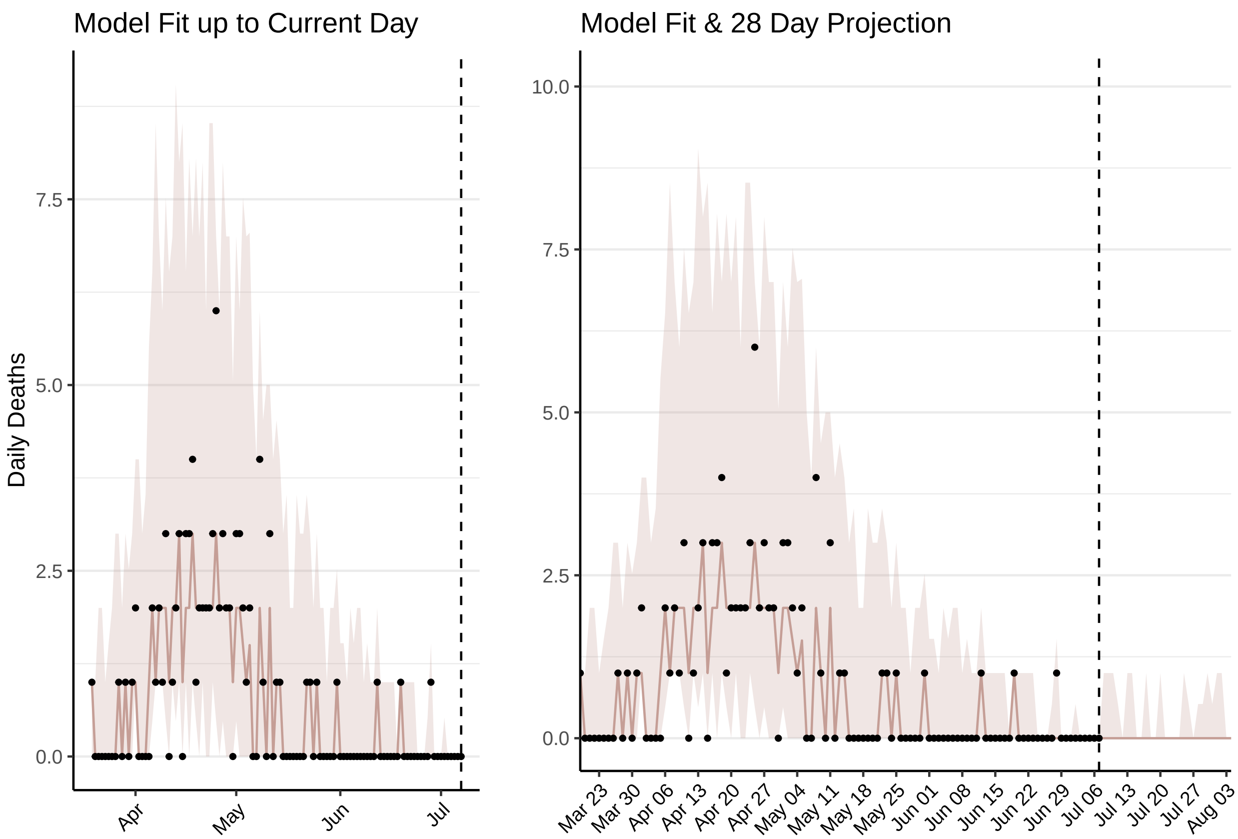

Figure 4: **Estimated daily deaths.** Projected deaths assuming the current level of interventions are maintained are shown in red (median and 95% quantile). Reported deaths are plotted in black. The plot on the left is focussed on the model fit prior to today, while the plot on the right forecasts the next 28 days.

Short-term Epidemic Scenarios

We make the following short-term projections of healthcare demand and new infections under the following three scenarios:

- **Scenario 1.** The epidemic continues to grow at the current rate.
- **Scenario 2.** Countries will further scale up interventions (either increasing current strategies or implementing new interventions) leading to a further 50% reduction in transmission.
- **Scenario 3.** Countries will relax current interventions by 50%

N.B. These scenarios currently assume that the impact of mobility on transmission will remain the same in the future as it has in the past. We are working to extend methods to estimate the impact of increases in mobility on transmission as lockdown and interventions are reversed. Consequently, projection are likely to represent an upper estimate of the healthcare demand and case load for each scenario

We estimate that over the next 4 weeks demand for hospital beds will change from 1 (95% CI: 1-2) patients requiring treatment with high-pressure oxygen at the current date to 1 (95% CI: 1-2) hospital beds being required on 2020-08-04 if no further interventions are introduced (Scenario 1). Similarly, we estimate that over the next 4 weeks demand for critical care (ICU) beds will change from 0 (95% CI: 0-1) patients requiring treatment with mechanical ventilation at the current date to 0 (95% CI: 0-1) by 2020-08-04. These projections assume that approximately 5% of all infections will require treatment with high-pressure oxygen and that approximately 30% of hospitalised cases will require treatment with mechanical ventilation (based on analysis of ongoing epidemics in Europe). **N.B. These scenarios are unlikely to show significant differences for the first week since there is a delay of approximately 10 days between infection and hospital admission. Consequently, the effectiveness of a change in policy is likely to be better captured by hospital admission data approximately 2 weeks after the policy change is implemented.**

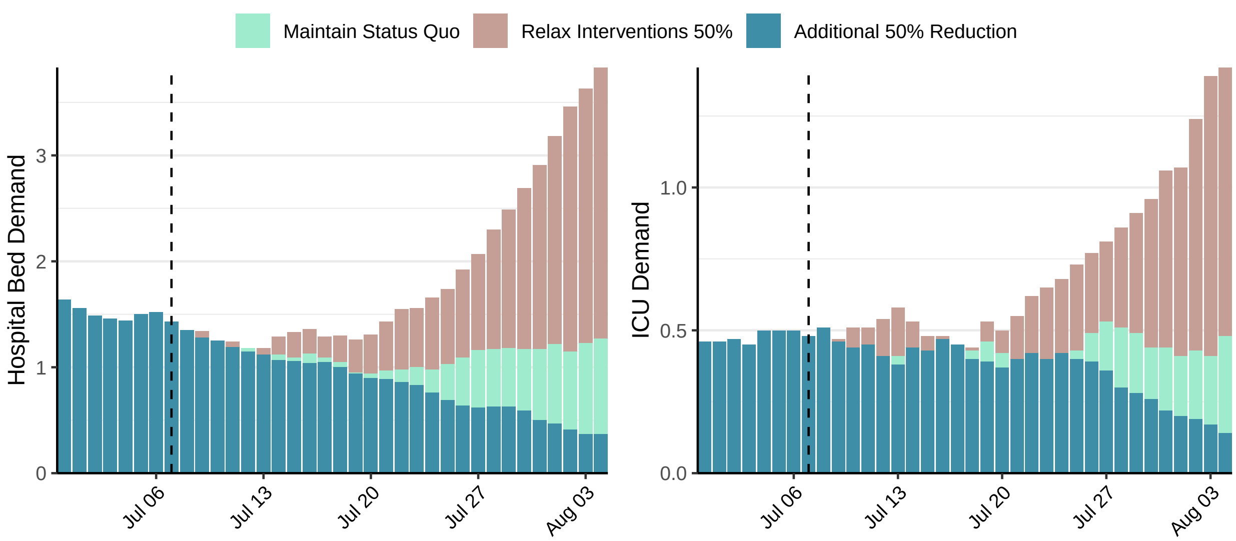

Figure 5: **Healthcare demands in the next 28 days.** Individuals needing an ICU bed are assumed to need mechanical ventilation. Projected demand for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

The impact of each scenario has a more immediate effect on the daily number of infections. The figure below shows the impact of each scenario on the estimated daily incidence of new infections. If interventions are scaled up (Scenario 2), the daily number of infections will change from 5 (95% CI: 4-7) at the current date to 1 (95% CI: 0-1) by 2020-08-04. If current interventions were relaxed by 50%, we estimate the daily number of infections will change from 5 (95% CI: 4-7) at the current date to 43 (95% CI: 17-69) by 2020-08-04.

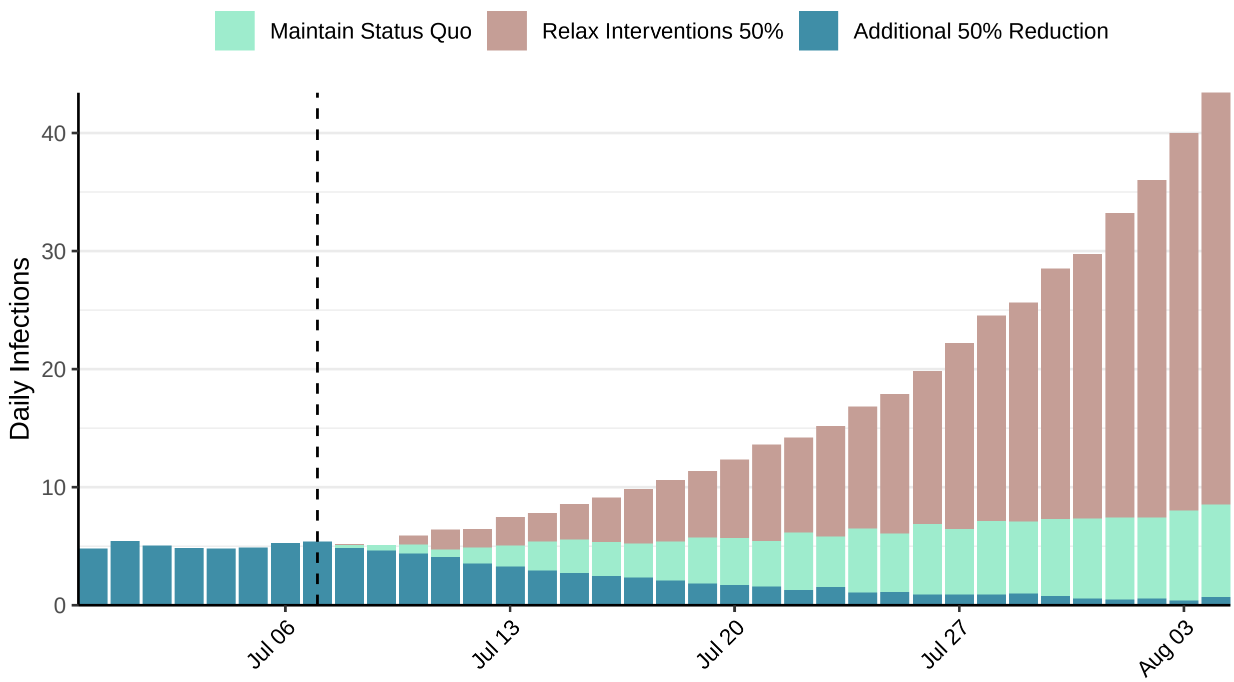

Figure 6: **Daily number of infections estimated by fitting to deaths.** Projected infections for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

To explore different scenarios, we recommend using our COVID-19 Scenario Analysis Tool - https://covidsim.org/, which can be used to simulate different intervention scenarios and explore the long term impact on healthcare demand.

Situation Report for COVID-19: Djibouti, 2020-07-07

Download the report for Djibouti, 2020-07-07 here. This report uses data from the European Centre for Disease Control. These data are updated daily and whilst there may be a short delay, they are generally consistent with Ministry reports. These data are then used to back-calculate an 'inferred number of COVID-19 infections' using mathematical modelling techniques (see Report 12 for further details) to estimate the number of people that have been infected and to make short-term projections for future healthcare needs.

Epidemiological Situation

Total Reported Cases	New Reported Cases	Total Reported Deaths	New Reported Deaths	Estimated R_t
4,822	30	55	0	1.15 (95% CI: 1.06-1.24)

The figure below shows the cumulative reported deaths as a function of the time since the 10th death was reported. Dashed lines show the expected trajectory for different doubling times of the epidemic. For example, with a doubling time of 3 days, if there are currently a total of 20 deaths reported, we would expect there to be 40 deaths in total reported in 3 days-time, 80 deaths in 6 days-time, 160 deaths in 9 days-time etc. For most epidemics, in the absence of interventions, we expect a doubling time of 3-4 days for this disease.

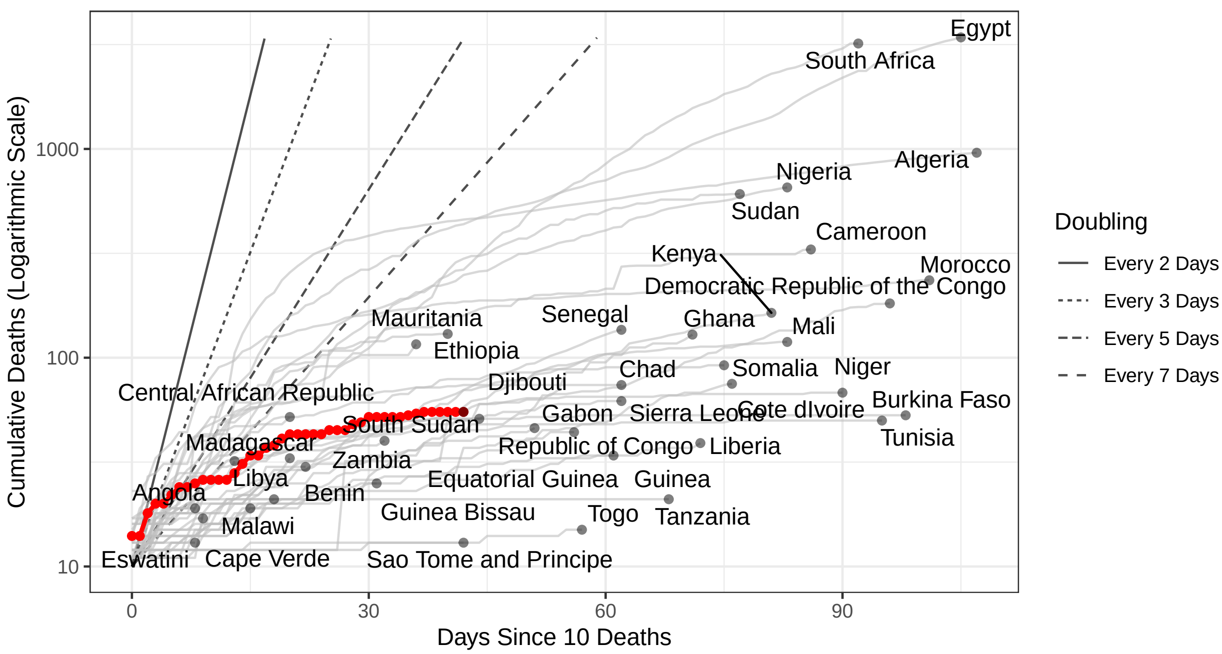

Figure 1: **Cumulative Deaths since 10 deaths.** Country not shown if fewer than 10 deaths.

COVID-19 Transmission Modelling

We assume that the deaths reported to date provide the best indication of the stage of the epidemic, as deaths are more consistently and accurately reported. Our current working estimate is that 1 death indicates that approximately 100 people will have been infected with the other 99 recovering (based on an infection fatality ratio of ~1%). These infections will have happened approximately 21 days previously – capturing a 5-day period from infection to onset of symptoms (the incubation period), 4 days from onset of symptoms to hospitalisation, and 12 days in hospital before death. With a 3-day doubling time, 100 infections that occurred 15 days ago will have generated 200 infections 12 days ago, 400 infections 9 days ago, 800 infections 6 days ago and 1,600 infections 3 days ago resulting in approximately 3,200 infections at the time the first death is observed.

To explore this, we fit our age-structured SEIR model (see Methods) to the time series of deaths in a country, in order to estimate the start date of the epidemic and the baseline R0. We assume that 100% of COVID-19 related deaths have been reported. We have also included the impact of interventions that have been put in place and their effect on human mobility and transmission based on the Google COVID-19 Community Mobility Reports. Using our mathematical model that formalises this approach, we estimate that there has been a total of 14,909 (95% CI: 13,133-16,685) infections over the past 4 weeks.

The figure below shows the estimated number of people infected over the past 4 weeks. The bar charts show, for comparison, the number of reported cases. The right-hand plot shows these data on a different scale as the estimated infections are likely to be much larger than the reported cases. **Importantly**, the estimated infections includes both asymptomatic and mild cases that would not necessarily be identified through surveillance. Consequently, the estimated infections are likely to be significantly higher than the reported cases (see our FAQ for further explanation of these differences and why the reported cases and estimated infections are unlikely to match).

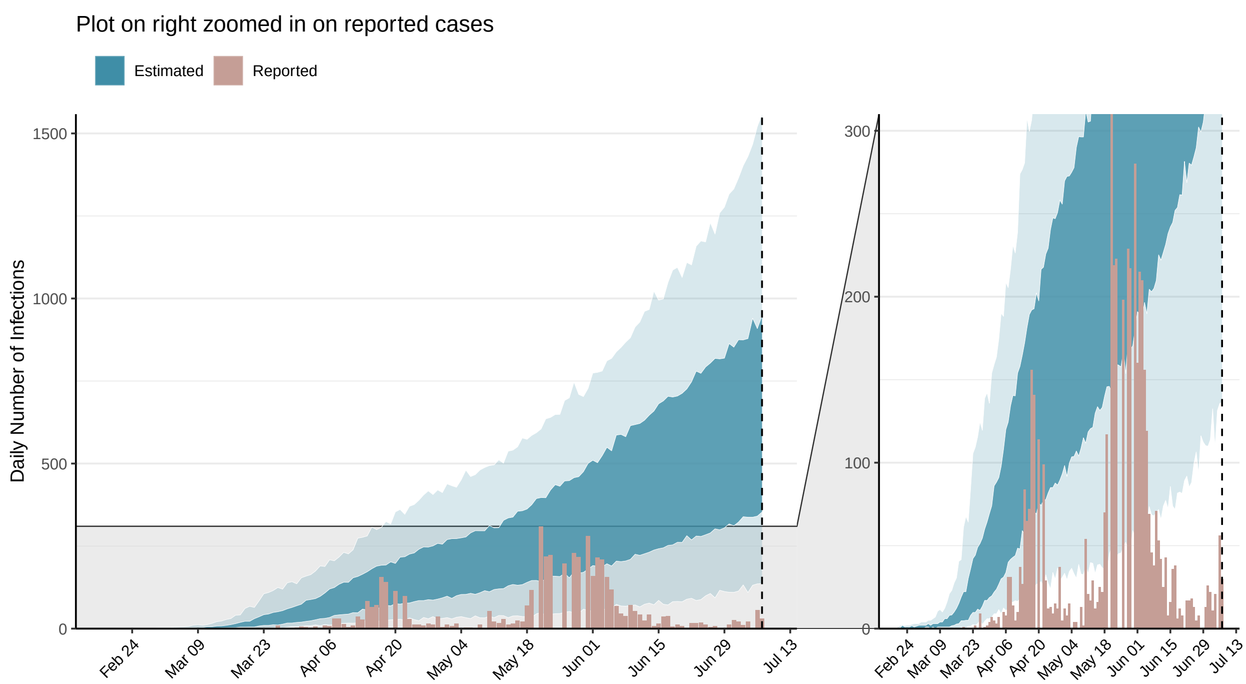

Figure 2: **Daily number of infections estimated by fitting to the current total of deaths.** Reported cases are shown in red. Model estimated infections are shown in blue (dark blue 50% interquartile range, light blue 95% quantile). The dashed line shows the current day.

By fitting to the time series of deaths, we are able to estimate a time-varying reproduction number, R_t. R_t is the the average number of secondary infections caused by a single infected person at a given time. If R_t is above 1, the rate of transmission is increasing and the number of new infections is increasing. R_t is assumed to change in relation to mobility fall in proportion. When fitting our model we assume that 100% of COVID-19 related deaths have been reported (please see our FAQ section for more information about this assumption). We also assume a fixed date at which the impact of mobility on transmission changes from pre-lockdown levels to post-lockdown levels, which may cause large changes in Rt. We are working to refine how this switch occurs and to formally calculate its shape.

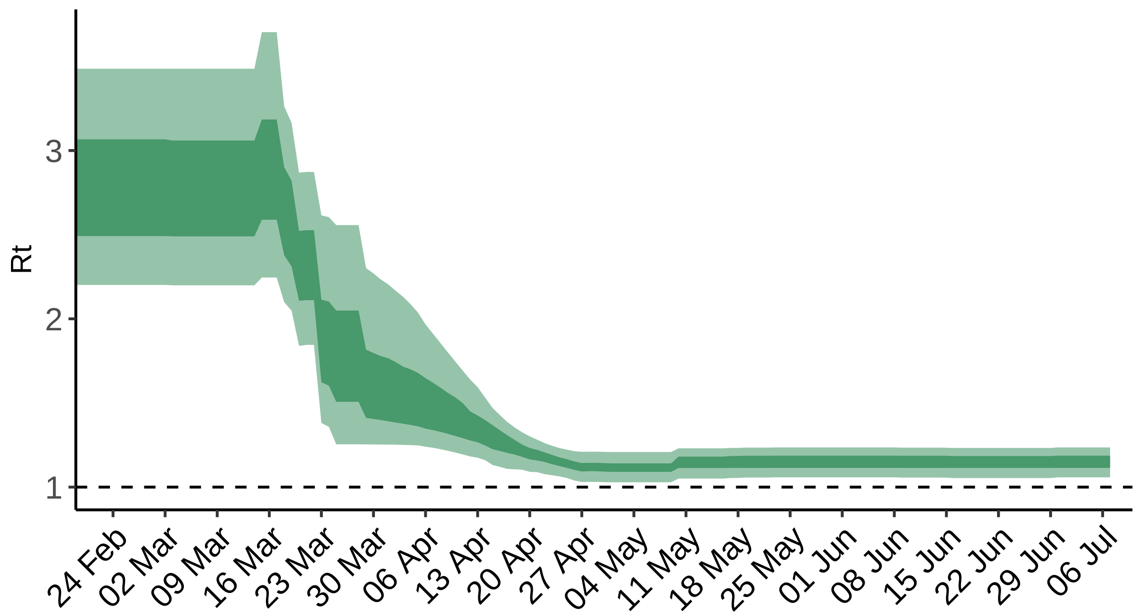

Figure 3: **Time-varying reproduction number, R_t.** R_t is the average number of secondary infections caused by a single infected person at time equal to t. $R_t < 1$ indicates a slowing epidemic in which new infections are not increasing. $R_t > 1$ indicates a growing epidemic in which new infections are increasing over time. Dark green shows the 50% CI and light green shows the 95% CI.

Using the model fit, we can forecast the expected trajectory for cumulative deaths, which is shown in the figure below. This assumes a severity pattern by age that is consistent with that observed in China, Europe and the U.S to date. This projection assumes that transmission is maintained at the current level of transmission as estimated by the final R_t value.

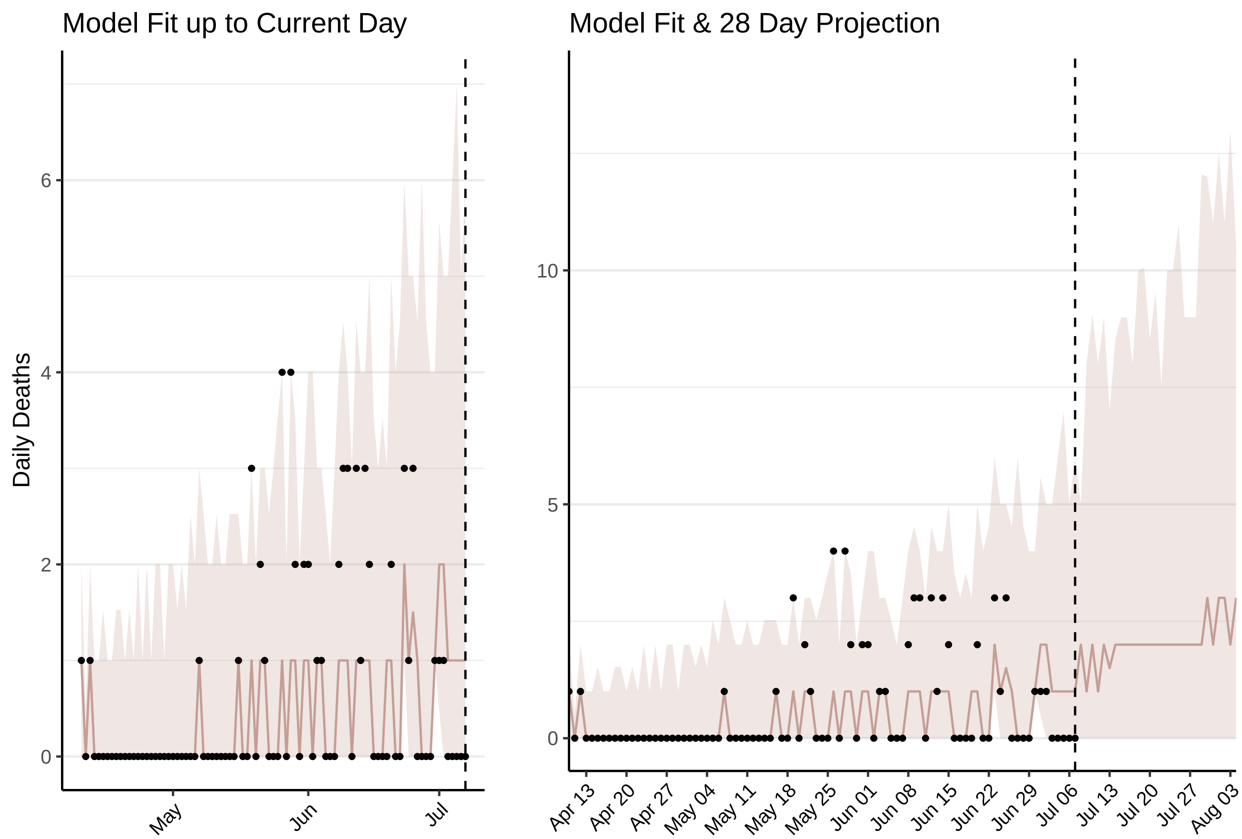

Figure 4: **Estimated daily deaths.** Projected deaths assuming the current level of interventions are maintained are shown in red (median and 95% quantile). Reported deaths are plotted in black. The plot on the left is focussed on the model fit prior to today, while the plot on the right forecasts the next 28 days.

Short-term Epidemic Scenarios

We make the following short-term projections of healthcare demand and new infections under the following three scenarios:

- **Scenario 1.** The epidemic continues to grow at the current rate.
- **Scenario 2.** Countries will further scale up interventions (either increasing current strategies or implementing new interventions) leading to a further 50% reduction in transmission.
- **Scenario 3.** Countries will relax current interventions by 50%

N.B. These scenarios currently assume that the impact of mobility on transmission will remain the same in the future as it has in the past. We are working to extend methods to estimate the impact of increases in mobility on transmission as lockdown and interventions are reversed. Consequently, projection are likely to represent an upper estimate of the healthcare demand and case load for each scenario

We estimate that over the next 4 weeks demand for hospital beds will change from 98 (95% CI: 86-110) patients requiring treatment with high-pressure oxygen at the current date to 152 (95% CI: 134-171) hospital beds being required on 2020-08-04 if no further interventions are introduced (Scenario 1). Similarly, we estimate that over the next 4 weeks demand for critical care (ICU) beds will change from 26 (95% CI: 23-29) patients requiring treatment with mechanical ventilation at the current date to 35 (95% CI: 32-39) by 2020-08-04. These projections assume that approximately 5% of all infections will require treatment with high-pressure oxygen and that approximately 30% of hospitalised cases will require treatment with mechanical ventilation (based on analysis of ongoing epidemics in Europe). **N.B. These scenarios are unlikely to show significant differences for the first week since there is a delay of approximately 10 days between infection and hospital admission. Consequently, the effectiveness of a change in policy is likely to be better captured by hospital admission data approximately 2 weeks after the policy change is implemented.**

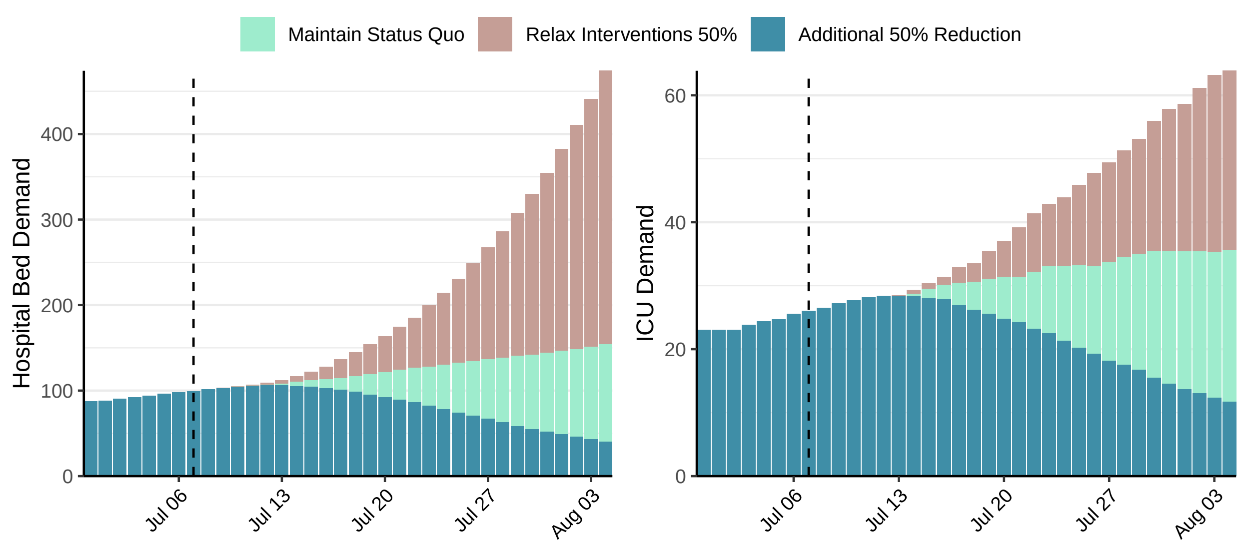

Figure 5: **Healthcare demands in the next 28 days.** Individuals needing an ICU bed are assumed to need mechanical ventilation. Projected demand for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

The impact of each scenario has a more immediate effect on the daily number of infections. The figure below shows the impact of each scenario on the estimated daily incidence of new infections. If interventions are scaled up (Scenario 2), the daily number of infections will change from 669 (95% CI: 587-751) at the current date to 80 (95% CI: 70-90) by 2020-08-04. If current interventions were relaxed by 50%, we estimate the daily number of infections will change from 669 (95% CI: 587-751) at the current date to 5,287 (95% CI: 4,717-5,857) by 2020-08-04.

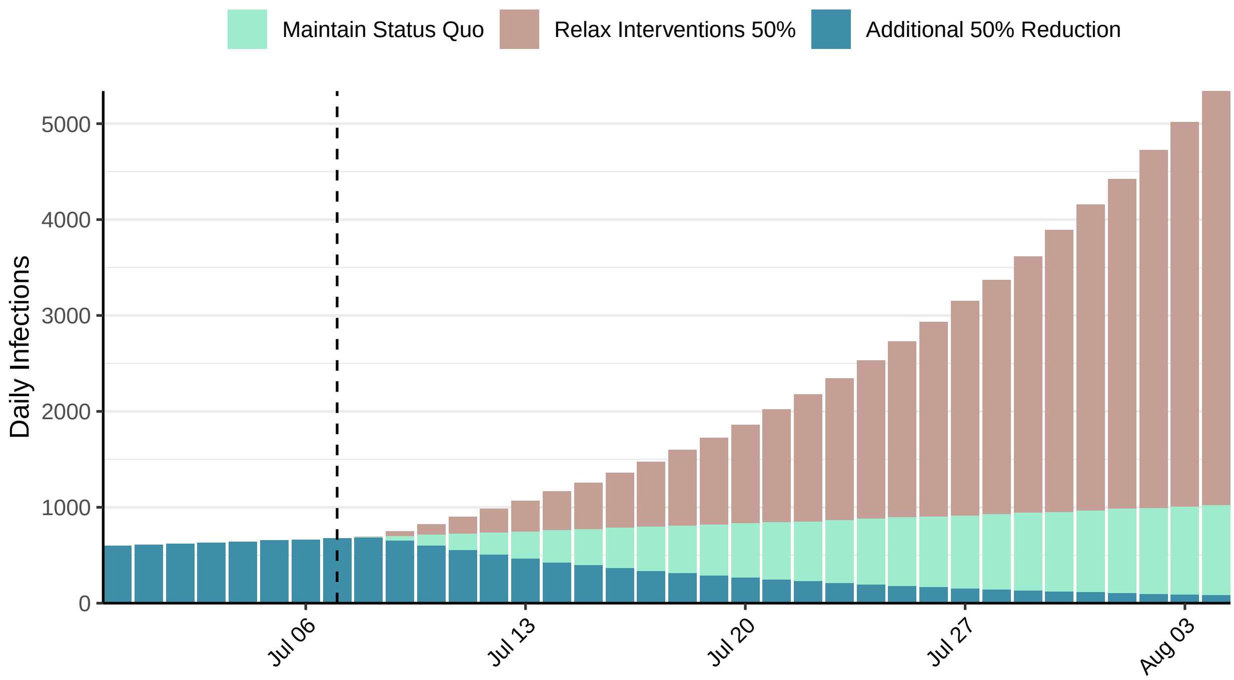

Figure 6: **Daily number of infections estimated by fitting to deaths.** Projected infections for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

To explore different scenarios, we recommend using our COVID-19 Scenario Analysis Tool - https://covidsim.org/, which can be used to simulate different intervention scenarios and explore the long term impact on healthcare demand.

Situation Report for COVID-19: Dominican Republic, 2020-07-07

Download the report for Dominican Republic, 2020-07-07 here. This report uses data from the European Centre for Disease Control. These data are updated daily and whilst there may be a short delay, they are generally consistent with Ministry reports. These data are then used to back-calculate an 'inferred number of COVID-19 infections' using mathematical modelling techniques (see Report 12 for further details) to estimate the number of people that have been infected and to make short-term projections for future healthcare needs.

Epidemiological Situation

Total Reported Cases	New Reported Cases	Total Reported Deaths	New Reported Deaths	Estimated R_t
38,128	703	804	10	1.35 (95% CI: 1.21-1.52)

The figure below shows the cumulative reported deaths as a function of the time since the 10th death was reported. Dashed lines show the expected trajectory for different doubling times of the epidemic. For example, with a doubling time of 3 days, if there are currently a total of 20 deaths reported, we would expect there to be 40 deaths in total reported in 3 days-time, 80 deaths in 6 days-time, 160 deaths in 9 days-time etc. For most epidemics, in the absence of interventions, we expect a doubling time of 3-4 days for this disease.

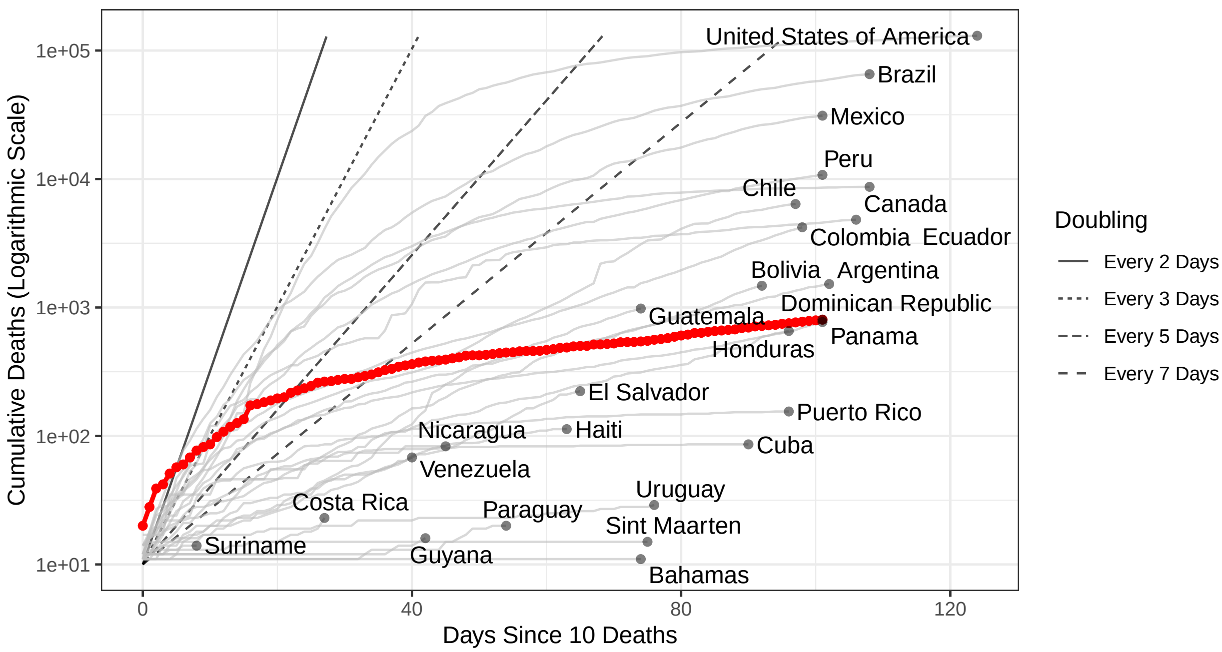

Figure 1: **Cumulative Deaths since 10 deaths.** Country not shown if fewer than 10 deaths.

COVID-19 Transmission Modelling

We assume that the deaths reported to date provide the best indication of the stage of the epidemic, as deaths are more consistently and accurately reported. Our current working estimate is that 1 death indicates that approximately 100 people will have been infected with the other 99 recovering (based on an infection fatality ratio of ~1%). These infections will have happened approximately 21 days previously – capturing a 5-day period from infection to onset of symptoms (the incubation period), 4 days from onset of symptoms to hospitalisation, and 12 days in hospital before death. With a 3-day doubling time, 100 infections that occurred 15 days ago will have generated 200 infections 12 days ago, 400 infections 9 days ago, 800 infections 6 days ago and 1,600 infections 3 days ago resulting in approximately 3,200 infections at the time the first death is observed.

To explore this, we fit our age-structured SEIR model (see Methods) to the time series of deaths in a country, in order to estimate the start date of the epidemic and the baseline R0. We assume that 100% of COVID-19 related deaths have been reported. We have also included the impact of interventions that have been put in place and their effect on human mobility and transmission based on the Google COVID-19 Community Mobility Reports. Using our mathematical model that formalises this approach, we estimate that there has been a total of 140,962 (95% CI: 131,898-150,025) infections over the past 4 weeks.

The figure below shows the estimated number of people infected over the past 4 weeks. The bar charts show, for comparison, the number of reported cases. The right-hand plot shows these data on a different scale as the estimated infections are likely to be much larger than the reported cases. **Importantly**, the estimated infections includes both asymptomatic and mild cases that would not necessarily be identified through surveillance. Consequently, the estimated infections are likely to be significantly higher than the reported cases (see our FAQ for further explanation of these differences and why the reported cases and estimated infections are unlikely to match).

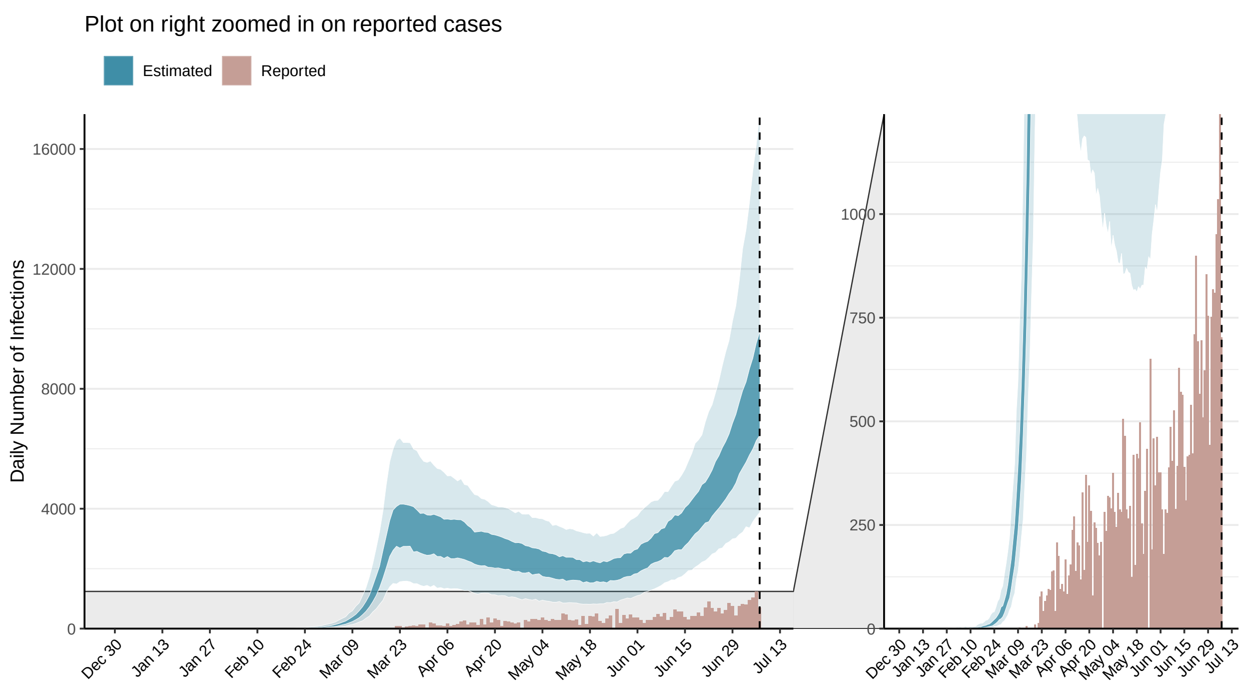

Figure 2: **Daily number of infections estimated by fitting to the current total of deaths.** Reported cases are shown in red. Model estimated infections are shown in blue (dark blue 50% interquartile range, light blue 95% quantile). The dashed line shows the current day.

By fitting to the time series of deaths, we are able to estimate a time-varying reproduction number, R_t. R_t is the the average number of secondary infections caused by a single infected person at a given time. If R_t is above 1, the rate of transmission is increasing and the number of new infections is increasing. R_t is assumed to change in relation to mobility fall in proportion. When fitting our model we assume that 100% of COVID-19 related deaths have been reported (please see our FAQ section for more information about this assumption). We also assume a fixed date at which the impact of mobility on transmission changes from pre-lockdown levels to post-lockdown levels, which may cause large changes in Rt. We are working to refine how this switch occurs and to formally calculate its shape.

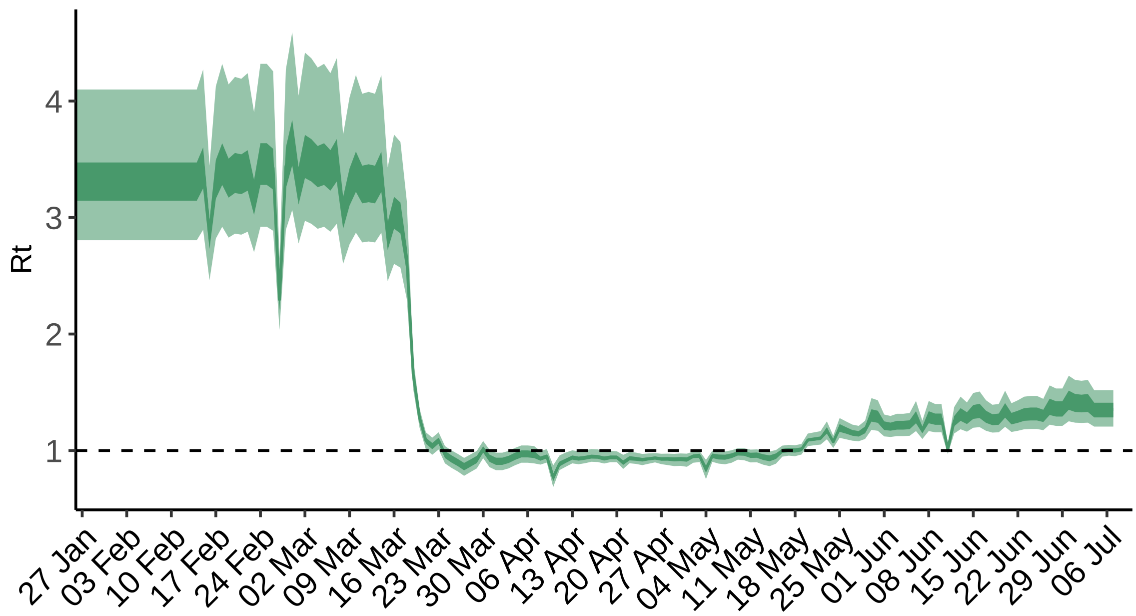

Figure 3: **Time-varying reproduction number, R_t.** R_t is the average number of secondary infections caused by a single infected person at time equal to t. $R_t < 1$ indicates a slowing epidemic in which new infections are not increasing. $R_t > 1$ indicates a growing epidemic in which new infections are increasing over time. Dark green shows the 50% CI and light green shows the 95% CI.

Using the model fit, we can forecast the expected trajectory for cumulative deaths, which is shown in the figure below. This assumes a severity pattern by age that is consistent with that observed in China, Europe and the U.S to date. This projection assumes that transmission is maintained at the current level of transmission as estimated by the final R_t value.

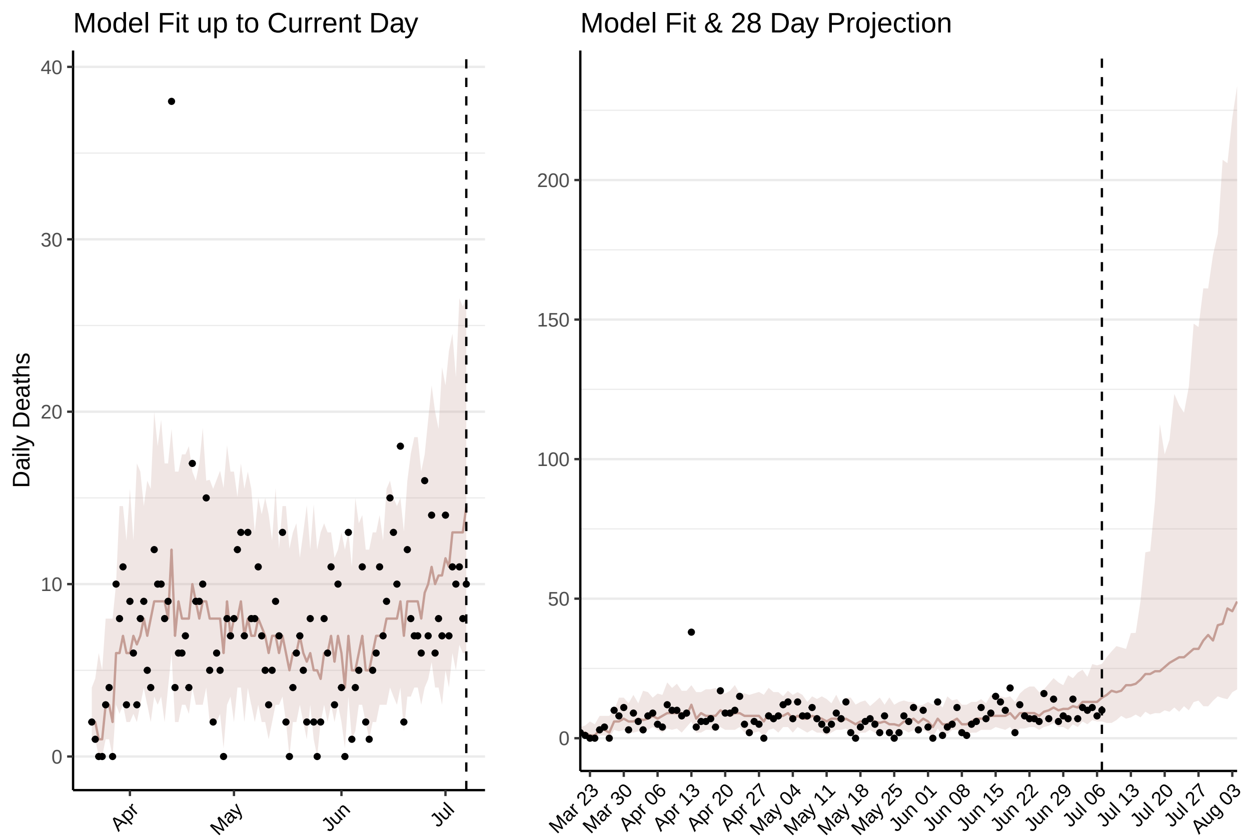

Figure 4: **Estimated daily deaths.** Projected deaths assuming the current level of interventions are maintained are shown in red (median and 95% quantile). Reported deaths are plotted in black. The plot on the left is focussed on the model fit prior to today, while the plot on the right forecasts the next 28 days.

Short-term Epidemic Scenarios

We make the following short-term projections of healthcare demand and new infections under the following three scenarios:

- **Scenario 1.** The epidemic continues to grow at the current rate.
- **Scenario 2.** Countries will further scale up interventions (either increasing current strategies or implementing new interventions) leading to a further 50% reduction in transmission.
- **Scenario 3.** Countries will relax current interventions by 50%

N.B. These scenarios currently assume that the impact of mobility on transmission will remain the same in the future as it has in the past. We are working to extend methods to estimate the impact of increases in mobility on transmission as lockdown and interventions are reversed. Consequently, projection are likely to represent an upper estimate of the healthcare demand and case load for each scenario

We estimate that over the next 4 weeks demand for hospital beds will change from 785 (95% CI: 732-838) patients requiring treatment with high-pressure oxygen at the current date to 2,487 (95% CI: 2,240-2,734) hospital beds being required on 2020-08-04 if no further interventions are introduced (Scenario 1). Similarly, we estimate that over the next 4 weeks demand for critical care (ICU) beds will change from 238 (95% CI: 222-254) patients requiring treatment with mechanical ventilation at the current date to 615 (95% CI: 580-649) by 2020-08-04. These projections assume that approximately 5% of all infections will require treatment with high-pressure oxygen and that approximately 30% of hospitalised cases will require treatment with mechanical ventilation (based on analysis of ongoing epidemics in Europe). **N.B. These scenarios are unlikely to show significant differences for the first week since there is a delay of approximately 10 days between infection and hospital admission. Consequently, the effectiveness of a change in policy is likely to be better captured by hospital admission data approximately 2 weeks after the policy change is implemented.**

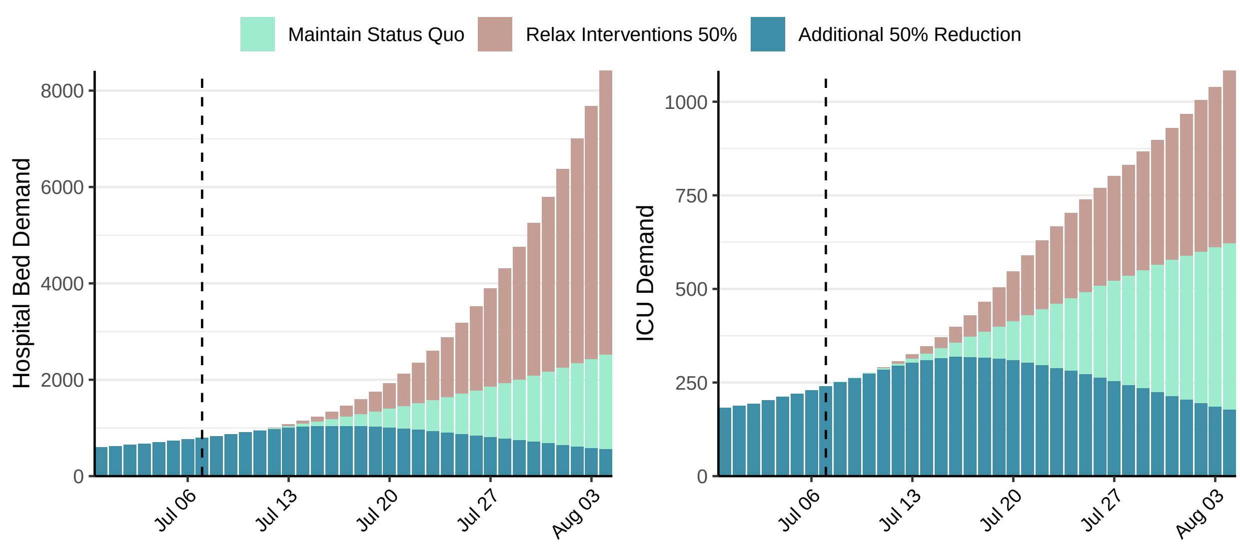

Figure 5: **Healthcare demands in the next 28 days.** Individuals needing an ICU bed are assumed to need mechanical ventilation. Projected demand for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

The impact of each scenario has a more immediate effect on the daily number of infections. The figure below shows the impact of each scenario on the estimated daily incidence of new infections. If interventions are scaled up (Scenario 2), the daily number of infections will change from 8,444 (95% CI: 7,786-9,102) at the current date to 1,780 (95% CI: 1,587-1,972) by 2020-08-04. If current interventions were relaxed by 50%, we estimate the daily number of infections will change from 8,444 (95% CI: 7,786-9,102) at the current date to 115,966 (95% CI: 106,564-125,367) by 2020-08-04.

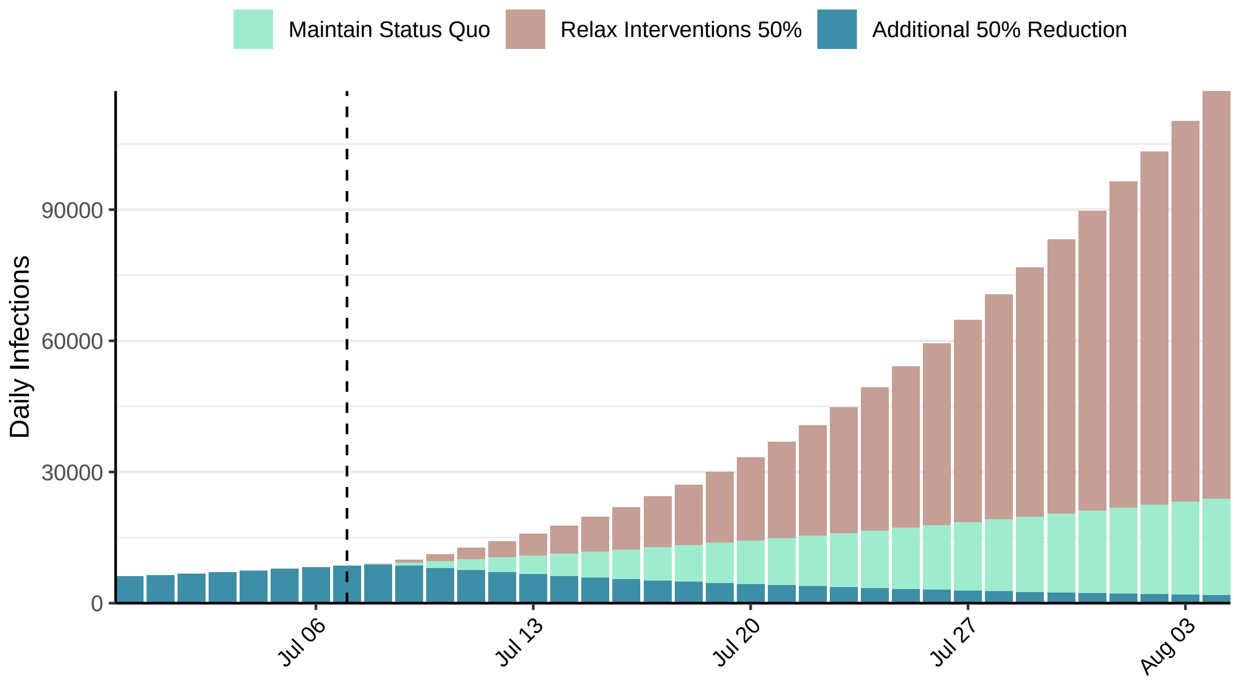

Figure 6: **Daily number of infections estimated by fitting to deaths.** Projected infections for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

To explore different scenarios, we recommend using our COVID-19 Scenario Analysis Tool - https://covidsim.org/, which can be used to simulate different intervention scenarios and explore the long term impact on healthcare demand.

Situation Report for COVID-19: Algeria, 2020-07-07

Download the report for Algeria, 2020-07-07 here. This report uses data from the European Centre for Disease Control. These data are updated daily and whilst there may be a short delay, they are generally consistent with Ministry reports. These data are then used to back-calculate an 'inferred number of COVID-19 infections' using mathematical modelling techniques (see Report 12 for further details) to estimate the number of people that have been infected and to make short-term projections for future healthcare needs.

Epidemiological Situation

Total Reported Cases	New Reported Cases	Total Reported Deaths	New Reported Deaths	Estimated R_t
16,404	463	959	7	1.27 (95% CI: 1.17-1.39)

The figure below shows the cumulative reported deaths as a function of the time since the 10th death was reported. Dashed lines show the expected trajectory for different doubling times of the epidemic. For example, with a doubling time of 3 days, if there are currently a total of 20 deaths reported, we would expect there to be 40 deaths in total reported in 3 days-time, 80 deaths in 6 days-time, 160 deaths in 9 days-time etc. For most epidemics, in the absence of interventions, we expect a doubling time of 3-4 days for this disease.

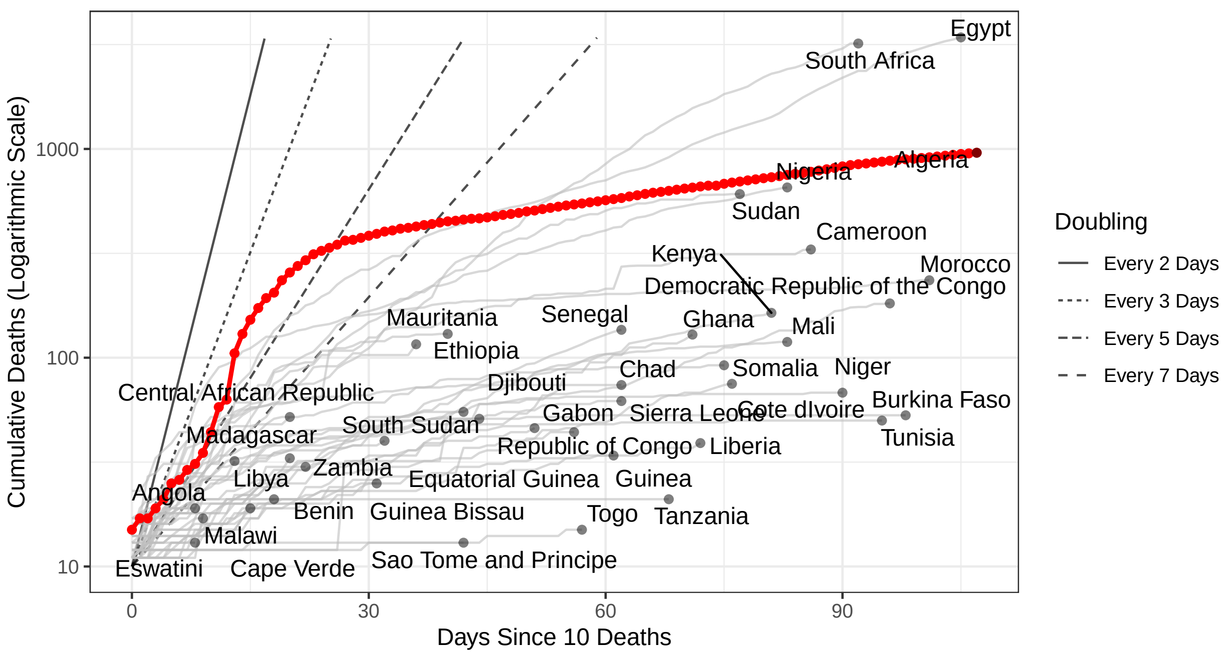

Figure 1: **Cumulative Deaths since 10 deaths.** Country not shown if fewer than 10 deaths.

COVID-19 Transmission Modelling

We assume that the deaths reported to date provide the best indication of the stage of the epidemic, as deaths are more consistently and accurately reported. Our current working estimate is that 1 death indicates that approximately 100 people will have been infected with the other 99 recovering (based on an infection fatality ratio of ~1%). These infections will have happened approximately 21 days previously – capturing a 5-day period from infection to onset of symptoms (the incubation period), 4 days from onset of symptoms to hospitalisation, and 12 days in hospital before death. With a 3-day doubling time, 100 infections that occurred 15 days ago will have generated 200 infections 12 days ago, 400 infections 9 days ago, 800 infections 6 days ago and 1,600 infections 3 days ago resulting in approximately 3,200 infections at the time the first death is observed.

To explore this, we fit our age-structured SEIR model (see Methods) to the time series of deaths in a country, in order to estimate the start date of the epidemic and the baseline R0. We assume that 100% of COVID-19 related deaths have been reported. We have also included the impact of interventions that have been put in place and their effect on human mobility and transmission based on the Google COVID-19 Community Mobility Reports. Using our mathematical model that formalises this approach, we estimate that there has been a total of 121,714 (95% CI: 110,566-132,862) infections over the past 4 weeks.

The figure below shows the estimated number of people infected over the past 4 weeks. The bar charts show, for comparison, the number of reported cases. The right-hand plot shows these data on a different scale as the estimated infections are likely to be much larger than the reported cases. **Importantly**, the estimated infections includes both asymptomatic and mild cases that would not necessarily be identified through surveillance. Consequently, the estimated infections are likely to be significantly higher than the reported cases (see our FAQ for further explanation of these differences and why the reported cases and estimated infections are unlikely to match).

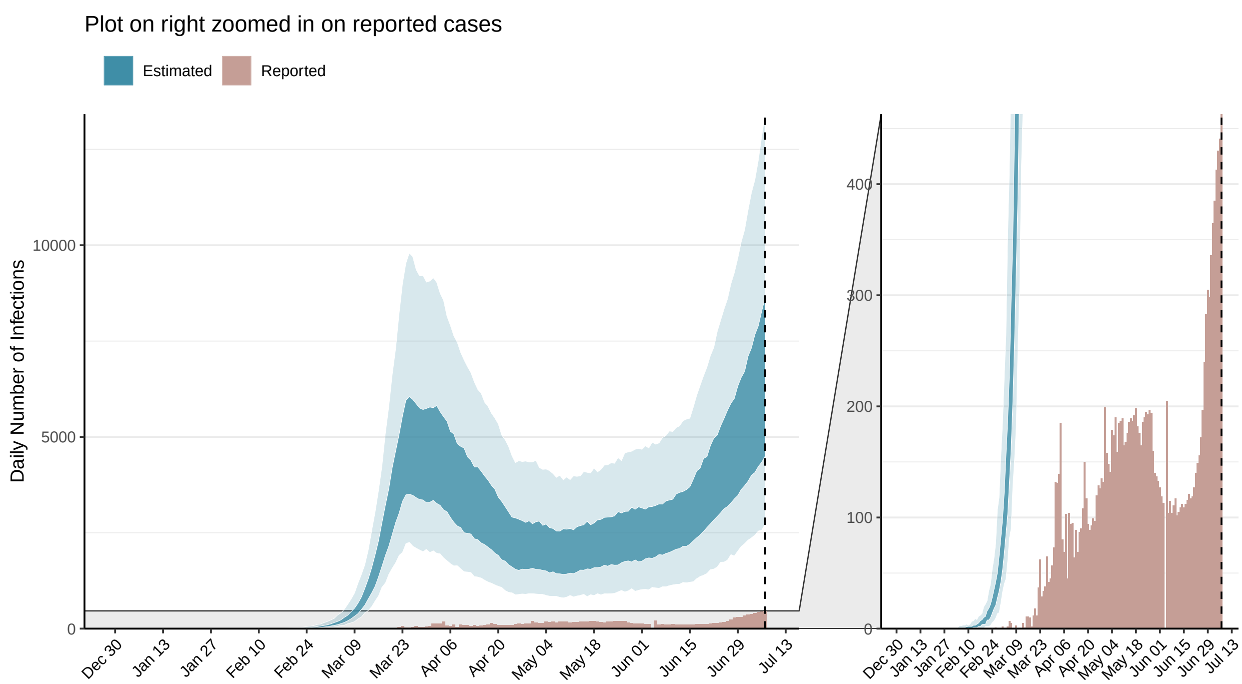

Figure 2: **Daily number of infections estimated by fitting to the current total of deaths.** Reported cases are shown in red. Model estimated infections are shown in blue (dark blue 50% interquartile range, light blue 95% quantile). The dashed line shows the current day.

By fitting to the time series of deaths, we are able to estimate a time-varying reproduction number, R_t. R_t is the the average number of secondary infections caused by a single infected person at a given time. If R_t is above 1, the rate of transmission is increasing and the number of new infections is increasing. R_t is assumed to change in relation to mobility fall in proportion. When fitting our model we assume that 100% of COVID-19 related deaths have been reported (please see our FAQ section for more information about this assumption). We also assume a fixed date at which the impact of mobility on transmission changes from pre-lockdown levels to post-lockdown levels, which may cause large changes in Rt. We are working to refine how this switch occurs and to formally calculate its shape.

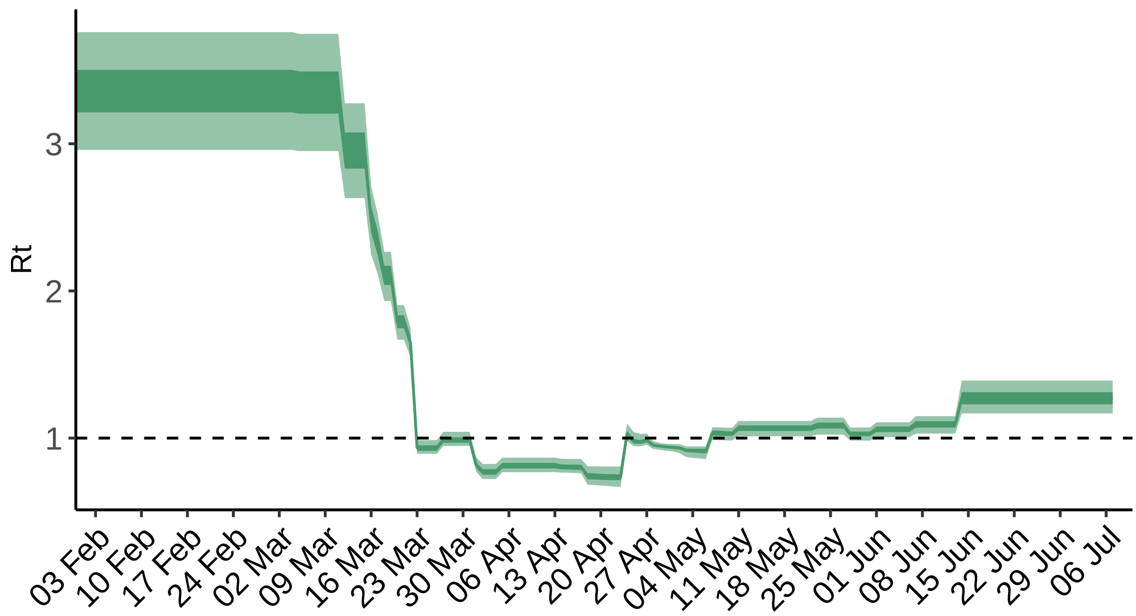

Figure 3: **Time-varying reproduction number, R_t.** R_t is the average number of secondary infections caused by a single infected person at time equal to t. $R_t < 1$ indicates a slowing epidemic in which new infections are not increasing. $R_t > 1$ indicates a growing epidemic in which new infections are increasing over time. Dark green shows the 50% CI and light green shows the 95% CI.

Using the model fit, we can forecast the expected trajectory for cumulative deaths, which is shown in the figure below. This assumes a severity pattern by age that is consistent with that observed in China, Europe and the U.S to date. This projection assumes that transmission is maintained at the current level of transmission as estimated by the final R_t value.

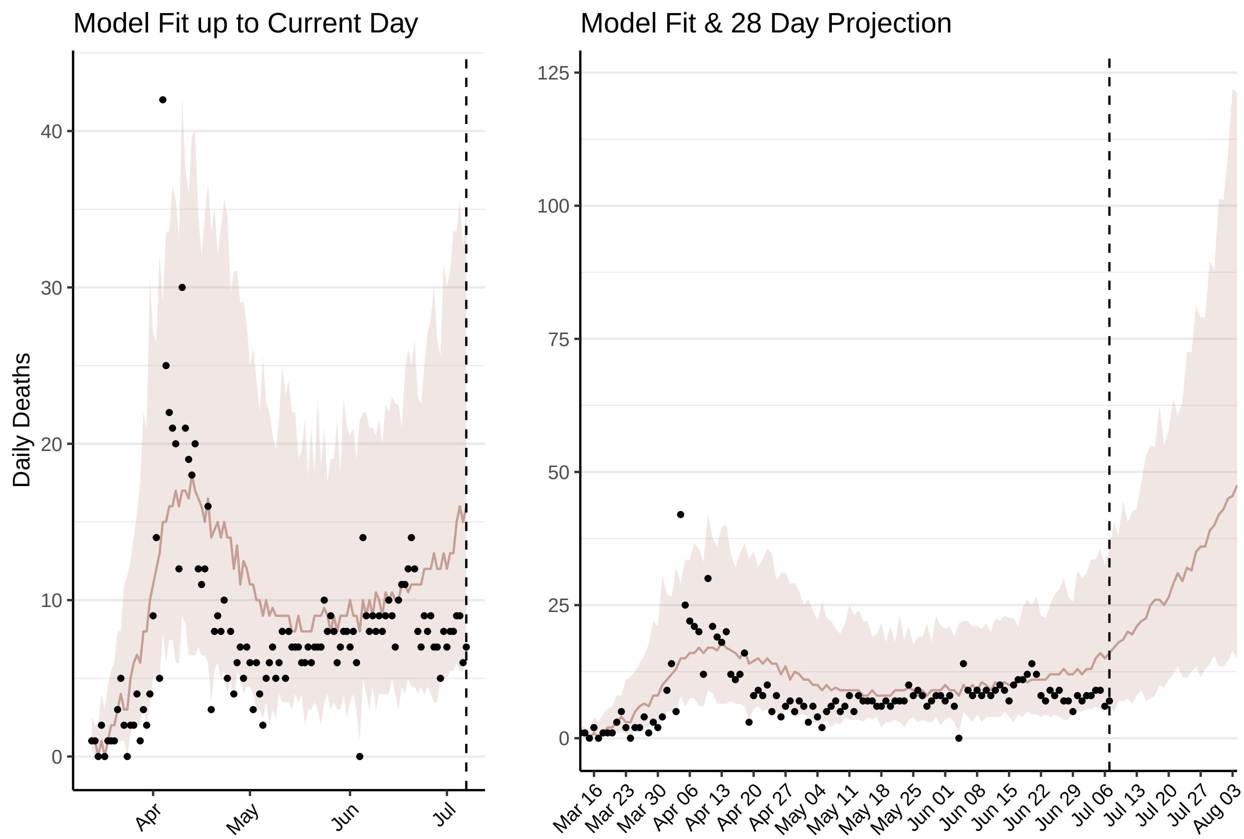

Figure 4: **Estimated daily deaths.** Projected deaths assuming the current level of interventions are maintained are shown in red (median and 95% quantile). Reported deaths are plotted in black. The plot on the left is focussed on the model fit prior to today, while the plot on the right forecasts the next 28 days.

Short-term Epidemic Scenarios

We make the following short-term projections of healthcare demand and new infections under the following three scenarios:

- **Scenario 1.** The epidemic continues to grow at the current rate.
- **Scenario 2.** Countries will further scale up interventions (either increasing current strategies or implementing new interventions) leading to a further 50% reduction in transmission.
- **Scenario 3.** Countries will relax current interventions by 50%

N.B. These scenarios currently assume that the impact of mobility on transmission will remain the same in the future as it has in the past. We are working to extend methods to estimate the impact of increases in mobility on transmission as lockdown and interventions are reversed. Consequently, projection are likely to represent an upper estimate of the healthcare demand and case load for each scenario

We estimate that over the next 4 weeks demand for hospital beds will change from 1,062 (95% CI: 963-1,161) patients requiring treatment with high-pressure oxygen at the current date to 3,008 (95% CI: 2,678-3,338) hospital beds being required on 2020-08-04 if no further interventions are introduced (Scenario 1). Similarly, we estimate that over the next 4 weeks demand for critical care (ICU) beds will change from 285 (95% CI: 258-312) patients requiring treatment with mechanical ventilation at the current date to 808 (95% CI: 720-896) by 2020-08-04. These projections assume that approximately 5% of all infections will require treatment with high-pressure oxygen and that approximately 30% of hospitalised cases will require treatment with mechanical ventilation (based on analysis of ongoing epidemics in Europe). **N.B. These scenarios are unlikely to show significant differences for the first week since there is a delay of approximately 10 days between infection and hospital admission. Consequently, the effectiveness of a change in policy is likely to be better captured by hospital admission data approximately 2 weeks after the policy change is implemented.**

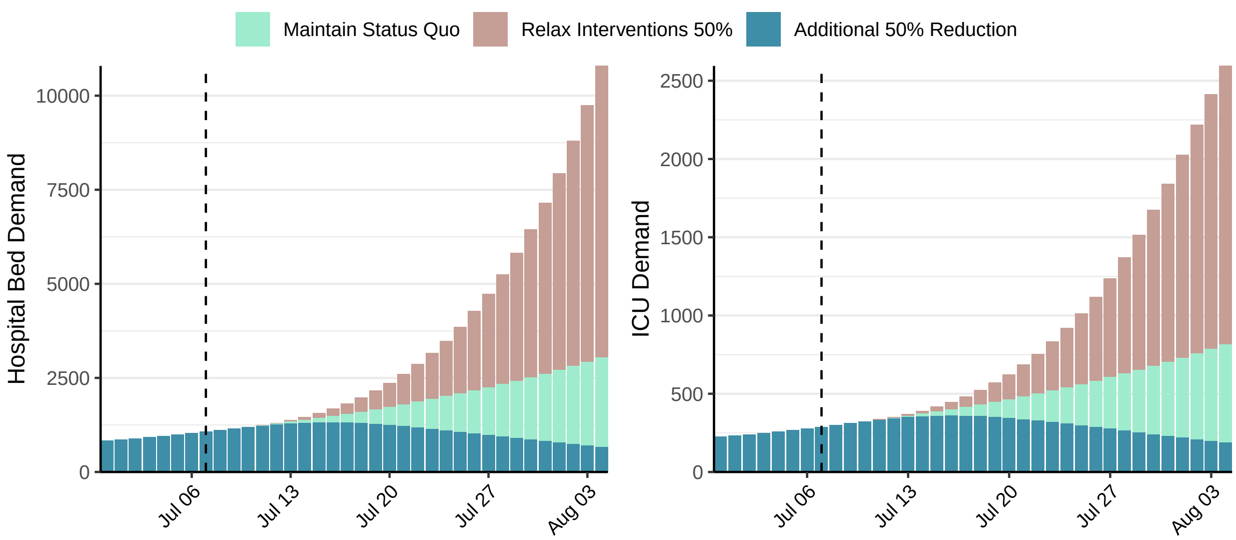

Figure 5: **Healthcare demands in the next 28 days.** Individuals needing an ICU bed are assumed to need mechanical ventilation. Projected demand for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

The impact of each scenario has a more immediate effect on the daily number of infections. The figure below shows the impact of each scenario on the estimated daily incidence of new infections. If interventions are scaled up (Scenario 2), the daily number of infections will change from 6,850 (95% CI: 6,182-7,519) at the current date to 1,362 (95% CI: 1,206-1,517) by 2020-08-04. If current interventions were relaxed by 50%, we estimate the daily number of infections will change from 6,850 (95% CI: 6,182-7,519) at the current date to 121,734 (95% CI: 108,017-135,450) by 2020-08-04.

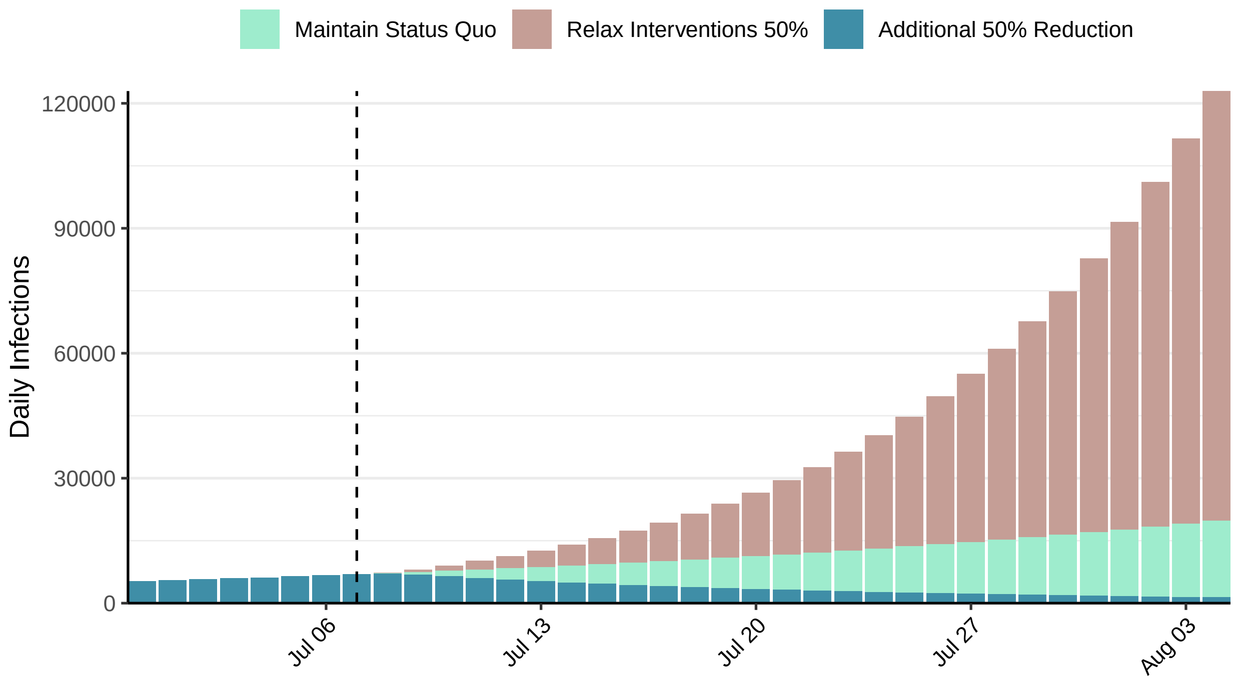

Figure 6: **Daily number of infections estimated by fitting to deaths.** Projected infections for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

To explore different scenarios, we recommend using our COVID-19 Scenario Analysis Tool - https://covidsim.org/, which can be used to simulate different intervention scenarios and explore the long term impact on healthcare demand.

Situation Report for COVID-19: Ecuador, 2020-07-07

Download the report for Ecuador, 2020-07-07 here. This report uses data from the European Centre for Disease Control. These data are updated daily and whilst there may be a short delay, they are generally consistent with Ministry reports. These data are then used to back-calculate an 'inferred number of COVID-19 infections' using mathematical modelling techniques (see Report 12 for further details) to estimate the number of people that have been infected and to make short-term projections for future healthcare needs.

Epidemiological Situation

Total Reported Cases	New Reported Cases	Total Reported Deaths	New Reported Deaths	Estimated R_t
62,380	422	4,821	40	1.1 (95% CI: 1.01-1.2)

The figure below shows the cumulative reported deaths as a function of the time since the 10th death was reported. Dashed lines show the expected trajectory for different doubling times of the epidemic. For example, with a doubling time of 3 days, if there are currently a total of 20 deaths reported, we would expect there to be 40 deaths in total reported in 3 days-time, 80 deaths in 6 days-time, 160 deaths in 9 days-time etc. For most epidemics, in the absence of interventions, we expect a doubling time of 3-4 days for this disease.

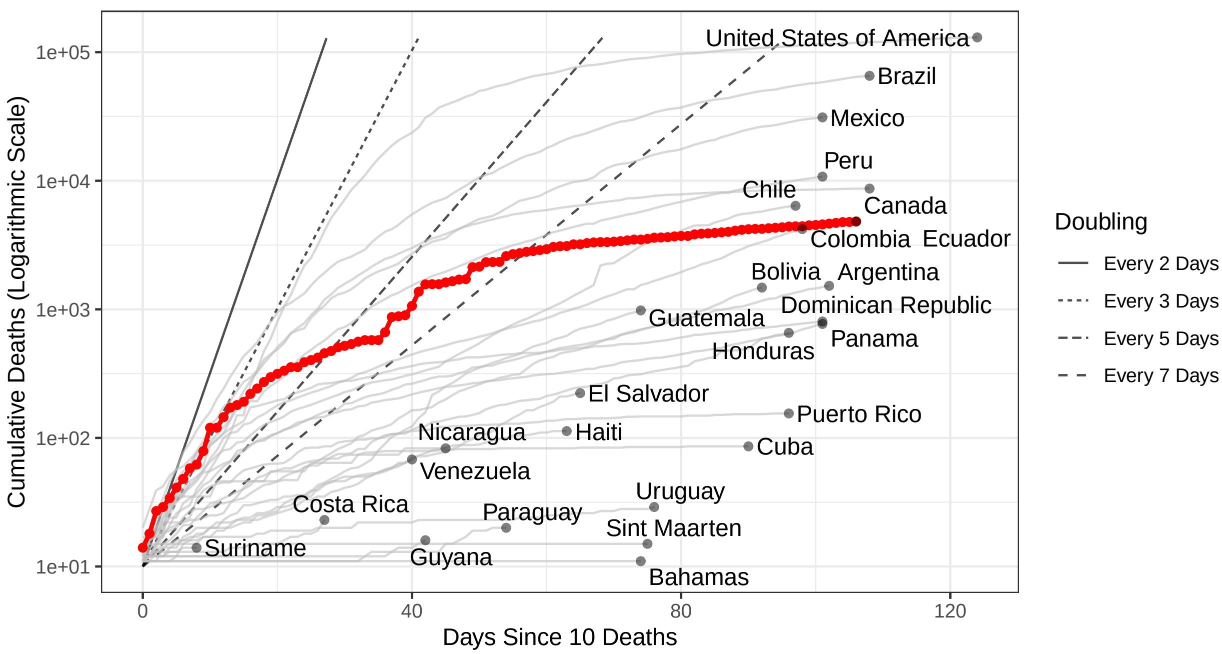

Figure 1: **Cumulative Deaths since 10 deaths.** Country not shown if fewer than 10 deaths.

COVID-19 Transmission Modelling

We assume that the deaths reported to date provide the best indication of the stage of the epidemic, as deaths are more consistently and accurately reported. Our current working estimate is that 1 death indicates that approximately 100 people will have been infected with the other 99 recovering (based on an infection fatality ratio of ~1%). These infections will have happened approximately 21 days previously – capturing a 5-day period from infection to onset of symptoms (the incubation period), 4 days from onset of symptoms to hospitalisation, and 12 days in hospital before death. With a 3-day doubling time, 100 infections that occurred 15 days ago will have generated 200 infections 12 days ago, 400 infections 9 days ago, 800 infections 6 days ago and 1,600 infections 3 days ago resulting in approximately 3,200 infections at the time the first death is observed.

To explore this, we fit our age-structured SEIR model (see Methods) to the time series of deaths in a country, in order to estimate the start date of the epidemic and the baseline R0. We assume that 100% of COVID-19 related deaths have been reported. We have also included the impact of interventions that have been put in place and their effect on human mobility and transmission based on the Google COVID-19 Community Mobility Reports. Using our mathematical model that formalises this approach, we estimate that there has been a total of 340,191 (95% CI: 326,628-353,754) infections over the past 4 weeks.

The figure below shows the estimated number of people infected over the past 4 weeks. The bar charts show, for comparison, the number of reported cases. The right-hand plot shows these data on a different scale as the estimated infections are likely to be much larger than the reported cases. **Importantly**, the estimated infections includes both asymptomatic and mild cases that would not necessarily be identified through surveillance. Consequently, the estimated infections are likely to be significantly higher than the reported cases (see our FAQ for further explanation of these differences and why the reported cases and estimated infections are unlikely to match). **N.B. Ecuador has revised their historic reported cases and thus have reported negative cases.**

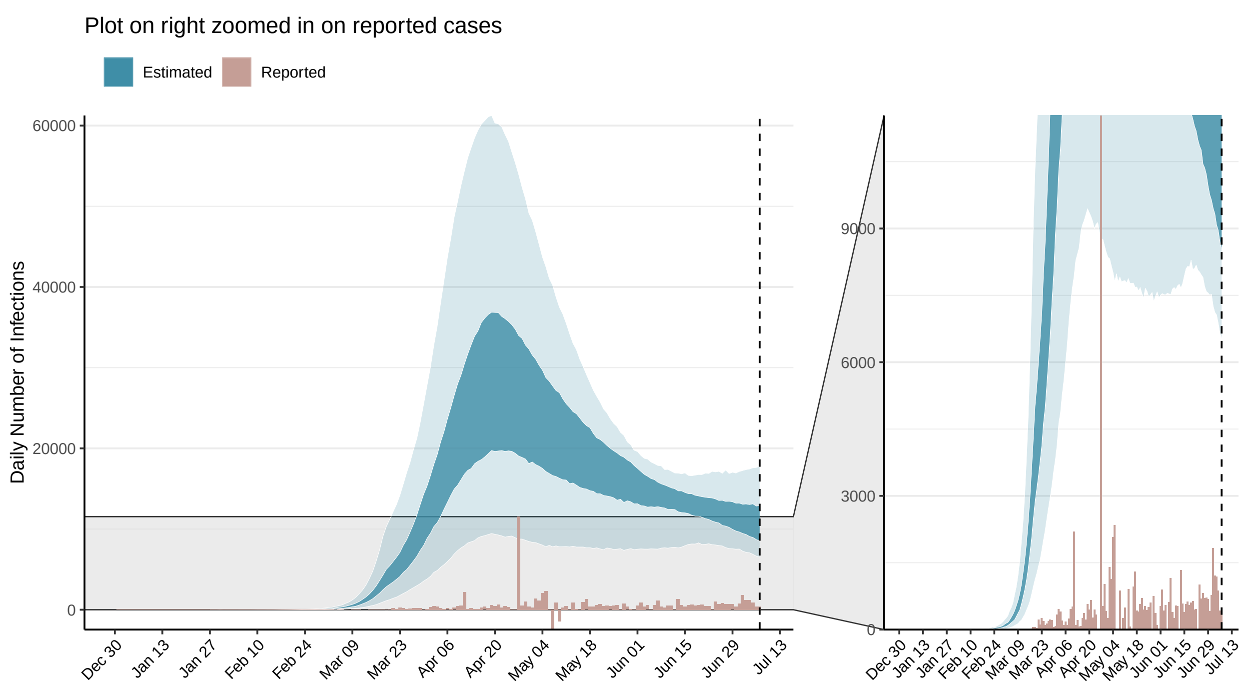

Figure 2: **Daily number of infections estimated by fitting to the current total of deaths.** Reported cases are shown in red. Model estimated infections are shown in blue (dark blue 50% interquartile range, light blue 95% quantile). The dashed line shows the current day.

By fitting to the time series of deaths, we are able to estimate a time-varying reproduction number, R_t. R_t is the the average number of secondary infections caused by a single infected person at a given time. If R_t is above 1, the rate of transmission is increasing and the number of new infections is increasing. R_t is assumed to change in relation to mobility fall in proportion. When fitting our model we assume that 100% of COVID-19 related deaths have been reported (please see our FAQ section for more information about this assumption). We also assume a fixed date at which the impact of mobility on transmission changes from pre-lockdown levels to post-lockdown levels, which may cause large changes in Rt. We are working to refine how this switch occurs and to formally calculate its shape.

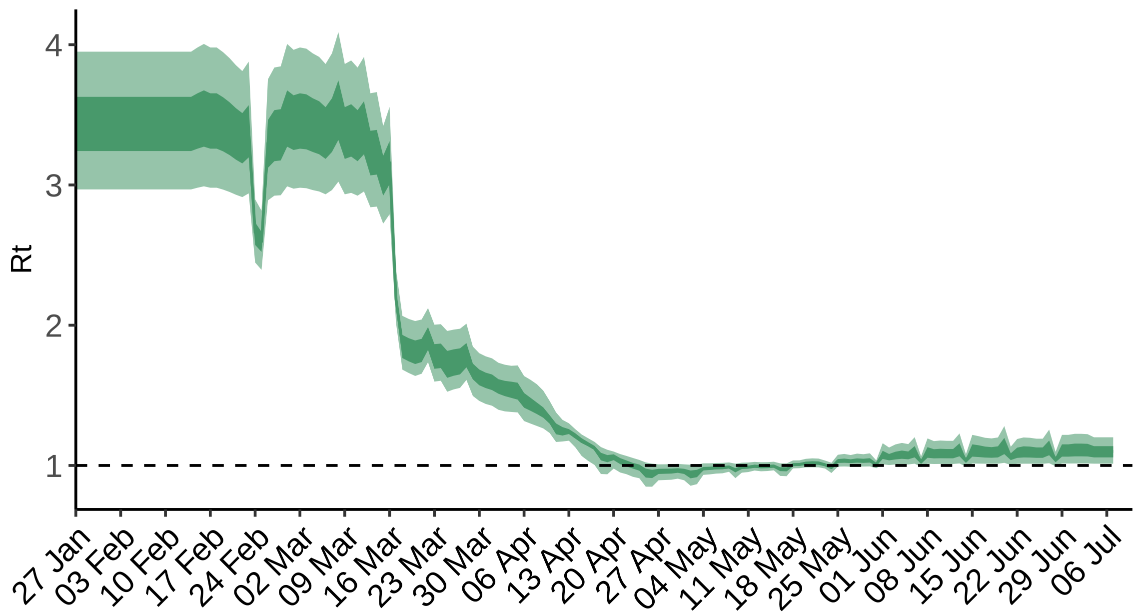

Figure 3: **Time-varying reproduction number, R_t.** R_t is the average number of secondary infections caused by a single infected person at time equal to t. $R_t < 1$ indicates a slowing epidemic in which new infections are not increasing. $R_t > 1$ indicates a growing epidemic in which new infections are increasing over time. Dark green shows the 50% CI and light green shows the 95% CI.

Using the model fit, we can forecast the expected trajectory for cumulative deaths, which is shown in the figure below. This assumes a severity pattern by age that is consistent with that observed in China, Europe and the U.S to date. This projection assumes that transmission is maintained at the current level of transmission as estimated by the final R_t value.

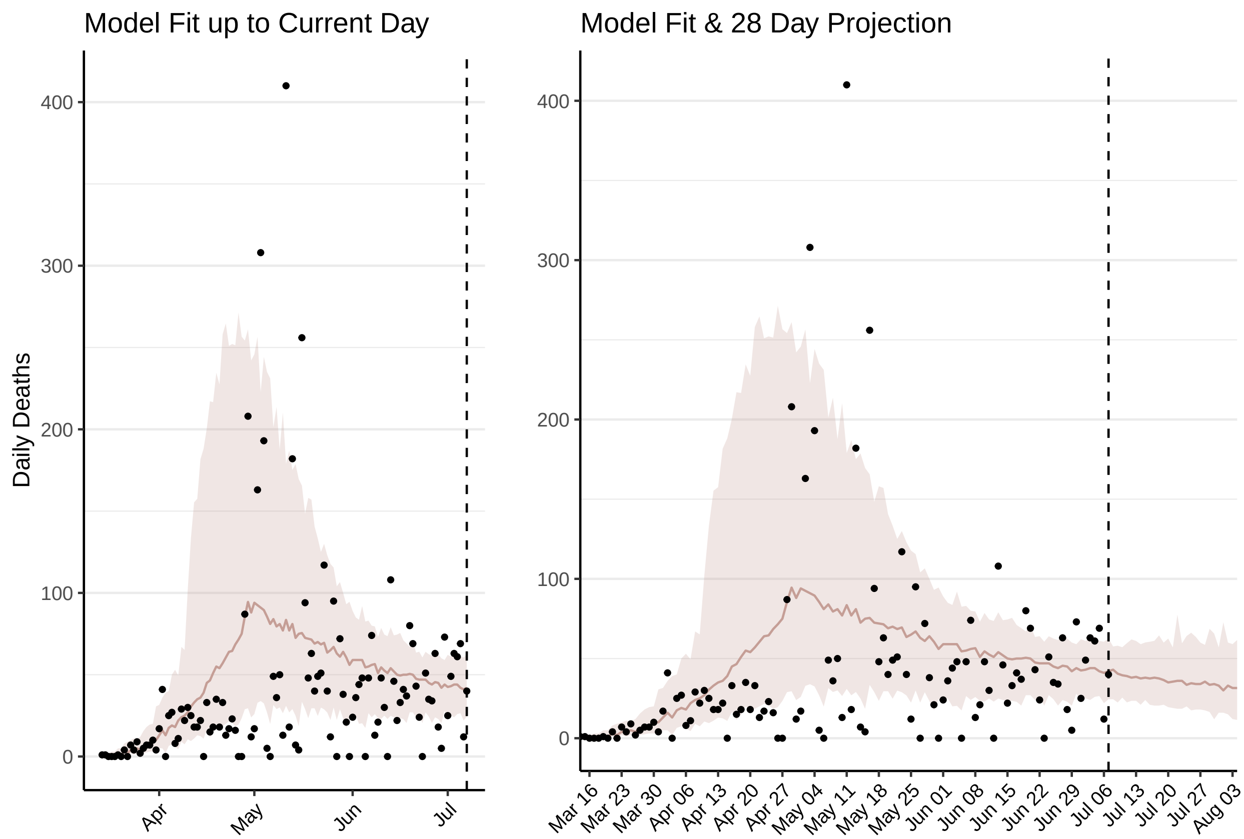

Figure 4: **Estimated daily deaths.** Projected deaths assuming the current level of interventions are maintained are shown in red (median and 95% quantile). Reported deaths are plotted in black. The plot on the left is focussed on the model fit prior to today, while the plot on the right forecasts the next 28 days.

Short-term Epidemic Scenarios

We make the following short-term projections of healthcare demand and new infections under the following three scenarios:

- **Scenario 1.** The epidemic continues to grow at the current rate.
- **Scenario 2.** Countries will further scale up interventions (either increasing current strategies or implementing new interventions) leading to a further 50% reduction in transmission.
- **Scenario 3.** Countries will relax current interventions by 50%

N.B. These scenarios currently assume that the impact of mobility on transmission will remain the same in the future as it has in the past. We are working to extend methods to estimate the impact of increases in mobility on transmission as lockdown and interventions are reversed. Consequently, projection are likely to represent an upper estimate of the healthcare demand and case load for each scenario

We estimate that over the next 4 weeks demand for hospital beds will change from 1,882 (95% CI: 1,802-1,961) patients requiring treatment with high-pressure oxygen at the current date to 1,495 (95% CI: 1,373-1,616) hospital beds being required on 2020-08-04 if no further interventions are introduced (Scenario 1). Similarly, we estimate that over the next 4 weeks demand for critical care (ICU) beds will change from 590 (95% CI: 566-615) patients requiring treatment with mechanical ventilation at the current date to 474 (95% CI: 436-511) by 2020-08-04. These projections assume that approximately 5% of all infections will require treatment with high-pressure oxygen and that approximately 30% of hospitalised cases will require treatment with mechanical ventilation (based on analysis of ongoing epidemics in Europe). **N.B. These scenarios are unlikely to show significant differences for the first week since there is a delay of approximately 10 days between infection and hospital admission. Consequently, the effectiveness of a change in policy is likely to be better captured by hospital admission data approximately 2 weeks after the policy change is implemented.**

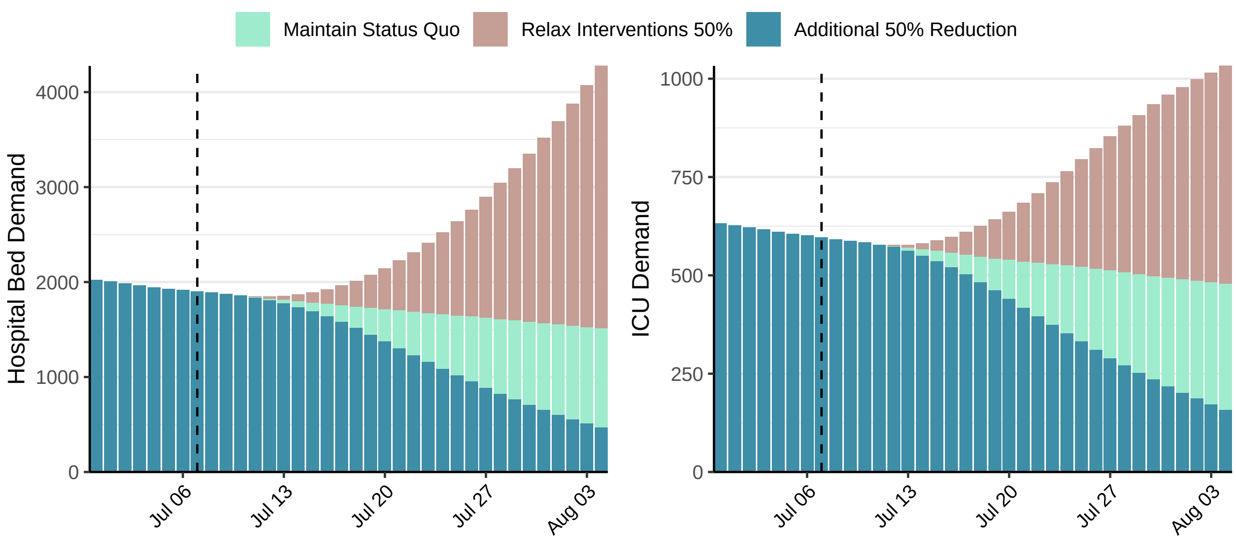

Figure 5: **Healthcare demands in the next 28 days.** Individuals needing an ICU bed are assumed to need mechanical ventilation. Projected demand for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

The impact of each scenario has a more immediate effect on the daily number of infections. The figure below shows the impact of each scenario on the estimated daily incidence of new infections. If interventions are scaled up (Scenario 2), the daily number of infections will change from 10,863 (95% CI: 10,251-11,476) at the current date to 771 (95% CI: 696-846) by 2020-08-04. If current interventions were relaxed by 50%, we estimate the daily number of infections will change from 10,863 (95% CI: 10,251-11,476) at the current date to 42,829 (95% CI: 38,358-47,300) by 2020-08-04.

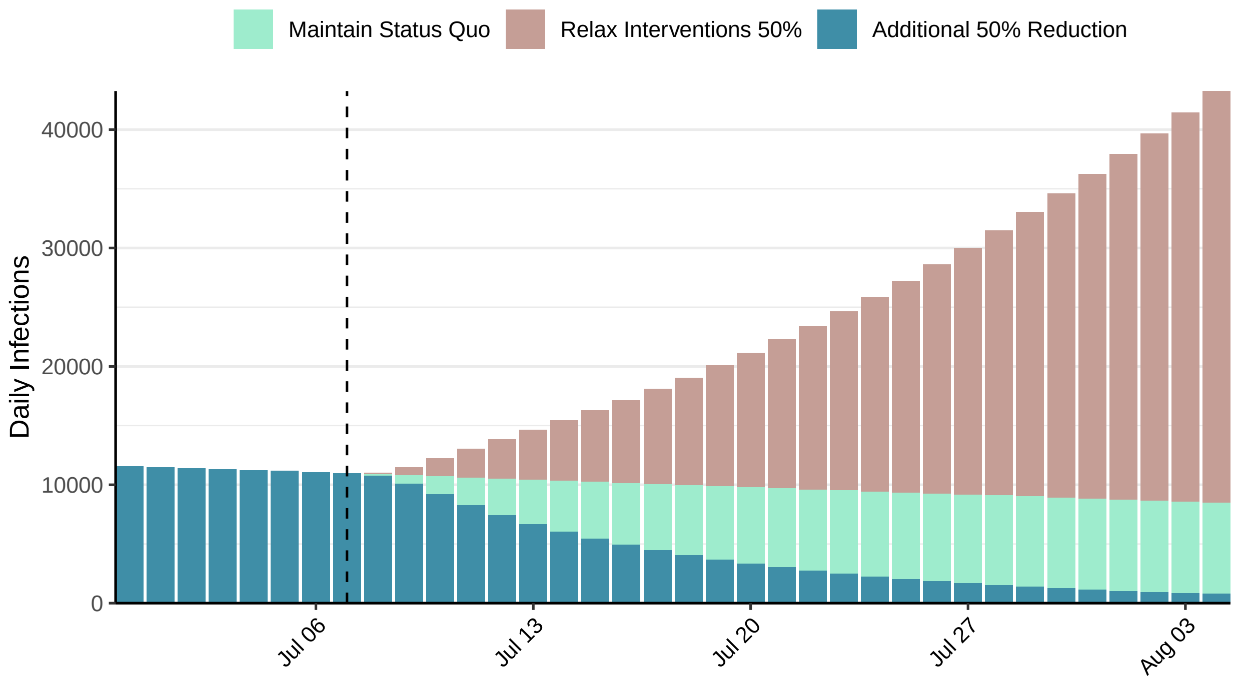

Figure 6: **Daily number of infections estimated by fitting to deaths.** Projected infections for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

To explore different scenarios, we recommend using our COVID-19 Scenario Analysis Tool - https://covidsim.org/, which can be used to simulate different intervention scenarios and explore the long term impact on healthcare demand.

Situation Report for COVID-19: Egypt, 2020-07-07

Download the report for Egypt, 2020-07-07 here. This report uses data from the European Centre for Disease Control. These data are updated daily and whilst there may be a short delay, they are generally consistent with Ministry reports. These data are then used to back-calculate an 'inferred number of COVID-19 infections' using mathematical modelling techniques (see Report 12 for further details) to estimate the number of people that have been infected and to make short-term projections for future healthcare needs.

Epidemiological Situation

Total Reported Cases	New Reported Cases	Total Reported Deaths	New Reported Deaths	Estimated R_t
76,222	969	3,422	79	1.4 (95% CI: 1.22-1.6)

The figure below shows the cumulative reported deaths as a function of the time since the 10th death was reported. Dashed lines show the expected trajectory for different doubling times of the epidemic. For example, with a doubling time of 3 days, if there are currently a total of 20 deaths reported, we would expect there to be 40 deaths in total reported in 3 days-time, 80 deaths in 6 days-time, 160 deaths in 9 days-time etc. For most epidemics, in the absence of interventions, we expect a doubling time of 3-4 days for this disease.

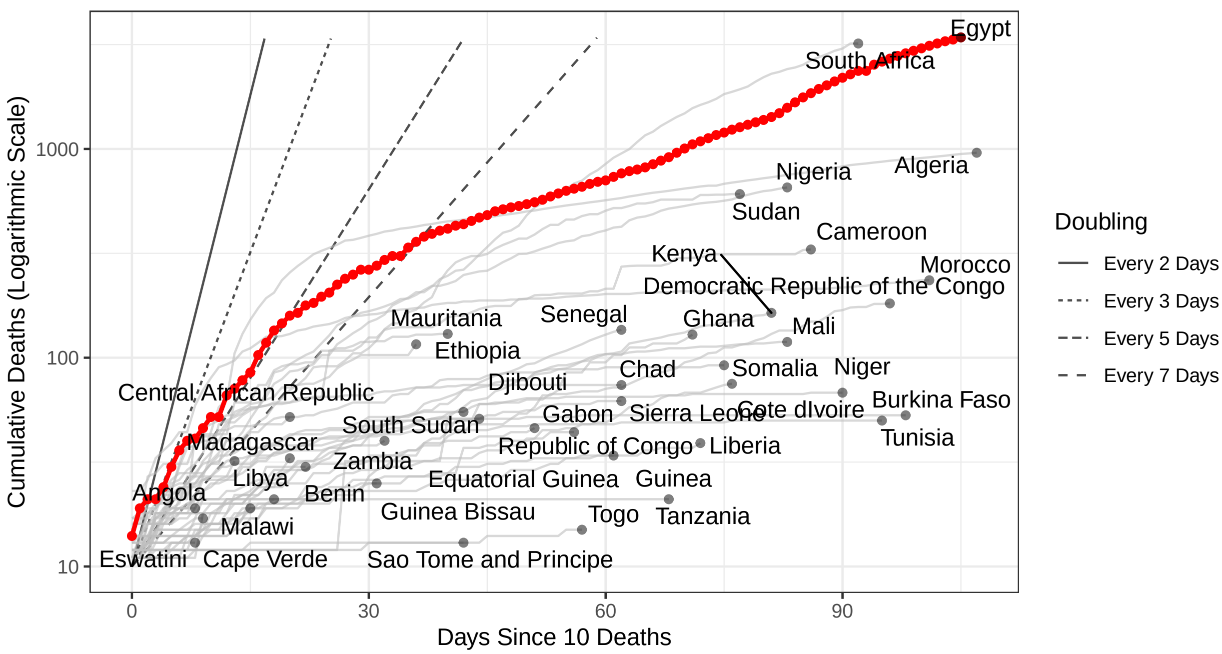

Figure 1: **Cumulative Deaths since 10 deaths.** Country not shown if fewer than 10 deaths.

COVID-19 Transmission Modelling

We assume that the deaths reported to date provide the best indication of the stage of the epidemic, as deaths are more consistently and accurately reported. Our current working estimate is that 1 death indicates that approximately 100 people will have been infected with the other 99 recovering (based on an infection fatality ratio of ~1%). These infections will have happened approximately 21 days previously – capturing a 5-day period from infection to onset of symptoms (the incubation period), 4 days from onset of symptoms to hospitalisation, and 12 days in hospital before death. With a 3-day doubling time, 100 infections that occurred 15 days ago will have generated 200 infections 12 days ago, 400 infections 9 days ago, 800 infections 6 days ago and 1,600 infections 3 days ago resulting in approximately 3,200 infections at the time the first death is observed.

To explore this, we fit our age-structured SEIR model (see Methods) to the time series of deaths in a country, in order to estimate the start date of the epidemic and the baseline R0. We assume that 100% of COVID-19 related deaths have been reported. We have also included the impact of interventions that have been put in place and their effect on human mobility and transmission based on the Google COVID-19 Community Mobility Reports. Using our mathematical model that formalises this approach, we estimate that there has been a total of 1,367,092 (95% CI: 1,222,868-1,511,317) infections over the past 4 weeks.

The figure below shows the estimated number of people infected over the past 4 weeks. The bar charts show, for comparison, the number of reported cases. The right-hand plot shows these data on a different scale as the estimated infections are likely to be much larger than the reported cases. **Importantly**, the estimated infections includes both asymptomatic and mild cases that would not necessarily be identified through surveillance. Consequently, the estimated infections are likely to be significantly higher than the reported cases (see our FAQ for further explanation of these differences and why the reported cases and estimated infections are unlikely to match).

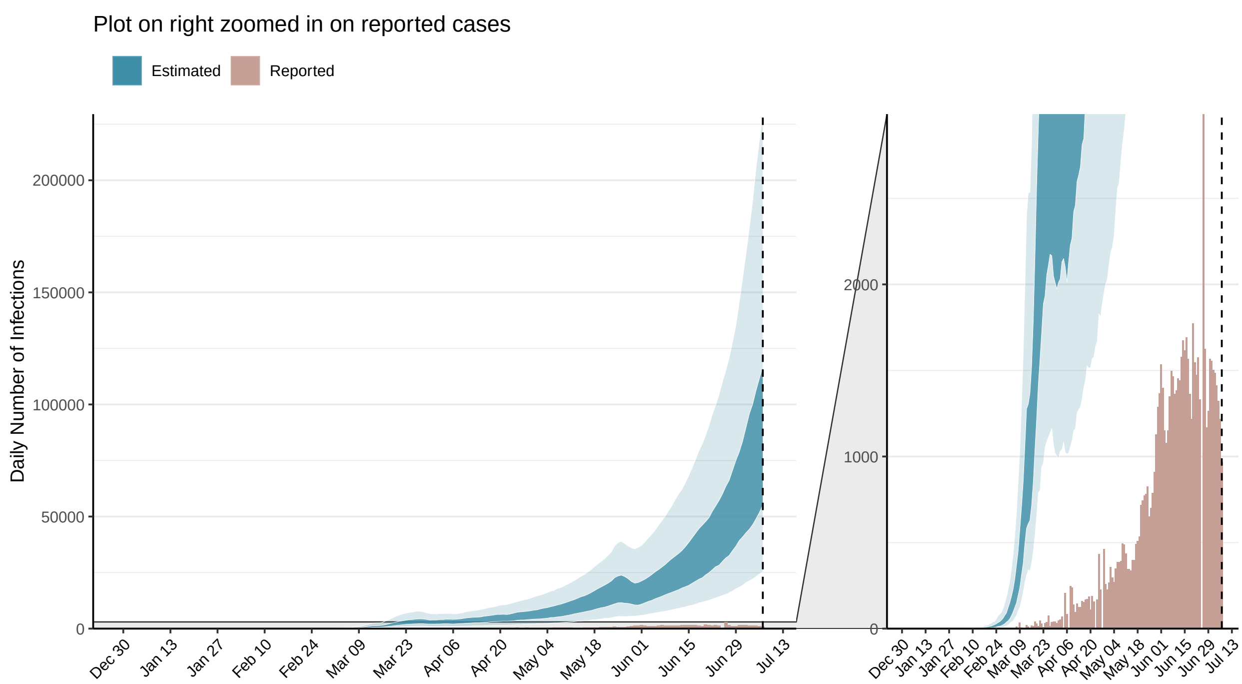

Figure 2: **Daily number of infections estimated by fitting to the current total of deaths.** Reported cases are shown in red. Model estimated infections are shown in blue (dark blue 50% interquartile range, light blue 95% quantile). The dashed line shows the current day.

By fitting to the time series of deaths, we are able to estimate a time-varying reproduction number, R_t. R_t is the the average number of secondary infections caused by a single infected person at a given time. If R_t is above 1, the rate of transmission is increasing and the number of new infections is increasing. R_t is assumed to change in relation to mobility fall in proportion. When fitting our model we assume that 100% of COVID-19 related deaths have been reported (please see our FAQ section for more information about this assumption). We also assume a fixed date at which the impact of mobility on transmission changes from pre-lockdown levels to post-lockdown levels, which may cause large changes in Rt. We are working to refine how this switch occurs and to formally calculate its shape.

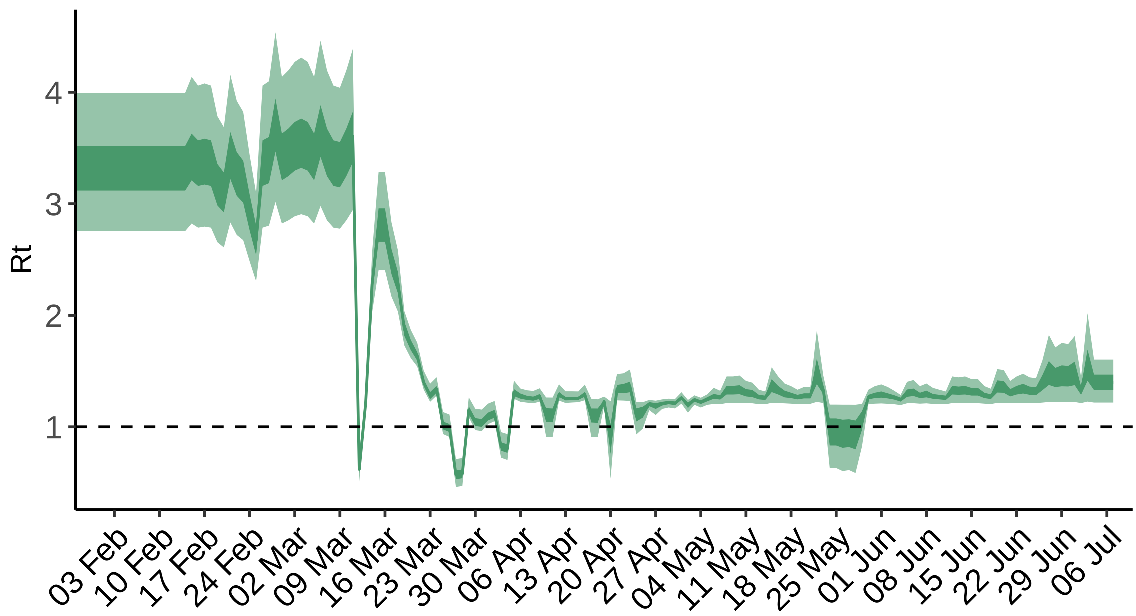

Figure 3: **Time-varying reproduction number, R_t.** R_t is the average number of secondary infections caused by a single infected person at time equal to t. $R_t < 1$ indicates a slowing epidemic in which new infections are not increasing. $R_t > 1$ indicates a growing epidemic in which new infections are increasing over time. Dark green shows the 50% CI and light green shows the 95% CI.

Using the model fit, we can forecast the expected trajectory for cumulative deaths, which is shown in the figure below. This assumes a severity pattern by age that is consistent with that observed in China, Europe and the U.S to date. This projection assumes that transmission is maintained at the current level of transmission as estimated by the final R_t value. **N.B. Egypt is forecast to be close to or surpassing our best estimates for healthcare capacity in the next 28 days.** Estimates of deaths in the next 28 days may be inaccurate due to our working assumptions for mortality in individuals who do not receive appropriate treatment. See our methods for more information.

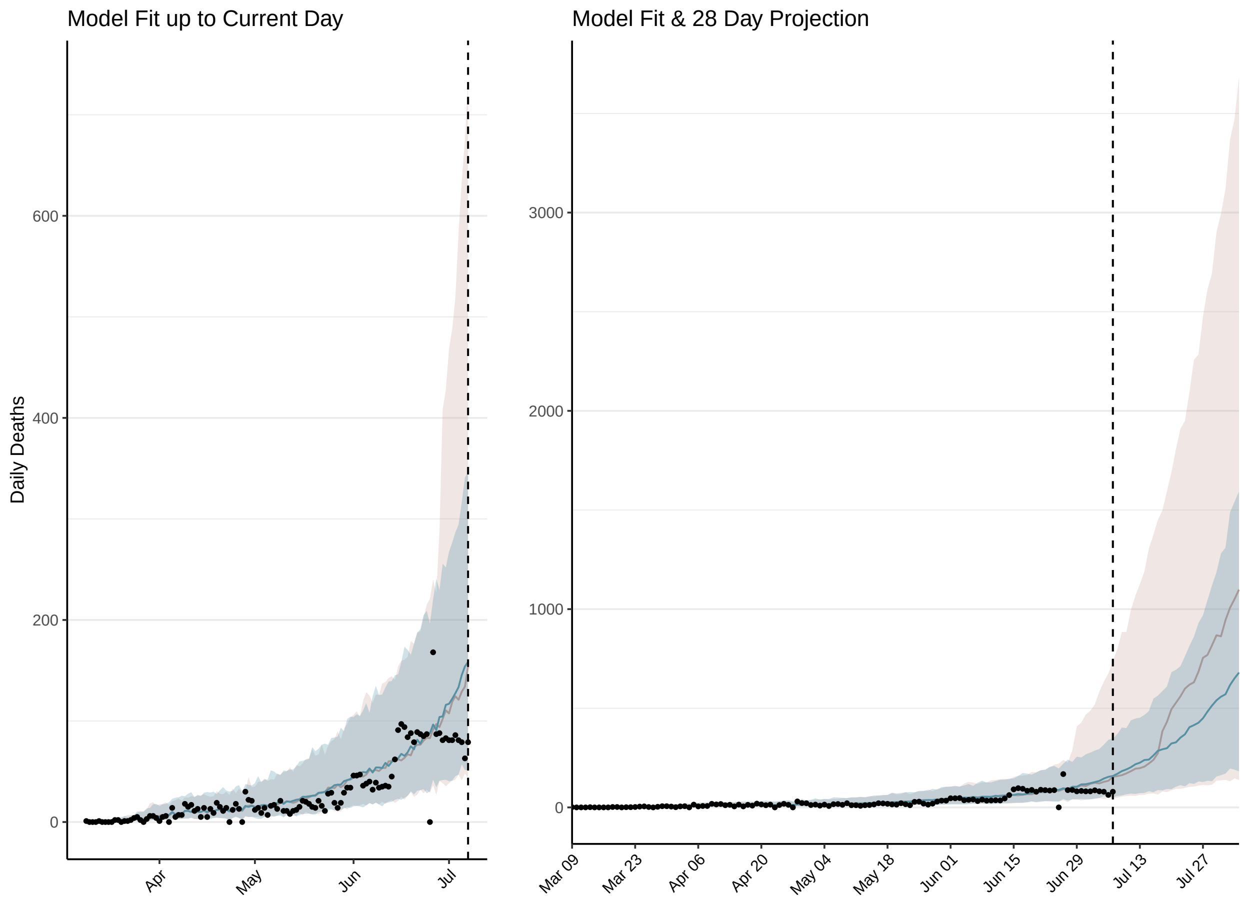

Figure 4: **Estimated daily deaths.** Projected deaths assuming the current level of interventions are maintained are shown in red (median and 95% quantile). Reported deaths are plotted in black. The plot on the left is focussed on the model fit prior to today, while the plot on the right forecasts the next 28 days. The forecasted deaths in blue assumes healthcare capacity has been surged to ensure sufficient supply of ICU and hospital beds. The red curve assumes no surging in healthcare capacity and subsequently projects increased deaths.

Short-term Epidemic Scenarios

We make the following short-term projections of healthcare demand and new infections under the following three scenarios:

- **Scenario 1.** The epidemic continues to grow at the current rate.
- **Scenario 2.** Countries will further scale up interventions (either increasing current strategies or implementing new interventions) leading to a further 50% reduction in transmission.
- **Scenario 3.** Countries will relax current interventions by 50%

N.B. These scenarios currently assume that the impact of mobility on transmission will remain the same in the future as it has in the past. We are working to extend methods to estimate the impact of increases in mobility on transmission as lockdown and interventions are reversed. Consequently, projection are likely to represent an upper estimate of the healthcare demand and case load for each scenario

We estimate that over the next 4 weeks demand for hospital beds will change from 9,139 (95% CI: 8,175-10,102) patients requiring treatment with high-pressure oxygen at the current date to 36,827 (95% CI: 31,984-41,670) hospital beds being required on 2020-08-04 if no further interventions are introduced (Scenario 1). Similarly, we estimate that over the next 4 weeks demand for critical care (ICU) beds will change from 2,512 (95% CI: 2,290-2,735) patients requiring treatment with mechanical ventilation at the current date to 4,932 (95% CI: 4,651-5,212) by 2020-08-04. These projections assume that approximately 5% of all infections will require treatment with high-pressure oxygen and that approximately 30% of hospitalised cases will require treatment with mechanical ventilation (based on analysis of ongoing epidemics in Europe). **N.B. These scenarios are unlikely to show significant differences for the first week since there is a delay of approximately 10 days between infection and hospital admission. Consequently, the effectiveness of a change in policy is likely to be better captured by hospital admission data approximately 2 weeks after the policy change is implemented.**

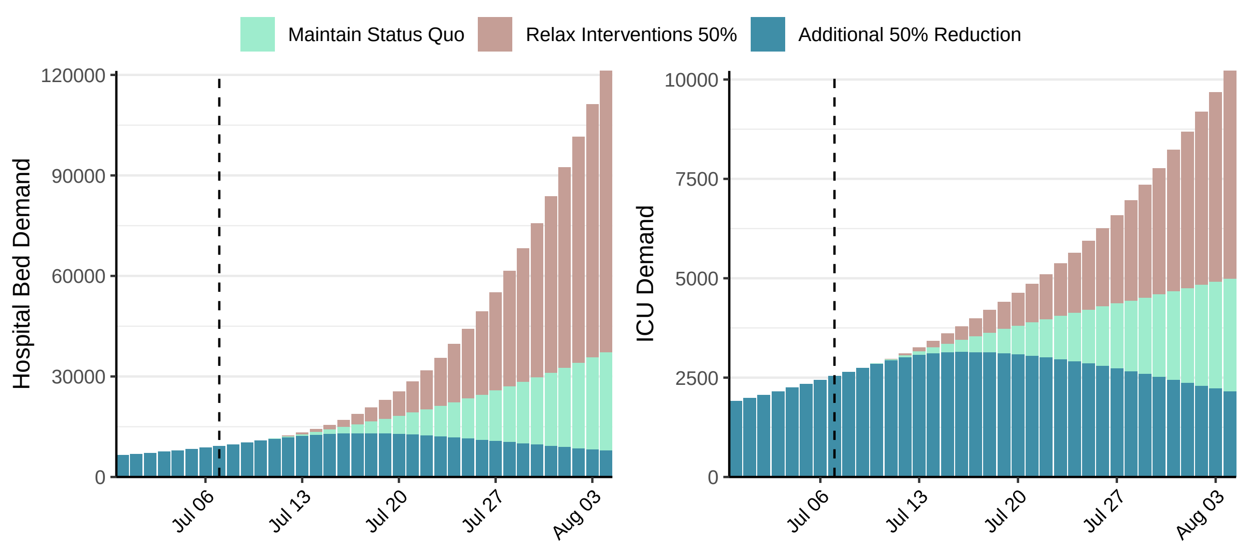

Figure 5: **Healthcare demands in the next 28 days.** Individuals needing an ICU bed are assumed to need mechanical ventilation. Projected demand for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

The impact of each scenario has a more immediate effect on the daily number of infections. The figure below shows the impact of each scenario on the estimated daily incidence of new infections. If interventions are scaled up (Scenario 2), the daily number of infections will change from 90,890 (95% CI: 80,462-101,318) at the current date to 24,227 (95% CI: 20,673-27,782) by 2020-08-04. If current interventions were relaxed by 50%, we estimate the daily number of infections will change from 90,890 (95% CI: 80,462-101,318) at the current date to 1,534,009 (95% CI: 1,389,710-1,678,307) by 2020-08-04.

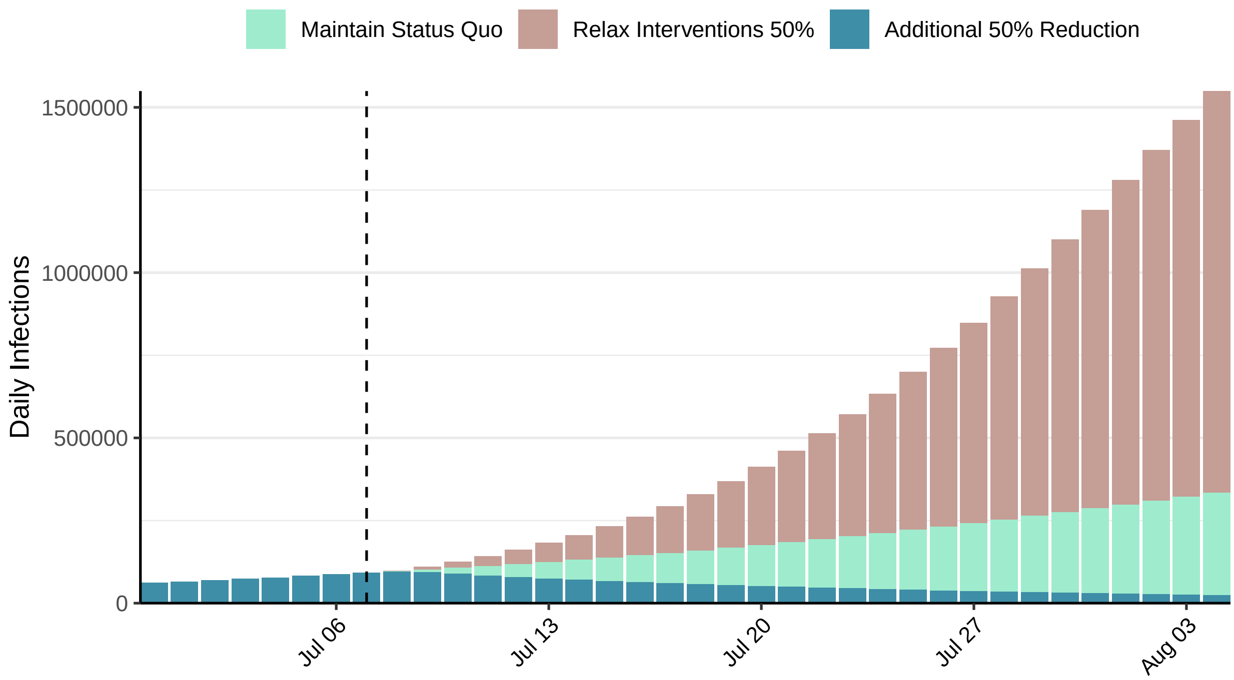

Figure 6: **Daily number of infections estimated by fitting to deaths.** Projected infections for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

To explore different scenarios, we recommend using our COVID-19 Scenario Analysis Tool - https://covidsim.org/, which can be used to simulate different intervention scenarios and explore the long term impact on healthcare demand.

Situation Report for COVID-19: Ethiopia, 2020-07-07

Download the report for Ethiopia, 2020-07-07 here. This report uses data from the European Centre for Disease Control. These data are updated daily and whilst there may be a short delay, they are generally consistent with Ministry reports. These data are then used to back-calculate an 'inferred number of COVID-19 infections' using mathematical modelling techniques (see Report 12 for further details) to estimate the number of people that have been infected and to make short-term projections for future healthcare needs.

Epidemiological Situation

Total Reported Cases	New Reported Cases	Total Reported Deaths	New Reported Deaths	Estimated R_t
6,386	540	116	13	1.32 (95% CI: 1.22-1.43)

The figure below shows the cumulative reported deaths as a function of the time since the 10th death was reported. Dashed lines show the expected trajectory for different doubling times of the epidemic. For example, with a doubling time of 3 days, if there are currently a total of 20 deaths reported, we would expect there to be 40 deaths in total reported in 3 days-time, 80 deaths in 6 days-time, 160 deaths in 9 days-time etc. For most epidemics, in the absence of interventions, we expect a doubling time of 3-4 days for this disease.

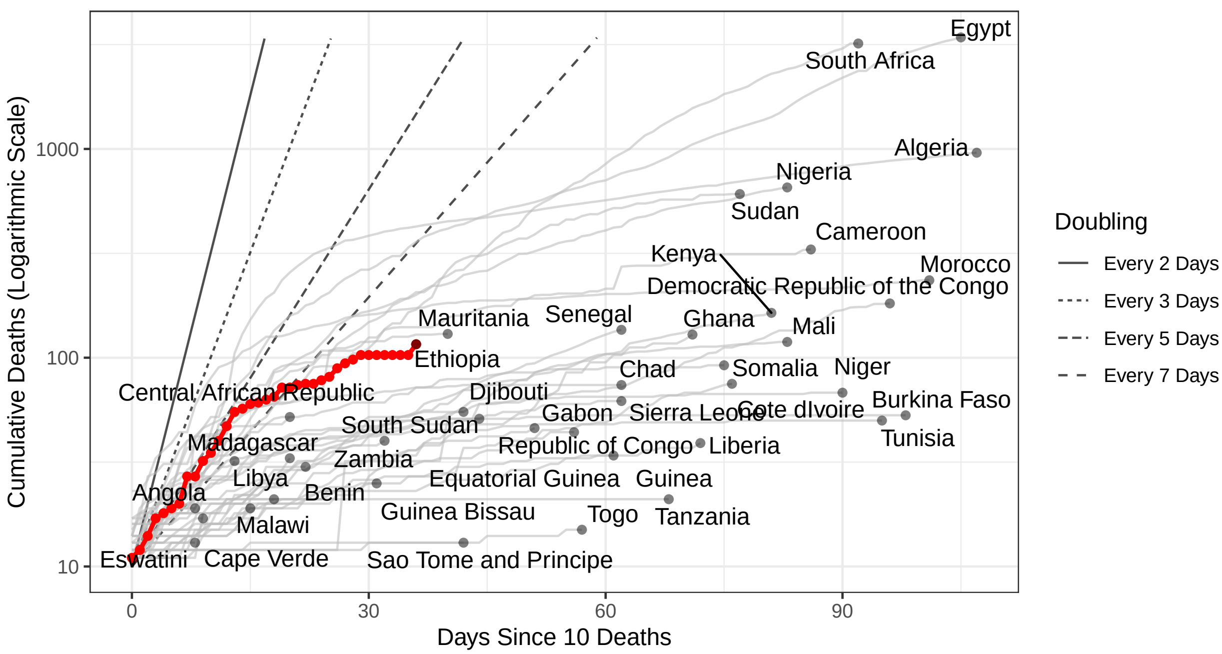

Figure 1: **Cumulative Deaths since 10 deaths.** Country not shown if fewer than 10 deaths.

COVID-19 Transmission Modelling

We assume that the deaths reported to date provide the best indication of the stage of the epidemic, as deaths are more consistently and accurately reported. Our current working estimate is that 1 death indicates that approximately 100 people will have been infected with the other 99 recovering (based on an infection fatality ratio of ~1%). These infections will have happened approximately 21 days previously – capturing a 5-day period from infection to onset of symptoms (the incubation period), 4 days from onset of symptoms to hospitalisation, and 12 days in hospital before death. With a 3-day doubling time, 100 infections that occurred 15 days ago will have generated 200 infections 12 days ago, 400 infections 9 days ago, 800 infections 6 days ago and 1,600 infections 3 days ago resulting in approximately 3,200 infections at the time the first death is observed.

To explore this, we fit our age-structured SEIR model (see Methods) to the time series of deaths in a country, in order to estimate the start date of the epidemic and the baseline R0. We assume that 100% of COVID-19 related deaths have been reported. We have also included the impact of interventions that have been put in place and their effect on human mobility and transmission based on the Google COVID-19 Community Mobility Reports. Using our mathematical model that formalises this approach, we estimate that there has been a total of 67,587 (95% CI: 57,889-77,285) infections over the past 4 weeks.

The figure below shows the estimated number of people infected over the past 4 weeks. The bar charts show, for comparison, the number of reported cases. The right-hand plot shows these data on a different scale as the estimated infections are likely to be much larger than the reported cases. **Importantly**, the estimated infections includes both asymptomatic and mild cases that would not necessarily be identified through surveillance. Consequently, the estimated infections are likely to be significantly higher than the reported cases (see our FAQ for further explanation of these differences and why the reported cases and estimated infections are unlikely to match).

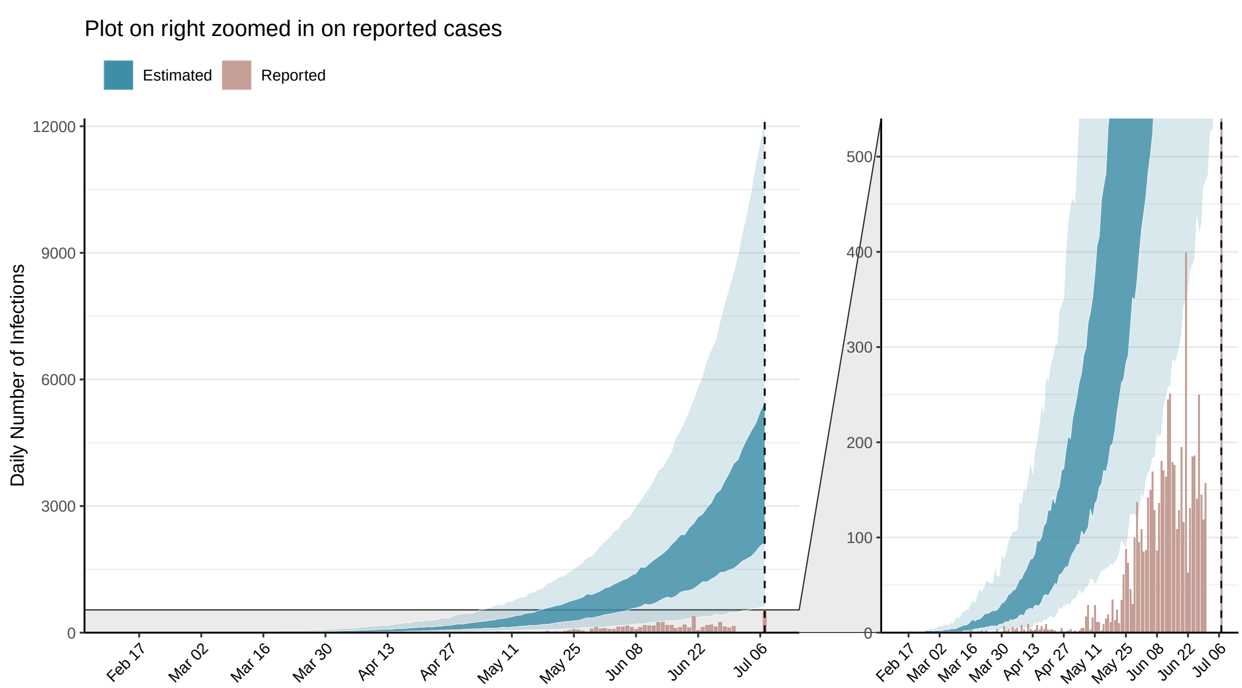

Figure 2: **Daily number of infections estimated by fitting to the current total of deaths.** Reported cases are shown in red. Model estimated infections are shown in blue (dark blue 50% interquartile range, light blue 95% quantile). The dashed line shows the current day.

By fitting to the time series of deaths, we are able to estimate a time-varying reproduction number, R_t. R_t is the the average number of secondary infections caused by a single infected person at a given time. If R_t is above 1, the rate of transmission is increasing and the number of new infections is increasing. R_t is assumed to change in relation to mobility fall in proportion. When fitting our model we assume that 100% of COVID-19 related deaths have been reported (please see our FAQ section for more information about this assumption). We also assume a fixed date at which the impact of mobility on transmission changes from pre-lockdown levels to post-lockdown levels, which may cause large changes in Rt. We are working to refine how this switch occurs and to formally calculate its shape.

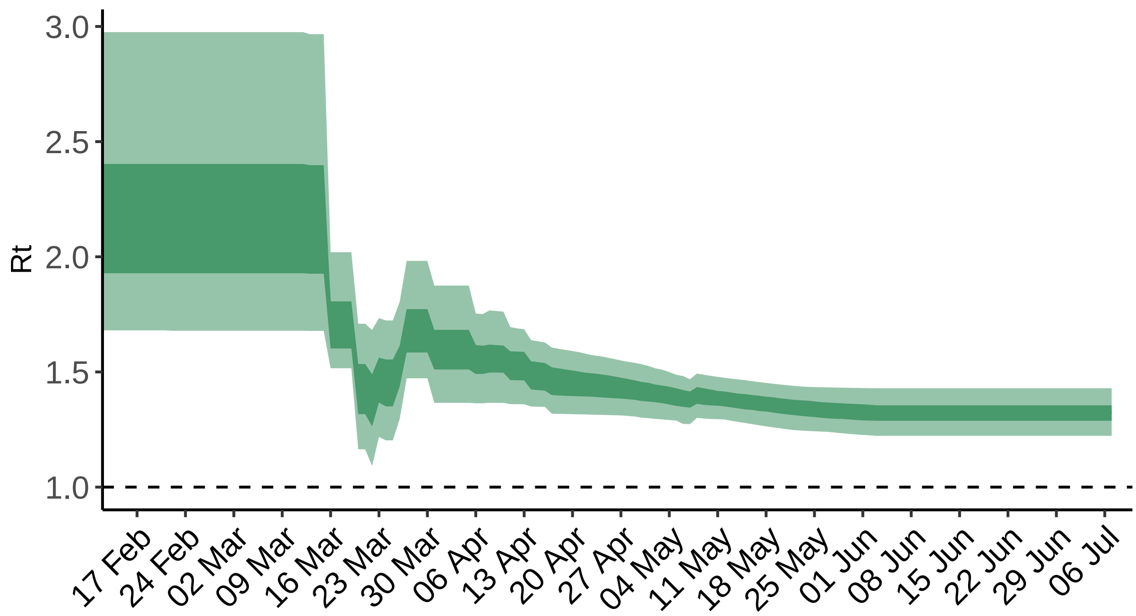

Figure 3: **Time-varying reproduction number, R_t.** R_t is the average number of secondary infections caused by a single infected person at time equal to t. $R_t < 1$ indicates a slowing epidemic in which new infections are not increasing. $R_t > 1$ indicates a growing epidemic in which new infections are increasing over time. Dark green shows the 50% CI and light green shows the 95% CI.

Using the model fit, we can forecast the expected trajectory for cumulative deaths, which is shown in the figure below. This assumes a severity pattern by age that is consistent with that observed in China, Europe and the U.S to date. This projection assumes that transmission is maintained at the current level of transmission as estimated by the final R_t value.

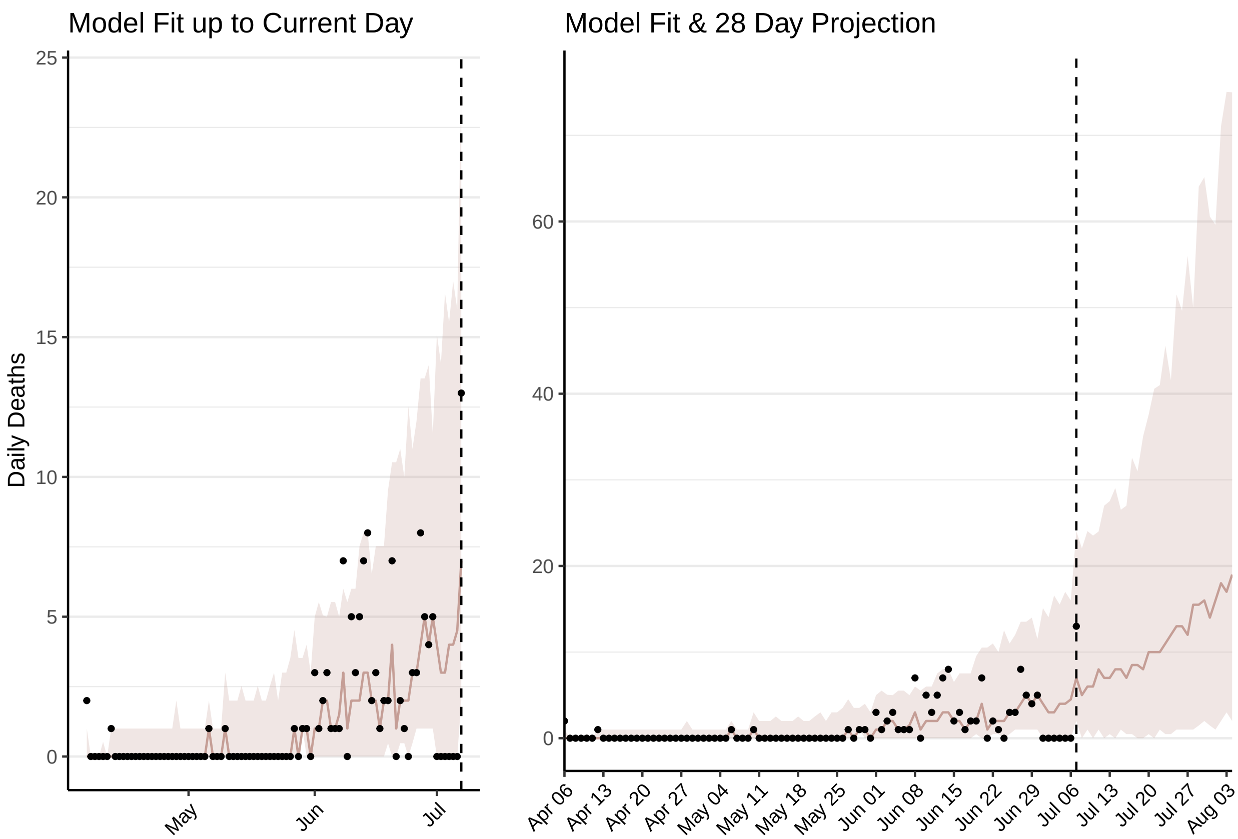

Figure 4: **Estimated daily deaths.** Projected deaths assuming the current level of interventions are maintained are shown in red (median and 95% quantile). Reported deaths are plotted in black. The plot on the left is focussed on the model fit prior to today, while the plot on the right forecasts the next 28 days.

Short-term Epidemic Scenarios

We make the following short-term projections of healthcare demand and new infections under the following three scenarios:

- **Scenario 1.** The epidemic continues to grow at the current rate.
- **Scenario 2.** Countries will further scale up interventions (either increasing current strategies or implementing new interventions) leading to a further 50% reduction in transmission.
- **Scenario 3.** Countries will relax current interventions by 50%

N.B. These scenarios currently assume that the impact of mobility on transmission will remain the same in the future as it has in the past. We are working to extend methods to estimate the impact of increases in mobility on transmission as lockdown and interventions are reversed. Consequently, projection are likely to represent an upper estimate of the healthcare demand and case load for each scenario

We estimate that over the next 4 weeks demand for hospital beds will change from 387 (95% CI: 331-444) patients requiring treatment with high-pressure oxygen at the current date to 1,413 (95% CI: 1,187-1,640) hospital beds being required on 2020-08-04 if no further interventions are introduced (Scenario 1). Similarly, we estimate that over the next 4 weeks demand for critical care (ICU) beds will change from 108 (95% CI: 92-124) patients requiring treatment with mechanical ventilation at the current date to 397 (95% CI: 333-461) by 2020-08-04. These projections assume that approximately 5% of all infections will require treatment with high-pressure oxygen and that approximately 30% of hospitalised cases will require treatment with mechanical ventilation (based on analysis of ongoing epidemics in Europe). **N.B. These scenarios are unlikely to show significant differences for the first week since there is a delay of approximately 10 days between infection and hospital admission. Consequently, the effectiveness of a change in policy is likely to be better captured by hospital admission data approximately 2 weeks after the policy change is implemented.**

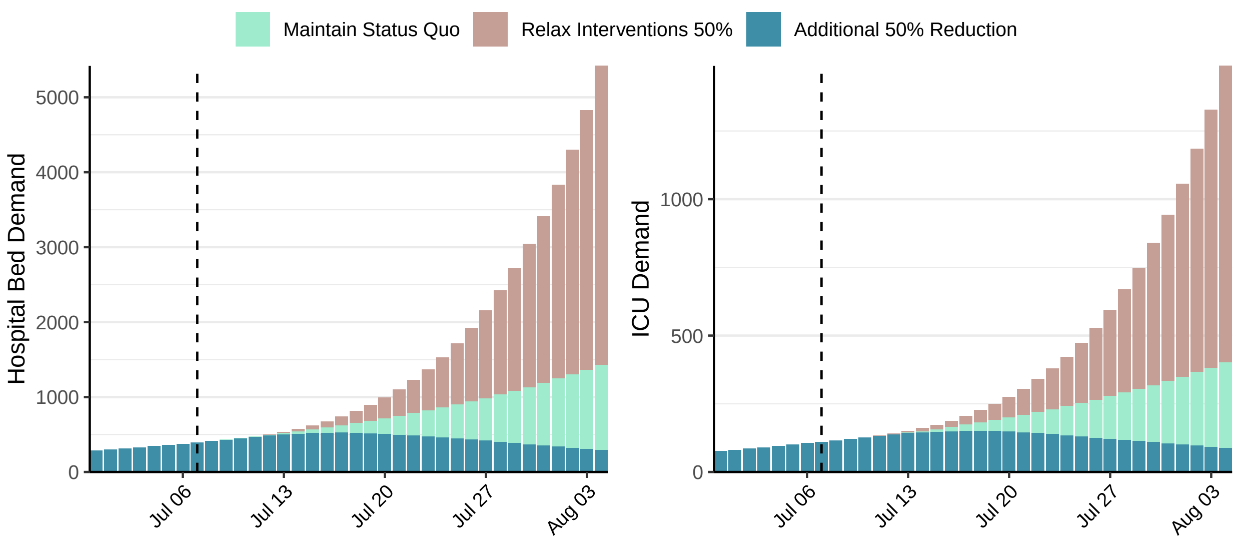

Figure 5: **Healthcare demands in the next 28 days.** Individuals needing an ICU bed are assumed to need mechanical ventilation. Projected demand for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

The impact of each scenario has a more immediate effect on the daily number of infections. The figure below shows the impact of each scenario on the estimated daily incidence of new infections. If interventions are scaled up (Scenario 2), the daily number of infections will change from 4,199 (95% CI: 3,573-4,825) at the current date to 1,012 (95% CI: 845-1,178) by 2020-08-04. If current interventions were relaxed by 50%, we estimate the daily number of infections will change from 4,199 (95% CI: 3,573-4,825) at the current date to 103,472 (95% CI: 86,251-120,692) by 2020-08-04.

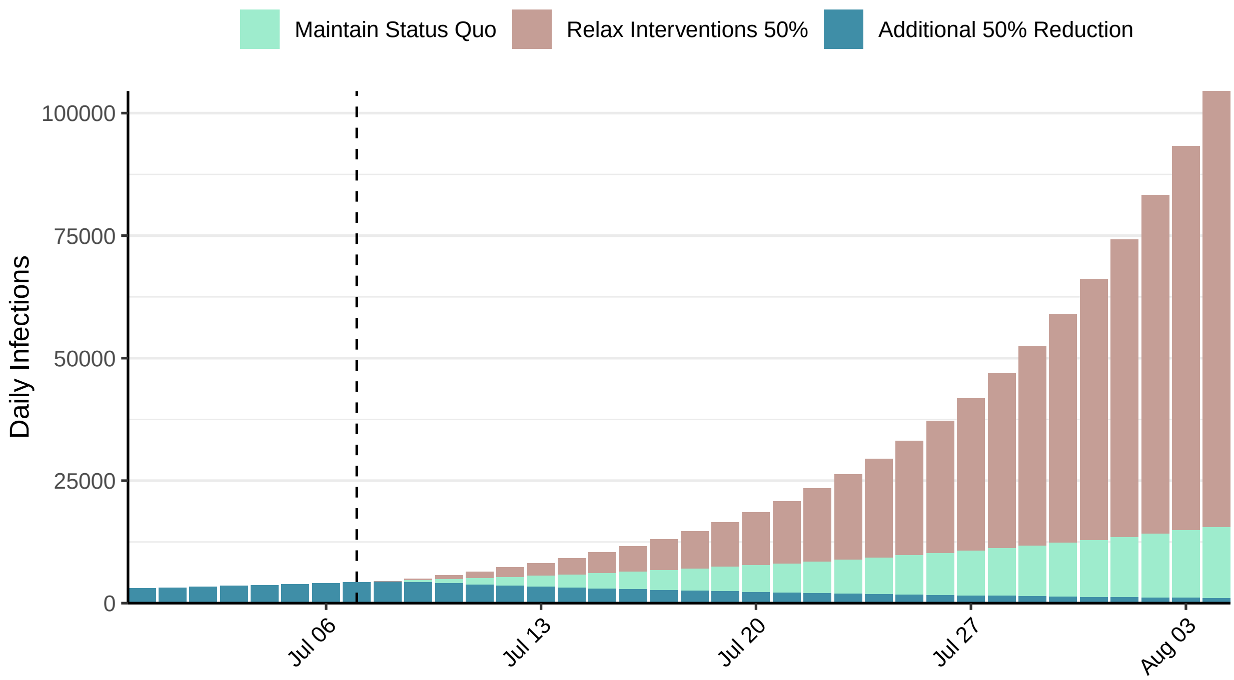

Figure 6: **Daily number of infections estimated by fitting to deaths.** Projected infections for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

To explore different scenarios, we recommend using our COVID-19 Scenario Analysis Tool - https://covidsim.org/, which can be used to simulate different intervention scenarios and explore the long term impact on healthcare demand.

Situation Report for COVID-19: Gabon, 2020-07-07

Download the report for Gabon, 2020-07-07 here. This report uses data from the European Centre for Disease Control. These data are updated daily and whilst there may be a short delay, they are generally consistent with Ministry reports. These data are then used to back-calculate an 'inferred number of COVID-19 infections' using mathematical modelling techniques (see Report 12 for further details) to estimate the number of people that have been infected and to make short-term projections for future healthcare needs.

Epidemiological Situation

Total Reported Cases	New Reported Cases	Total Reported Deaths	New Reported Deaths	Estimated R_t
5,743	123	46	2	1.18 (95% CI: 1.02-1.39)

The figure below shows the cumulative reported deaths as a function of the time since the 10th death was reported. Dashed lines show the expected trajectory for different doubling times of the epidemic. For example, with a doubling time of 3 days, if there are currently a total of 20 deaths reported, we would expect there to be 40 deaths in total reported in 3 days-time, 80 deaths in 6 days-time, 160 deaths in 9 days-time etc. For most epidemics, in the absence of interventions, we expect a doubling time of 3-4 days for this disease.

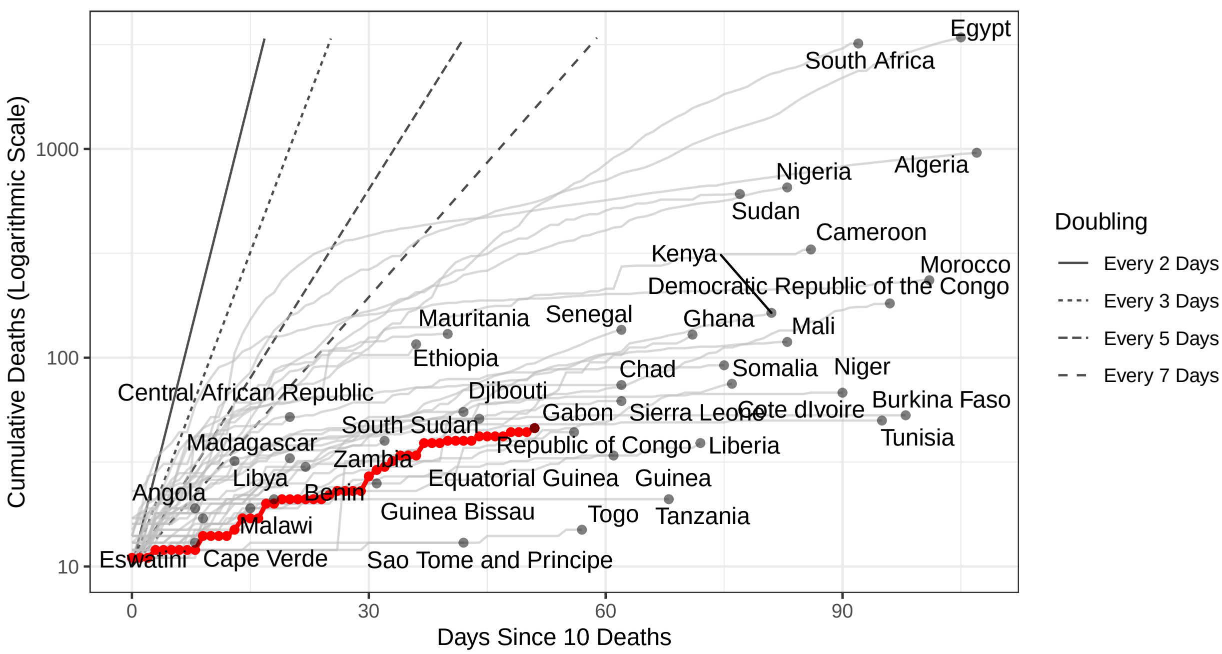

Figure 1: **Cumulative Deaths since 10 deaths.** Country not shown if fewer than 10 deaths.

COVID-19 Transmission Modelling

We assume that the deaths reported to date provide the best indication of the stage of the epidemic, as deaths are more consistently and accurately reported. Our current working estimate is that 1 death indicates that approximately 100 people will have been infected with the other 99 recovering (based on an infection fatality ratio of ~1%). These infections will have happened approximately 21 days previously – capturing a 5-day period from infection to onset of symptoms (the incubation period), 4 days from onset of symptoms to hospitalisation, and 12 days in hospital before death. With a 3-day doubling time, 100 infections that occurred 15 days ago will have generated 200 infections 12 days ago, 400 infections 9 days ago, 800 infections 6 days ago and 1,600 infections 3 days ago resulting in approximately 3,200 infections at the time the first death is observed.

To explore this, we fit our age-structured SEIR model (see Methods) to the time series of deaths in a country, in order to estimate the start date of the epidemic and the baseline R0. We assume that 100% of COVID-19 related deaths have been reported. We have also included the impact of interventions that have been put in place and their effect on human mobility and transmission based on the Google COVID-19 Community Mobility Reports. Using our mathematical model that formalises this approach, we estimate that there has been a total of 15,859 (95% CI: 13,815-17,902) infections over the past 4 weeks.

The figure below shows the estimated number of people infected over the past 4 weeks. The bar charts show, for comparison, the number of reported cases. The right-hand plot shows these data on a different scale as the estimated infections are likely to be much larger than the reported cases. **Importantly**, the estimated infections includes both asymptomatic and mild cases that would not necessarily be identified through surveillance. Consequently, the estimated infections are likely to be significantly higher than the reported cases (see our FAQ for further explanation of these differences and why the reported cases and estimated infections are unlikely to match).

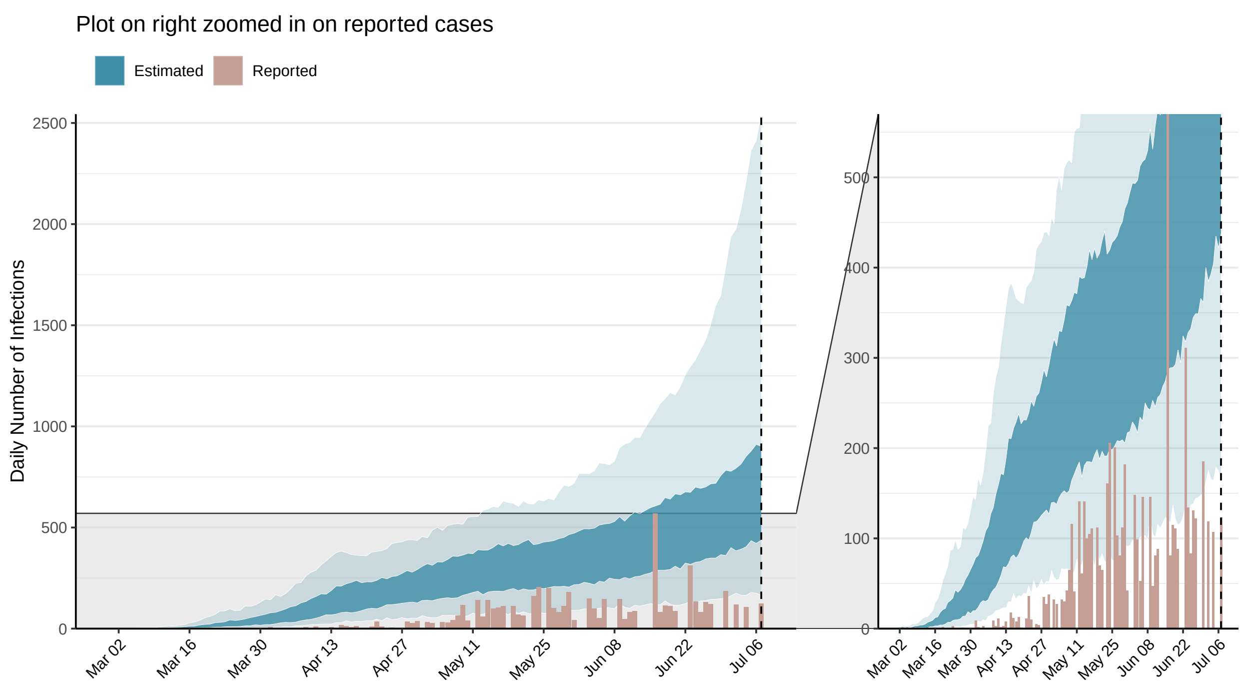

Figure 2: **Daily number of infections estimated by fitting to the current total of deaths.** Reported cases are shown in red. Model estimated infections are shown in blue (dark blue 50% interquartile range, light blue 95% quantile). The dashed line shows the current day.

By fitting to the time series of deaths, we are able to estimate a time-varying reproduction number, R_t. R_t is the the average number of secondary infections caused by a single infected person at a given time. If R_t is above 1, the rate of transmission is increasing and the number of new infections is increasing. R_t is assumed to change in relation to mobility fall in proportion. When fitting our model we assume that 100% of COVID-19 related deaths have been reported (please see our FAQ section for more information about this assumption). We also assume a fixed date at which the impact of mobility on transmission changes from pre-lockdown levels to post-lockdown levels, which may cause large changes in Rt. We are working to refine how this switch occurs and to formally calculate its shape.

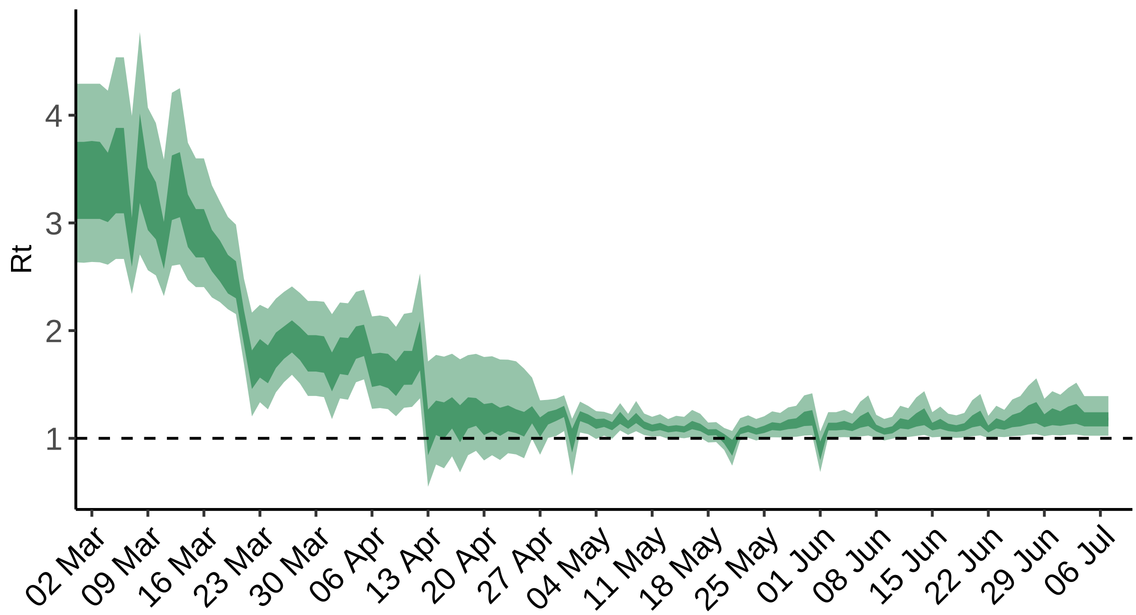

Figure 3: **Time-varying reproduction number, R_t.** R_t is the average number of secondary infections caused by a single infected person at time equal to t. $R_t < 1$ indicates a slowing epidemic in which new infections are not increasing. $R_t > 1$ indicates a growing epidemic in which new infections are increasing over time. Dark green shows the 50% CI and light green shows the 95% CI.

Using the model fit, we can forecast the expected trajectory for cumulative deaths, which is shown in the figure below. This assumes a severity pattern by age that is consistent with that observed in China, Europe and the U.S to date. This projection assumes that transmission is maintained at the current level of transmission as estimated by the final R_t value.

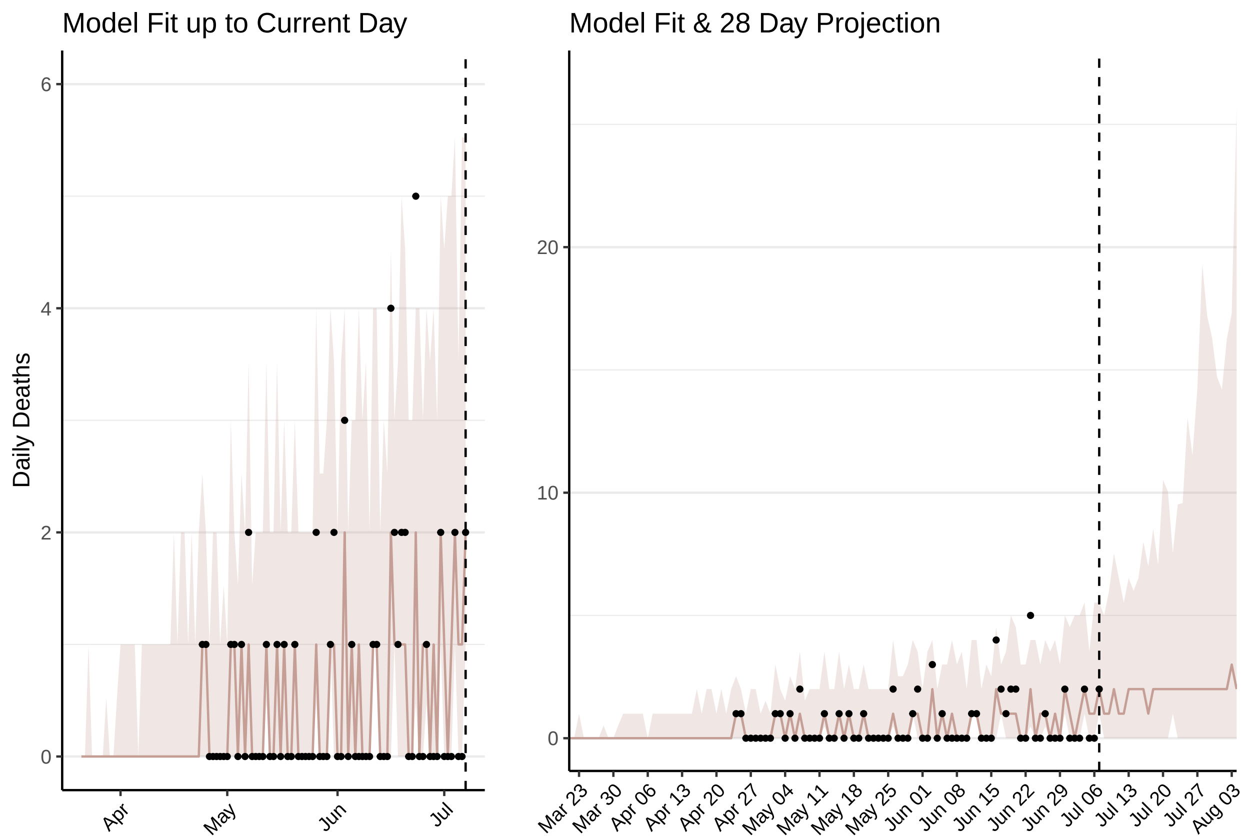

Figure 4: **Estimated daily deaths.** Projected deaths assuming the current level of interventions are maintained are shown in red (median and 95% quantile). Reported deaths are plotted in black. The plot on the left is focussed on the model fit prior to today, while the plot on the right forecasts the next 28 days.

Short-term Epidemic Scenarios

We make the following short-term projections of healthcare demand and new infections under the following three scenarios:

- **Scenario 1.** The epidemic continues to grow at the current rate.
- **Scenario 2.** Countries will further scale up interventions (either increasing current strategies or implementing new interventions) leading to a further 50% reduction in transmission.
- **Scenario 3.** Countries will relax current interventions by 50%

N.B. These scenarios currently assume that the impact of mobility on transmission will remain the same in the future as it has in the past. We are working to extend methods to estimate the impact of increases in mobility on transmission as lockdown and interventions are reversed. Consequently, projection are likely to represent an upper estimate of the healthcare demand and case load for each scenario

We estimate that over the next 4 weeks demand for hospital beds will change from 94 (95% CI: 82-106) patients requiring treatment with high-pressure oxygen at the current date to 203 (95% CI: 161-245) hospital beds being required on 2020-08-04 if no further interventions are introduced (Scenario 1). Similarly, we estimate that over the next 4 weeks demand for critical care (ICU) beds will change from 26 (95% CI: 22-29) patients requiring treatment with mechanical ventilation at the current date to 52 (95% CI: 43-61) by 2020-08-04. These projections assume that approximately 5% of all infections will require treatment with high-pressure oxygen and that approximately 30% of hospitalised cases will require treatment with mechanical ventilation (based on analysis of ongoing epidemics in Europe). **N.B. These scenarios are unlikely to show significant differences for the first week since there is a delay of approximately 10 days between infection and hospital admission. Consequently, the effectiveness of a change in policy is likely to be better captured by hospital admission data approximately 2 weeks after the policy change is implemented.**

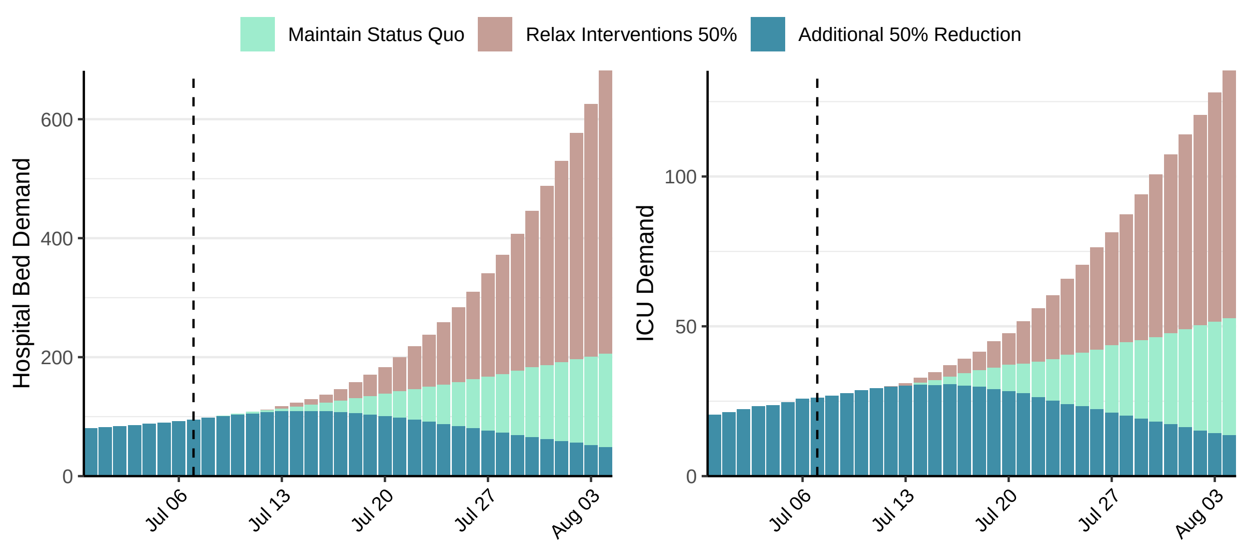

Figure 5: **Healthcare demands in the next 28 days.** Individuals needing an ICU bed are assumed to need mechanical ventilation. Projected demand for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

The impact of each scenario has a more immediate effect on the daily number of infections. The figure below shows the impact of each scenario on the estimated daily incidence of new infections. If interventions are scaled up (Scenario 2), the daily number of infections will change from 798 (95% CI: 672-923) at the current date to 132 (95% CI: 102-162) by 2020-08-04. If current interventions were relaxed by 50%, we estimate the daily number of infections will change from 798 (95% CI: 672-923) at the current date to 9,428 (95% CI: 7,668-11,189) by 2020-08-04.

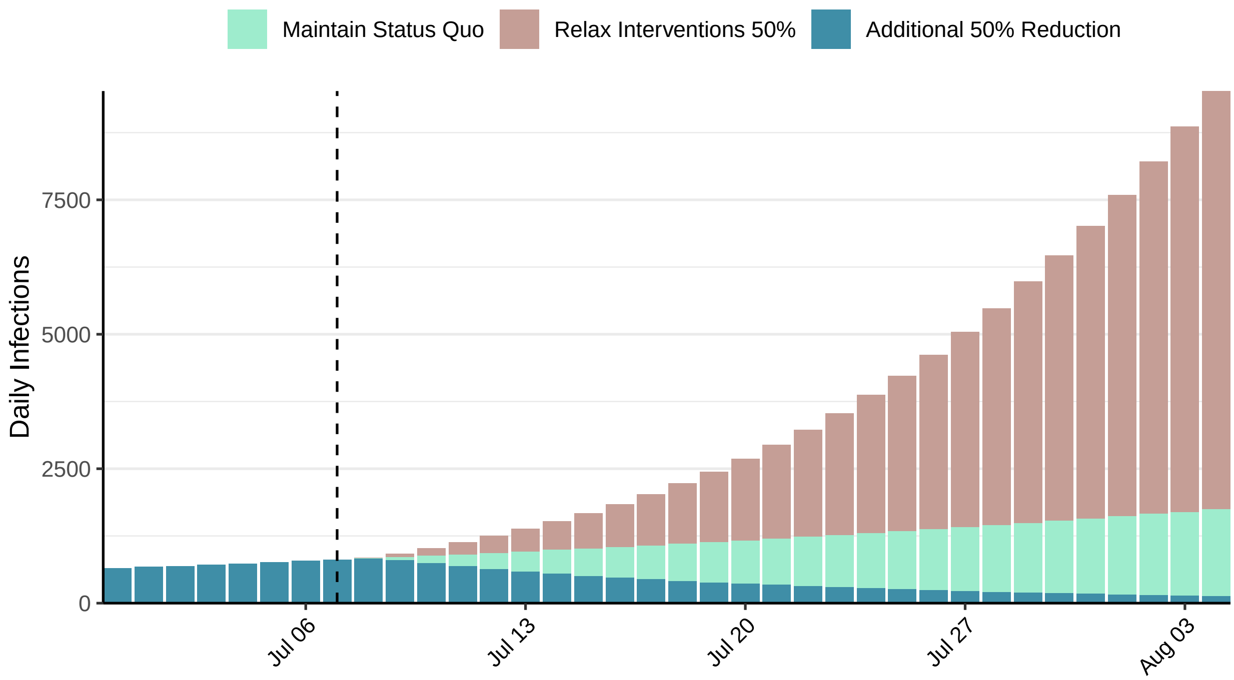

Figure 6: **Daily number of infections estimated by fitting to deaths.** Projected infections for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

To explore different scenarios, we recommend using our COVID-19 Scenario Analysis Tool - https://covidsim.org/, which can be used to simulate different intervention scenarios and explore the long term impact on healthcare demand.

Situation Report for COVID-19: Georgia, 2020-07-07

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Epidemiological Situation

Total Reported Cases	New Reported Cases	Total Reported Deaths	New Reported Deaths	Estimated R_t
958	5	15	0	0.83 (95% CI: 0.66-0.99)

The figure below shows the cumulative reported deaths as a function of the time since the 10th death was reported. Dashed lines show the expected trajectory for different doubling times of the epidemic. For example, with a doubling time of 3 days, if there are currently a total of 20 deaths reported, we would expect there to be 40 deaths in total reported in 3 days-time, 80 deaths in 6 days-time, 160 deaths in 9 days-time etc. For most epidemics, in the absence of interventions, we expect a doubling time of 3-4 days for this disease.

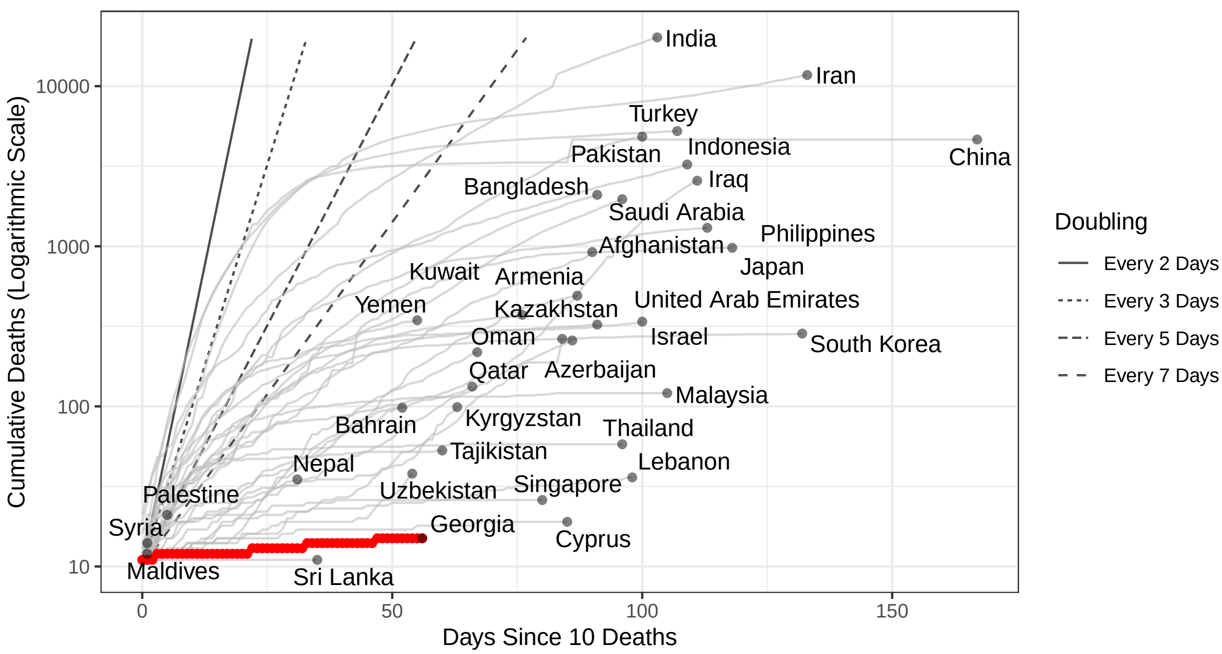

Figure 1: **Cumulative Deaths since 10 deaths.** Country not shown if fewer than 10 deaths.

COVID-19 Transmission Modelling

We assume that the deaths reported to date provide the best indication of the stage of the epidemic, as deaths are more consistently and accurately reported. Our current working estimate is that 1 death indicates that approximately 100 people will have been infected with the other 99 recovering (based on an infection fatality ratio of ~1%). These infections will have happened approximately 21 days previously – capturing a 5-day period from infection to onset of symptoms (the incubation period), 4 days from onset of symptoms to hospitalisation, and 12 days in hospital before death. With a 3-day doubling time, 100 infections that occurred 15 days ago will have generated 200 infections 12 days ago, 400 infections 9 days ago, 800 infections 6 days ago and 1,600 infections 3 days ago resulting in approximately 3,200 infections at the time the first death is observed.

To explore this, we fit our age-structured SEIR model (see Methods) to the time series of deaths in a country, in order to estimate the start date of the epidemic and the baseline R0. We assume that 100% of COVID-19 related deaths have been reported. We have also included the impact of interventions that have been put in place and their effect on human mobility and transmission based on the Google COVID-19 Community Mobility Reports. Using our mathematical model that formalises this approach, we estimate that there has been a total of 435 (95% CI: 333-538) infections over the past 4 weeks.

The figure below shows the estimated number of people infected over the past 4 weeks. The bar charts show, for comparison, the number of reported cases. The right-hand plot shows these data on a different scale as the estimated infections are likely to be much larger than the reported cases. **Importantly**, the estimated infections includes both asymptomatic and mild cases that would not necessarily be identified through surveillance. Consequently, the estimated infections are likely to be significantly higher than the reported cases (see our FAQ for further explanation of these differences and why the reported cases and estimated infections are unlikely to match).

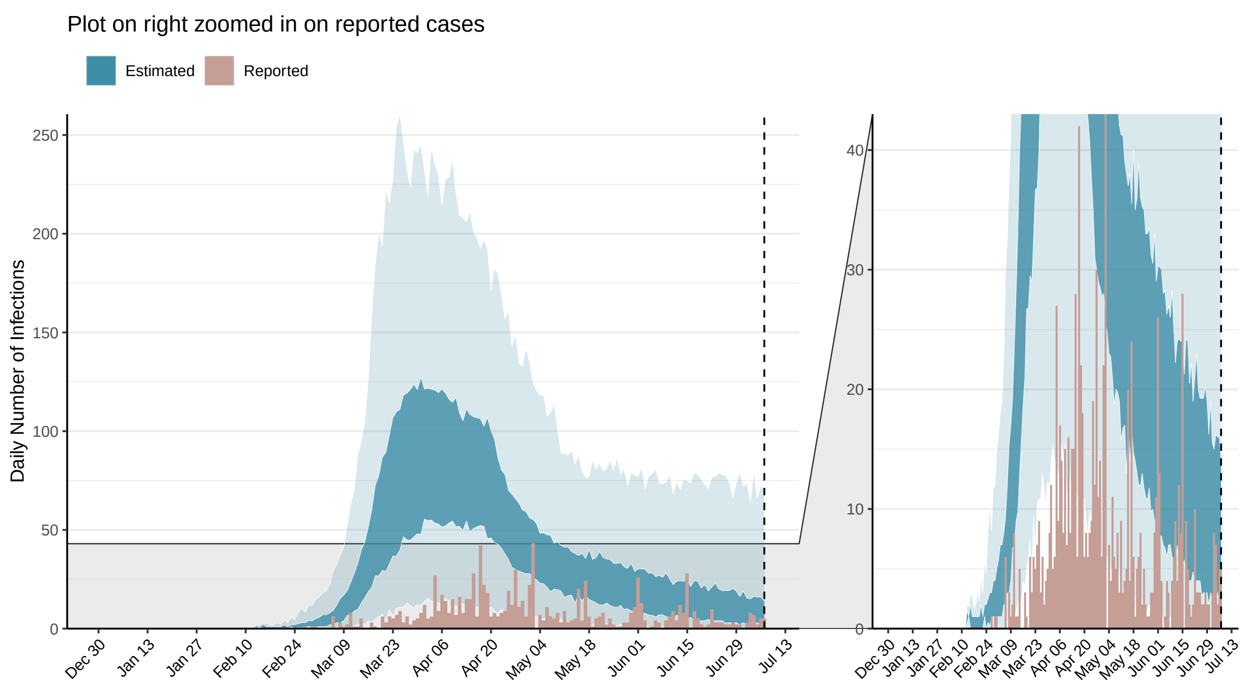

Figure 2: **Daily number of infections estimated by fitting to the current total of deaths.** Reported cases are shown in red. Model estimated infections are shown in blue (dark blue 50% interquartile range, light blue 95% quantile). The dashed line shows the current day.

By fitting to the time series of deaths, we are able to estimate a time-varying reproduction number, R_t. R_t is the the average number of secondary infections caused by a single infected person at a given time. If R_t is above 1, the rate of transmission is increasing and the number of new infections is increasing. R_t is assumed to change in relation to mobility fall in proportion. When fitting our model we assume that 100% of COVID-19 related deaths have been reported (please see our FAQ section for more information about this assumption). We also assume a fixed date at which the impact of mobility on transmission changes from pre-lockdown levels to post-lockdown levels, which may cause large changes in Rt. We are working to refine how this switch occurs and to formally calculate its shape.

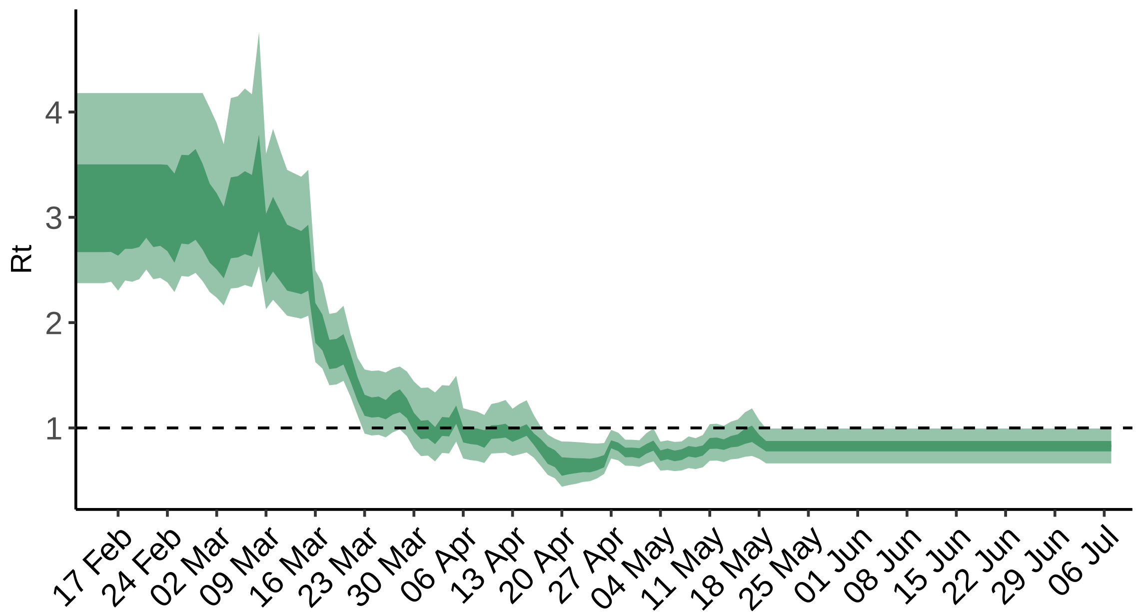

Figure 3: **Time-varying reproduction number, R_t.** R_t is the average number of secondary infections caused by a single infected person at time equal to t. $R_t < 1$ indicates a slowing epidemic in which new infections are not increasing. $R_t > 1$ indicates a growing epidemic in which new infections are increasing over time. Dark green shows the 50% CI and light green shows the 95% CI.

Using the model fit, we can forecast the expected trajectory for cumulative deaths, which is shown in the figure below. This assumes a severity pattern by age that is consistent with that observed in China, Europe and the U.S to date. This projection assumes that transmission is maintained at the current level of transmission as estimated by the final R_t value.

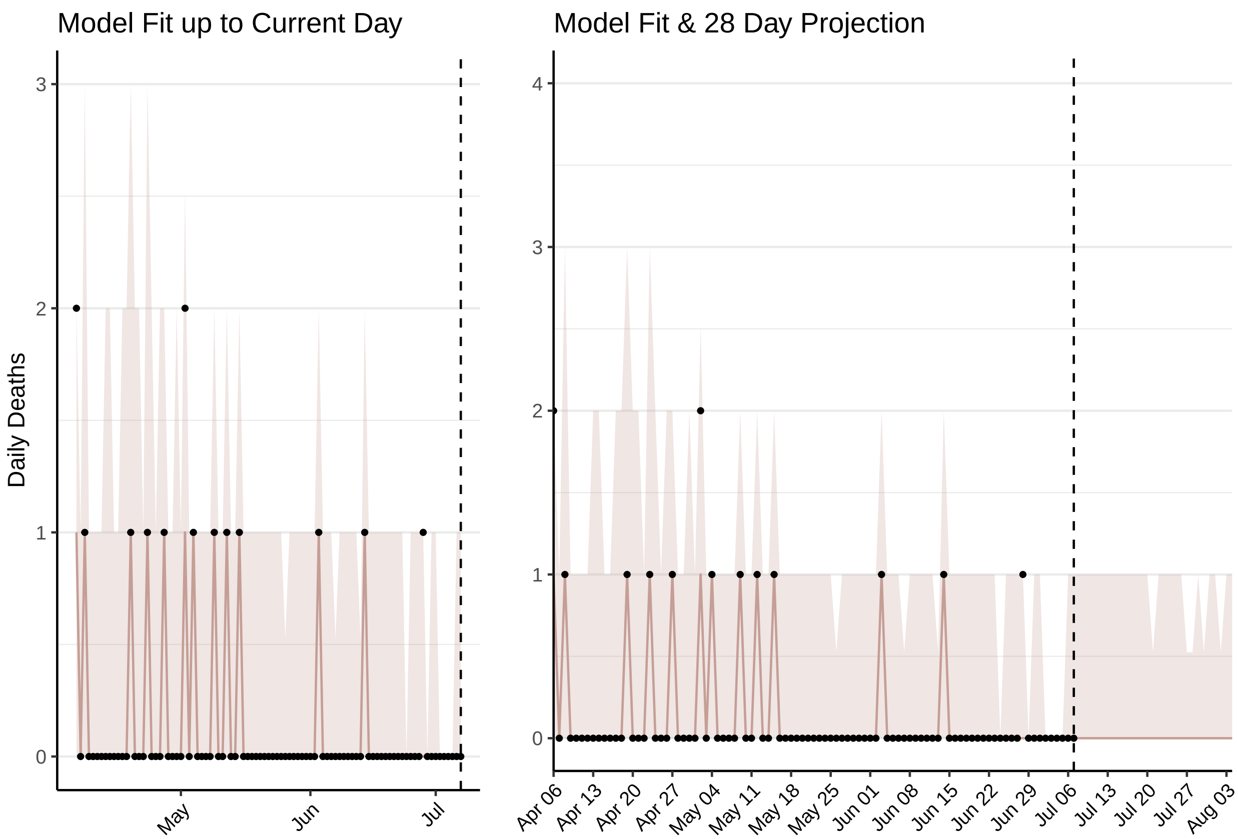

Figure 4: **Estimated daily deaths.** Projected deaths assuming the current level of interventions are maintained are shown in red (median and 95% quantile). Reported deaths are plotted in black. The plot on the left is focussed on the model fit prior to today, while the plot on the right forecasts the next 28 days.

Short-term Epidemic Scenarios

We make the following short-term projections of healthcare demand and new infections under the following three scenarios:

- **Scenario 1.** The epidemic continues to grow at the current rate.
- **Scenario 2.** Countries will further scale up interventions (either increasing current strategies or implementing new interventions) leading to a further 50% reduction in transmission.
- **Scenario 3.** Countries will relax current interventions by 50%

N.B. These scenarios currently assume that the impact of mobility on transmission will remain the same in the future as it has in the past. We are working to extend methods to estimate the impact of increases in mobility on transmission as lockdown and interventions are reversed. Consequently, projection are likely to represent an upper estimate of the healthcare demand and case load for each scenario

We estimate that over the next 4 weeks demand for hospital beds will change from 3 (95% CI: 2-4) patients requiring treatment with high-pressure oxygen at the current date to 2 (95% CI: 1-3) hospital beds being required on 2020-08-04 if no further interventions are introduced (Scenario 1). Similarly, we estimate that over the next 4 weeks demand for critical care (ICU) beds will change from 1 (95% CI: 1-1) patients requiring treatment with mechanical ventilation at the current date to 1 (95% CI: 0-1) by 2020-08-04. These projections assume that approximately 5% of all infections will require treatment with high-pressure oxygen and that approximately 30% of hospitalised cases will require treatment with mechanical ventilation (based on analysis of ongoing epidemics in Europe). **N.B. These scenarios are unlikely to show significant differences for the first week since there is a delay of approximately 10 days between infection and hospital admission. Consequently, the effectiveness of a change in policy is likely to be better captured by hospital admission data approximately 2 weeks after the policy change is implemented.**

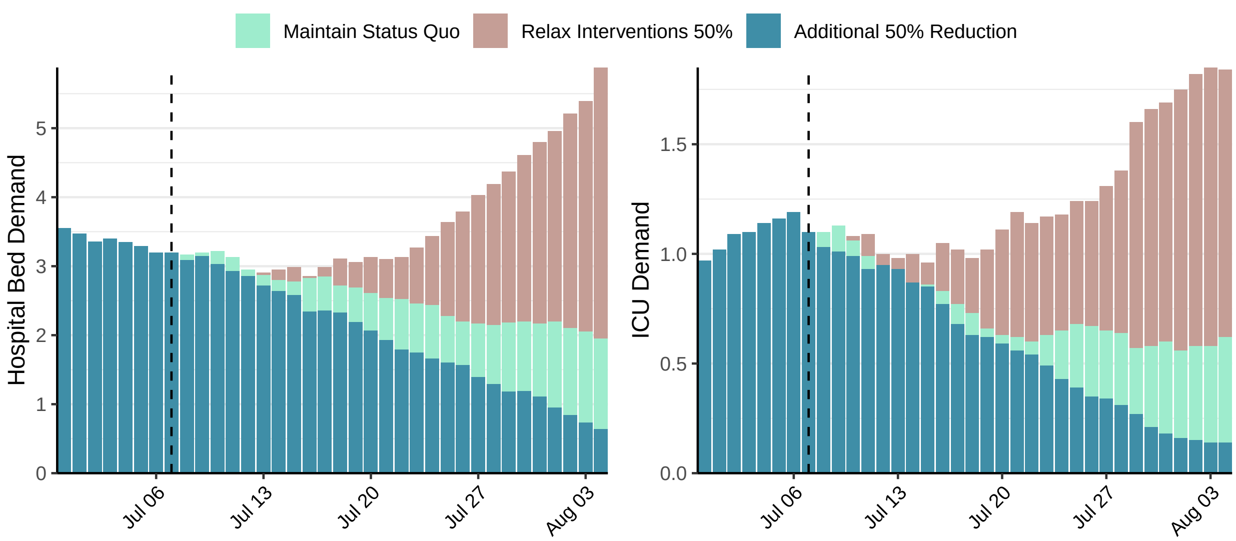

Figure 5: **Healthcare demands in the next 28 days.** Individuals needing an ICU bed are assumed to need mechanical ventilation. Projected demand for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

The impact of each scenario has a more immediate effect on the daily number of infections. The figure below shows the impact of each scenario on the estimated daily incidence of new infections. If interventions are scaled up (Scenario 2), the daily number of infections will change from 12 (95% CI: 9-16) at the current date to 1 (95% CI: 0-1) by 2020-08-04. If current interventions were relaxed by 50%, we estimate the daily number of infections will change from 12 (95% CI: 9-16) at the current date to 49 (95% CI: 31-68) by 2020-08-04.

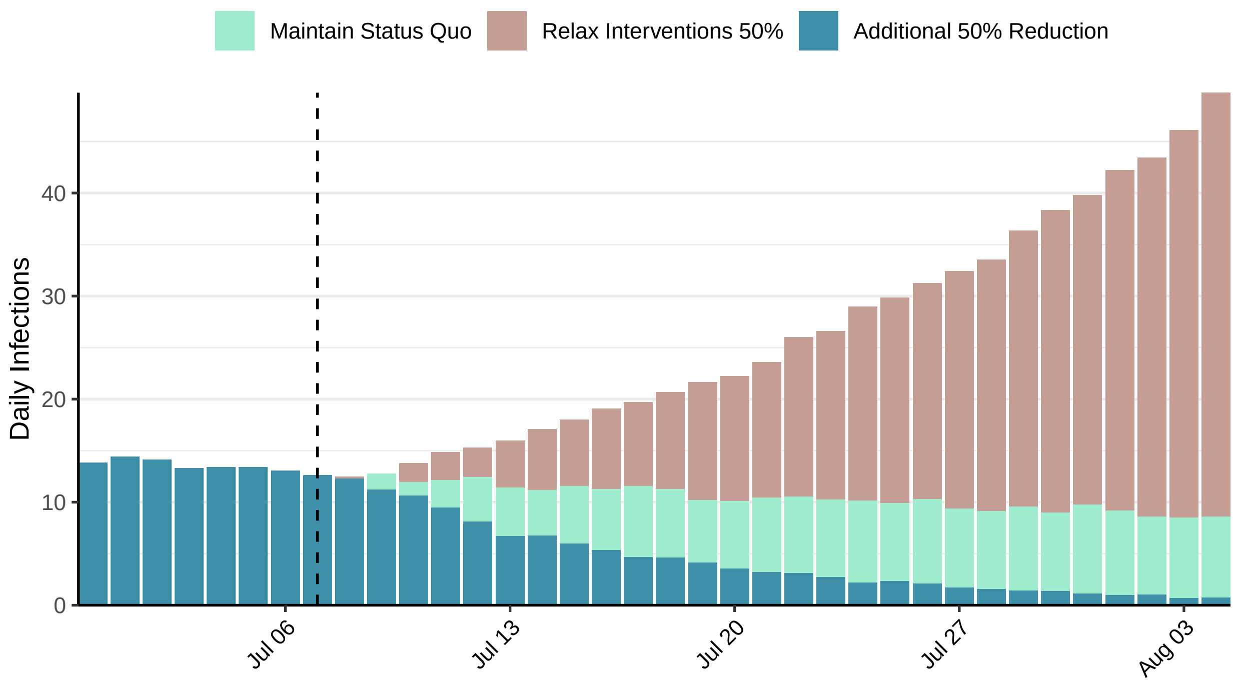

Figure 6: **Daily number of infections estimated by fitting to deaths.** Projected infections for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

To explore different scenarios, we recommend using our COVID-19 Scenario Analysis Tool - https://covidsim.org/, which can be used to simulate different intervention scenarios and explore the long term impact on healthcare demand.

Situation Report for COVID-19: Ghana, 2020-07-07

Download the report for Ghana, 2020-07-07 here. This report uses data from the European Centre for Disease Control. These data are updated daily and whilst there may be a short delay, they are generally consistent with Ministry reports. These data are then used to back-calculate an 'inferred number of COVID-19 infections' using mathematical modelling techniques (see Report 12 for further details) to estimate the number of people that have been infected and to make short-term projections for future healthcare needs.

Epidemiological Situation

Total Reported Cases	New Reported Cases	Total Reported Deaths	New Reported Deaths	Estimated R_t
21,077	992	129	7	1.36 (95% CI: 1.2-1.52)

The figure below shows the cumulative reported deaths as a function of the time since the 10th death was reported. Dashed lines show the expected trajectory for different doubling times of the epidemic. For example, with a doubling time of 3 days, if there are currently a total of 20 deaths reported, we would expect there to be 40 deaths in total reported in 3 days-time, 80 deaths in 6 days-time, 160 deaths in 9 days-time etc. For most epidemics, in the absence of interventions, we expect a doubling time of 3-4 days for this disease.

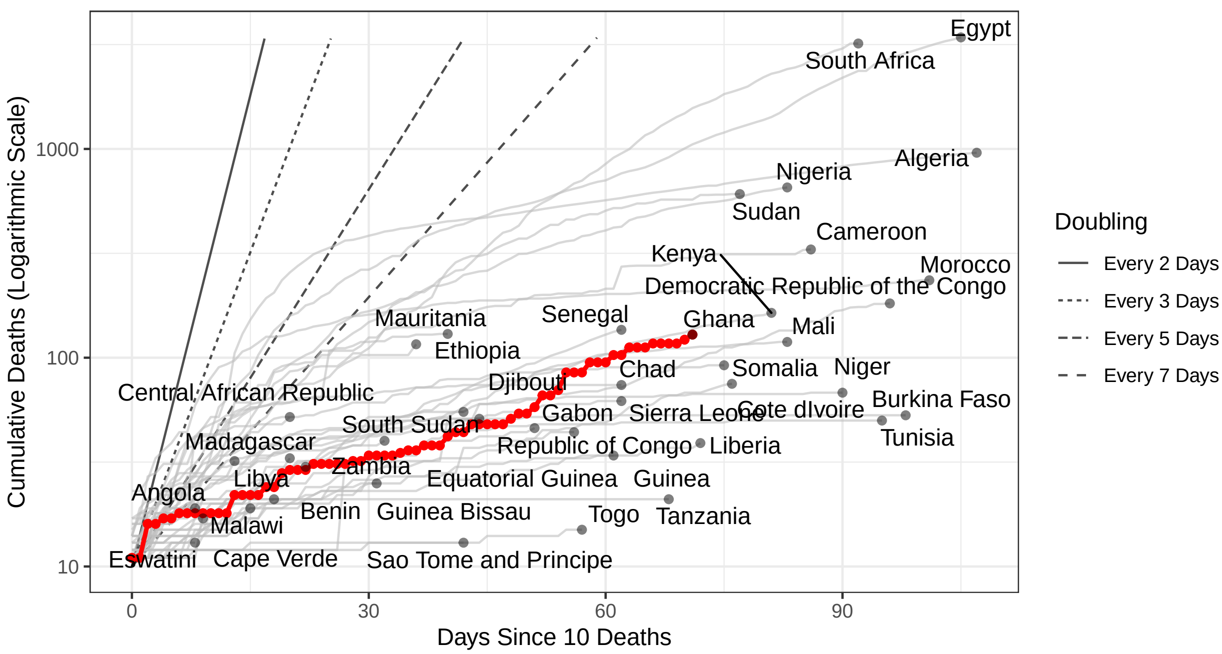

Figure 1: **Cumulative Deaths since 10 deaths.** Country not shown if fewer than 10 deaths.

COVID-19 Transmission Modelling

We assume that the deaths reported to date provide the best indication of the stage of the epidemic, as deaths are more consistently and accurately reported. Our current working estimate is that 1 death indicates that approximately 100 people will have been infected with the other 99 recovering (based on an infection fatality ratio of ~1%). These infections will have happened approximately 21 days previously – capturing a 5-day period from infection to onset of symptoms (the incubation period), 4 days from onset of symptoms to hospitalisation, and 12 days in hospital before death. With a 3-day doubling time, 100 infections that occurred 15 days ago will have generated 200 infections 12 days ago, 400 infections 9 days ago, 800 infections 6 days ago and 1,600 infections 3 days ago resulting in approximately 3,200 infections at the time the first death is observed.

To explore this, we fit our age-structured SEIR model (see Methods) to the time series of deaths in a country, in order to estimate the start date of the epidemic and the baseline R0. We assume that 100% of COVID-19 related deaths have been reported. We have also included the impact of interventions that have been put in place and their effect on human mobility and transmission based on the Google COVID-19 Community Mobility Reports. Using our mathematical model that formalises this approach, we estimate that there has been a total of 88,074 (95% CI: 76,457-99,691) infections over the past 4 weeks.

The figure below shows the estimated number of people infected over the past 4 weeks. The bar charts show, for comparison, the number of reported cases. The right-hand plot shows these data on a different scale as the estimated infections are likely to be much larger than the reported cases. **Importantly**, the estimated infections includes both asymptomatic and mild cases that would not necessarily be identified through surveillance. Consequently, the estimated infections are likely to be significantly higher than the reported cases (see our FAQ for further explanation of these differences and why the reported cases and estimated infections are unlikely to match).

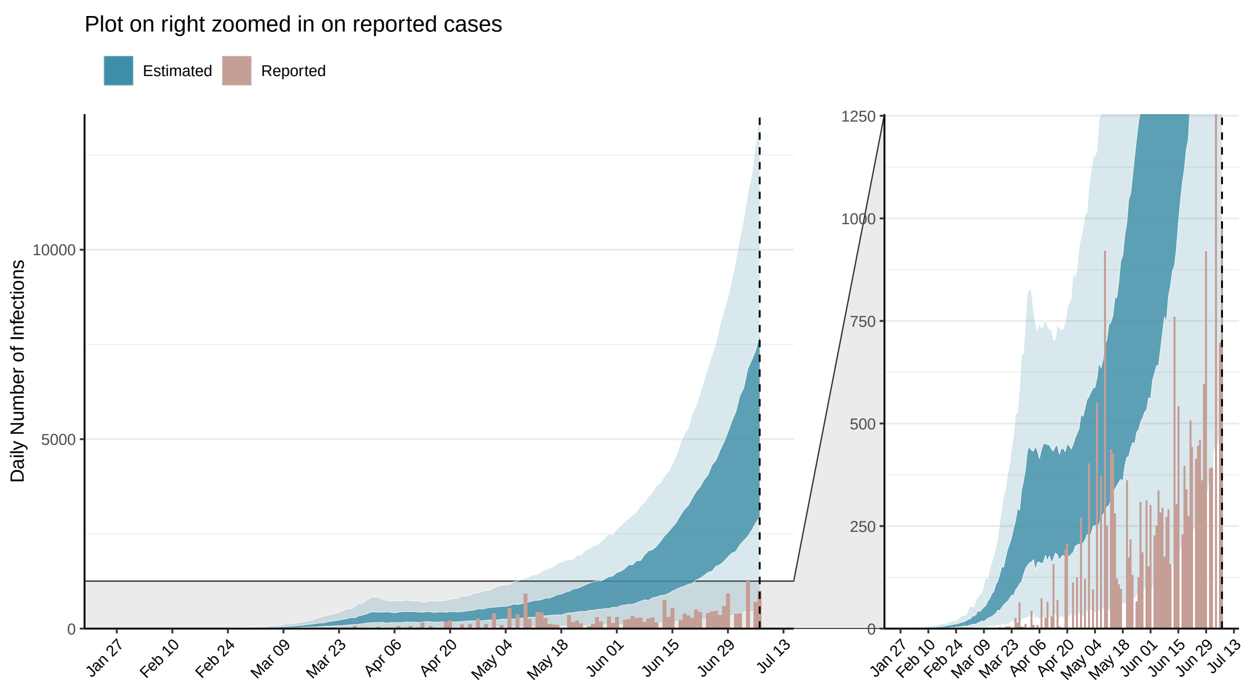

Figure 2: **Daily number of infections estimated by fitting to the current total of deaths.** Reported cases are shown in red. Model estimated infections are shown in blue (dark blue 50% interquartile range, light blue 95% quantile). The dashed line shows the current day.

By fitting to the time series of deaths, we are able to estimate a time-varying reproduction number, R_t. R_t is the the average number of secondary infections caused by a single infected person at a given time. If R_t is above 1, the rate of transmission is increasing and the number of new infections is increasing. R_t is assumed to change in relation to mobility fall in proportion. When fitting our model we assume that 100% of COVID-19 related deaths have been reported (please see our FAQ section for more information about this assumption). We also assume a fixed date at which the impact of mobility on transmission changes from pre-lockdown levels to post-lockdown levels, which may cause large changes in Rt. We are working to refine how this switch occurs and to formally calculate its shape.

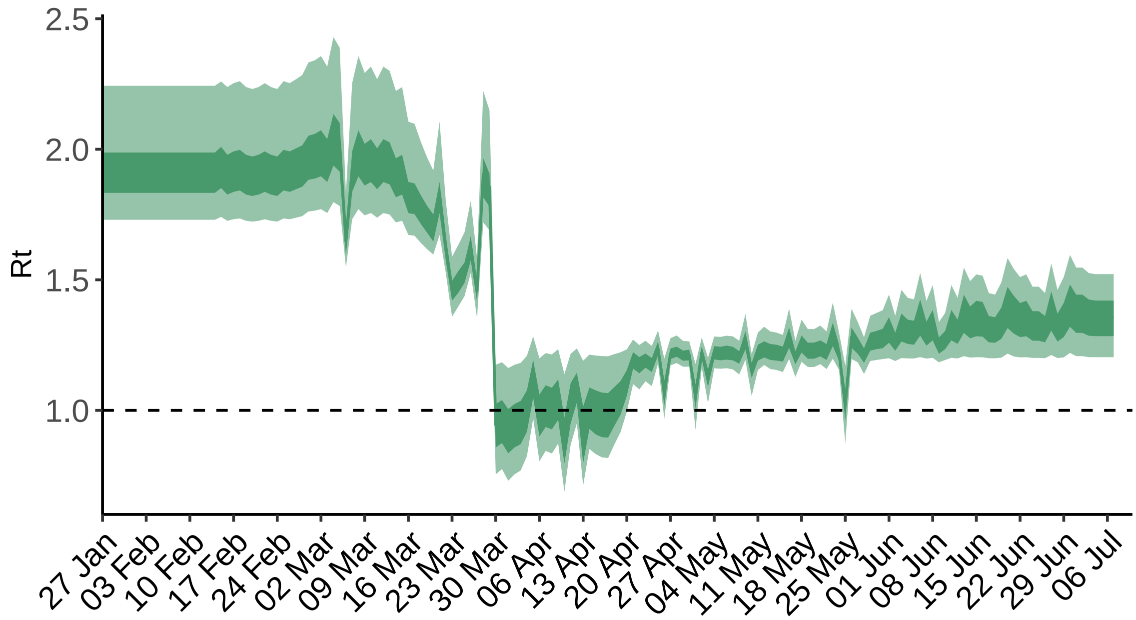

Figure 3: **Time-varying reproduction number, R_t.** R_t is the average number of secondary infections caused by a single infected person at time equal to t. $R_t < 1$ indicates a slowing epidemic in which new infections are not increasing. $R_t > 1$ indicates a growing epidemic in which new infections are increasing over time. Dark green shows the 50% CI and light green shows the 95% CI.

Using the model fit, we can forecast the expected trajectory for cumulative deaths, which is shown in the figure below. This assumes a severity pattern by age that is consistent with that observed in China, Europe and the U.S to date. This projection assumes that transmission is maintained at the current level of transmission as estimated by the final R_t value.

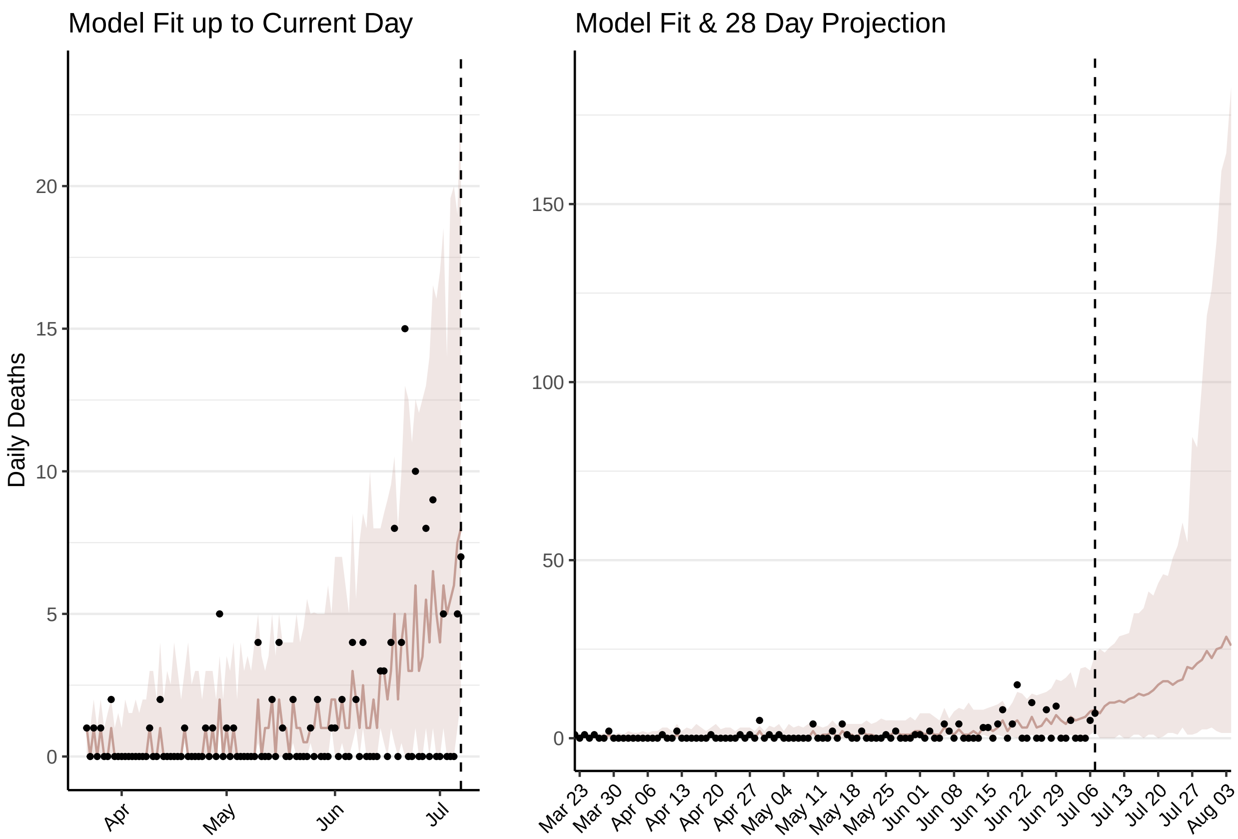

Figure 4: **Estimated daily deaths.** Projected deaths assuming the current level of interventions are maintained are shown in red (median and 95% quantile). Reported deaths are plotted in black. The plot on the left is focussed on the model fit prior to today, while the plot on the right forecasts the next 28 days.

Short-term Epidemic Scenarios

We make the following short-term projections of healthcare demand and new infections under the following three scenarios:

- **Scenario 1.** The epidemic continues to grow at the current rate.
- **Scenario 2.** Countries will further scale up interventions (either increasing current strategies or implementing new interventions) leading to a further 50% reduction in transmission.
- **Scenario 3.** Countries will relax current interventions by 50%

N.B. These scenarios currently assume that the impact of mobility on transmission will remain the same in the future as it has in the past. We are working to extend methods to estimate the impact of increases in mobility on transmission as lockdown and interventions are reversed. Consequently, projection are likely to represent an upper estimate of the healthcare demand and case load for each scenario

We estimate that over the next 4 weeks demand for hospital beds will change from 534 (95% CI: 463-606) patients requiring treatment with high-pressure oxygen at the current date to 2,165 (95% CI: 1,798-2,532) hospital beds being required on 2020-08-04 if no further interventions are introduced (Scenario 1). Similarly, we estimate that over the next 4 weeks demand for critical care (ICU) beds will change from 140 (95% CI: 122-159) patients requiring treatment with mechanical ventilation at the current date to 497 (95% CI: 435-560) by 2020-08-04. These projections assume that approximately 5% of all infections will require treatment with high-pressure oxygen and that approximately 30% of hospitalised cases will require treatment with mechanical ventilation (based on analysis of ongoing epidemics in Europe). **N.B. These scenarios are unlikely to show significant differences for the first week since there is a delay of approximately 10 days between infection and hospital admission. Consequently, the effectiveness of a change in policy is likely to be better captured by hospital admission data approximately 2 weeks after the policy change is implemented.**

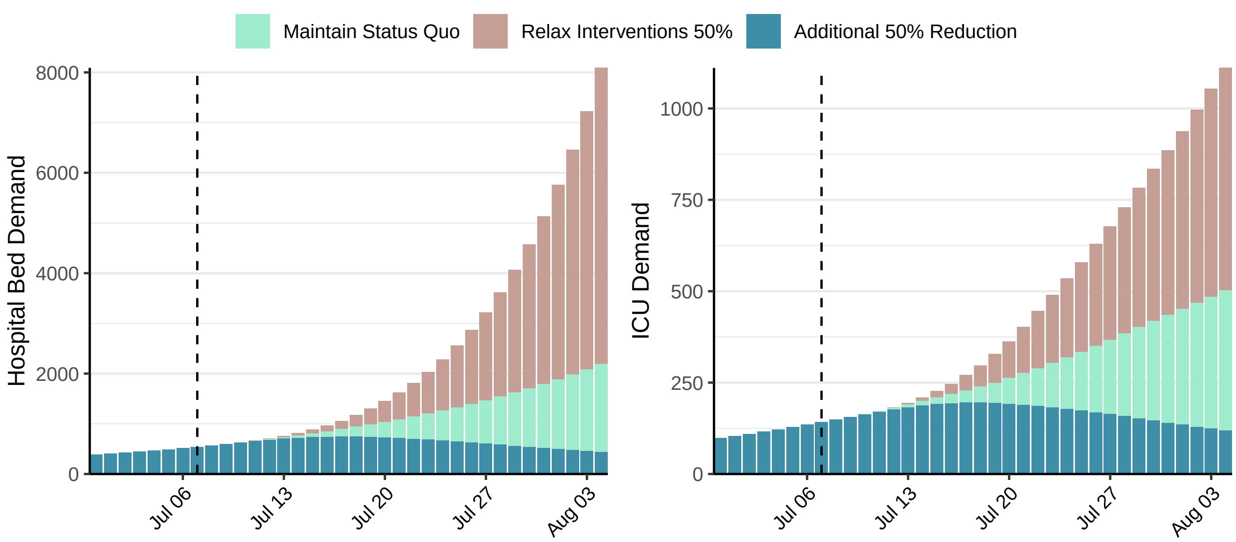

Figure 5: **Healthcare demands in the next 28 days.** Individuals needing an ICU bed are assumed to need mechanical ventilation. Projected demand for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

The impact of each scenario has a more immediate effect on the daily number of infections. The figure below shows the impact of each scenario on the estimated daily incidence of new infections. If interventions are scaled up (Scenario 2), the daily number of infections will change from 5,662 (95% CI: 4,839-6,485) at the current date to 1,503 (95% CI: 1,228-1,777) by 2020-08-04. If current interventions were relaxed by 50%, we estimate the daily number of infections will change from 5,662 (95% CI: 4,839-6,485) at the current date to 141,871 (95% CI: 118,470-165,272) by 2020-08-04.

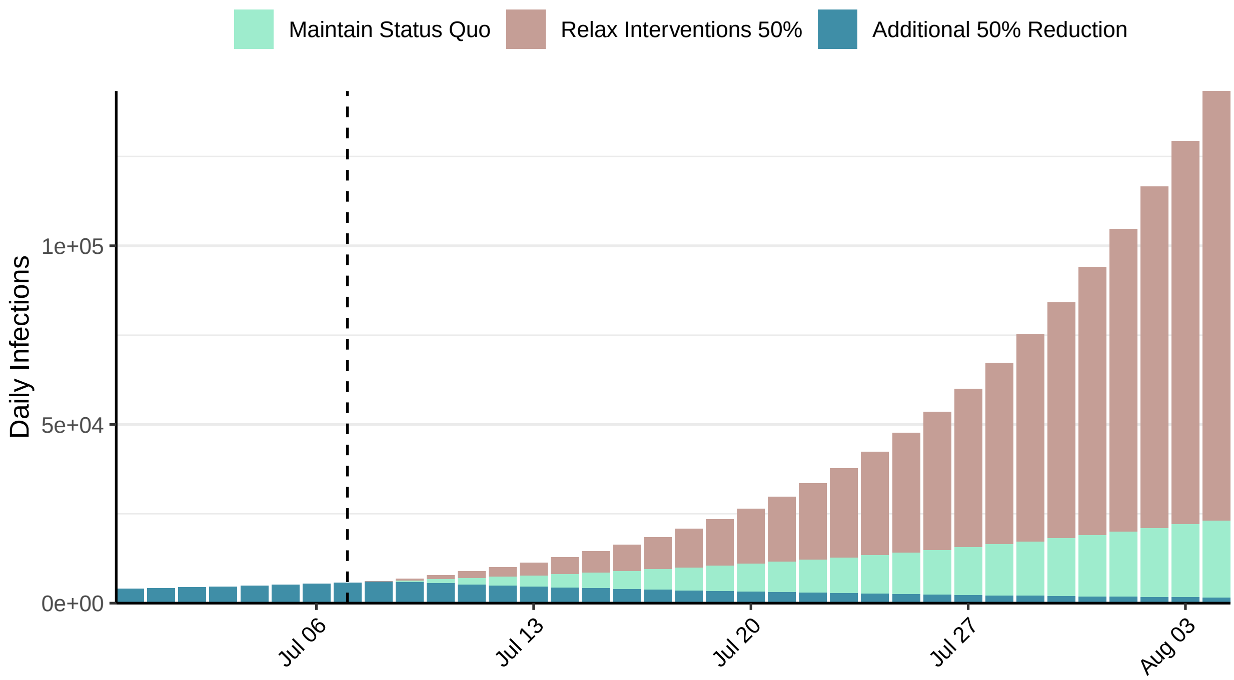

Figure 6: **Daily number of infections estimated by fitting to deaths.** Projected infections for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

To explore different scenarios, we recommend using our COVID-19 Scenario Analysis Tool - https://covidsim.org/, which can be used to simulate different intervention scenarios and explore the long term impact on healthcare demand.

Situation Report for COVID-19: Guinea, 2020-07-07

Download the report for Guinea, 2020-07-07 here. This report uses data from the European Centre for Disease Control. These data are updated daily and whilst there may be a short delay, they are generally consistent with Ministry reports. These data are then used to back-calculate an 'inferred number of COVID-19 infections' using mathematical modelling techniques (see Report 12 for further details) to estimate the number of people that have been infected and to make short-term projections for future healthcare needs.

Epidemiological Situation

Total Reported Cases	New Reported Cases	Total Reported Deaths	New Reported Deaths	Estimated R_t
5,636	26	34	0	1.23 (95% CI: 0.95-1.63)

The figure below shows the cumulative reported deaths as a function of the time since the 10th death was reported. Dashed lines show the expected trajectory for different doubling times of the epidemic. For example, with a doubling time of 3 days, if there are currently a total of 20 deaths reported, we would expect there to be 40 deaths in total reported in 3 days-time, 80 deaths in 6 days-time, 160 deaths in 9 days-time etc. For most epidemics, in the absence of interventions, we expect a doubling time of 3-4 days for this disease.

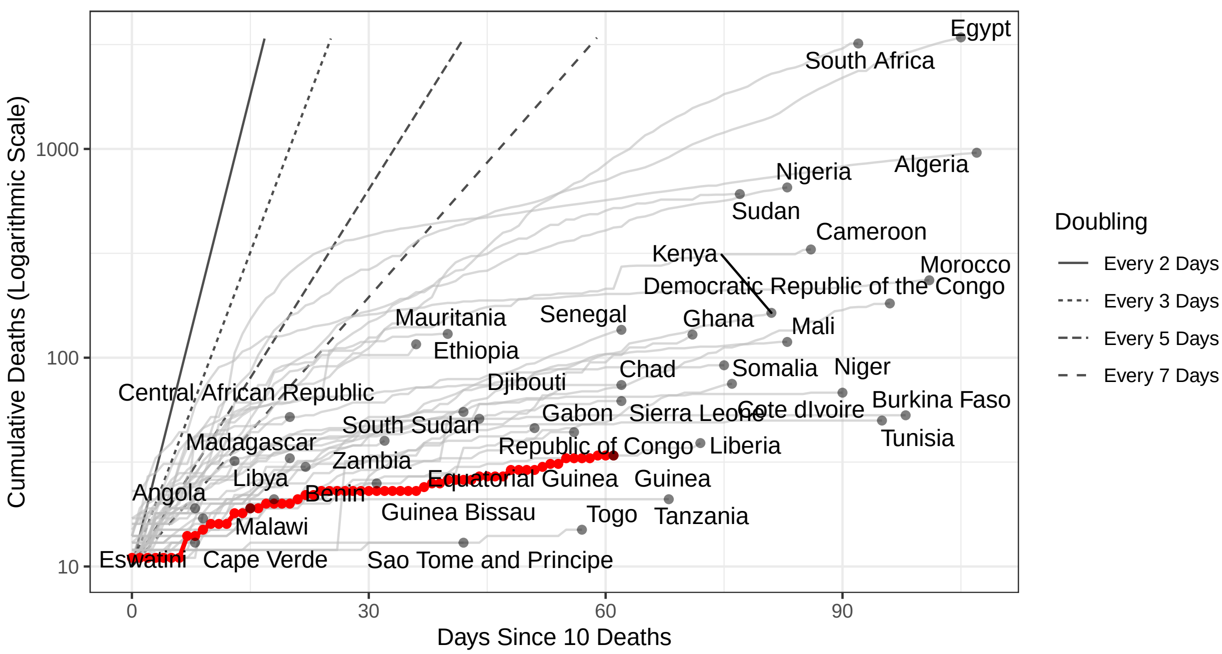

Figure 1: **Cumulative Deaths since 10 deaths.** Country not shown if fewer than 10 deaths.

COVID-19 Transmission Modelling

We assume that the deaths reported to date provide the best indication of the stage of the epidemic, as deaths are more consistently and accurately reported. Our current working estimate is that 1 death indicates that approximately 100 people will have been infected with the other 99 recovering (based on an infection fatality ratio of ~1%). These infections will have happened approximately 21 days previously – capturing a 5-day period from infection to onset of symptoms (the incubation period), 4 days from onset of symptoms to hospitalisation, and 12 days in hospital before death. With a 3-day doubling time, 100 infections that occurred 15 days ago will have generated 200 infections 12 days ago, 400 infections 9 days ago, 800 infections 6 days ago and 1,600 infections 3 days ago resulting in approximately 3,200 infections at the time the first death is observed.

To explore this, we fit our age-structured SEIR model (see Methods) to the time series of deaths in a country, in order to estimate the start date of the epidemic and the baseline R0. We assume that 100% of COVID-19 related deaths have been reported. We have also included the impact of interventions that have been put in place and their effect on human mobility and transmission based on the Google COVID-19 Community Mobility Reports. Using our mathematical model that formalises this approach, we estimate that there has been a total of 7,441 (95% CI: 6,499-8,383) infections over the past 4 weeks.

The figure below shows the estimated number of people infected over the past 4 weeks. The bar charts show, for comparison, the number of reported cases. The right-hand plot shows these data on a different scale as the estimated infections are likely to be much larger than the reported cases. **Importantly**, the estimated infections includes both asymptomatic and mild cases that would not necessarily be identified through surveillance. Consequently, the estimated infections are likely to be significantly higher than the reported cases (see our FAQ for further explanation of these differences and why the reported cases and estimated infections are unlikely to match).

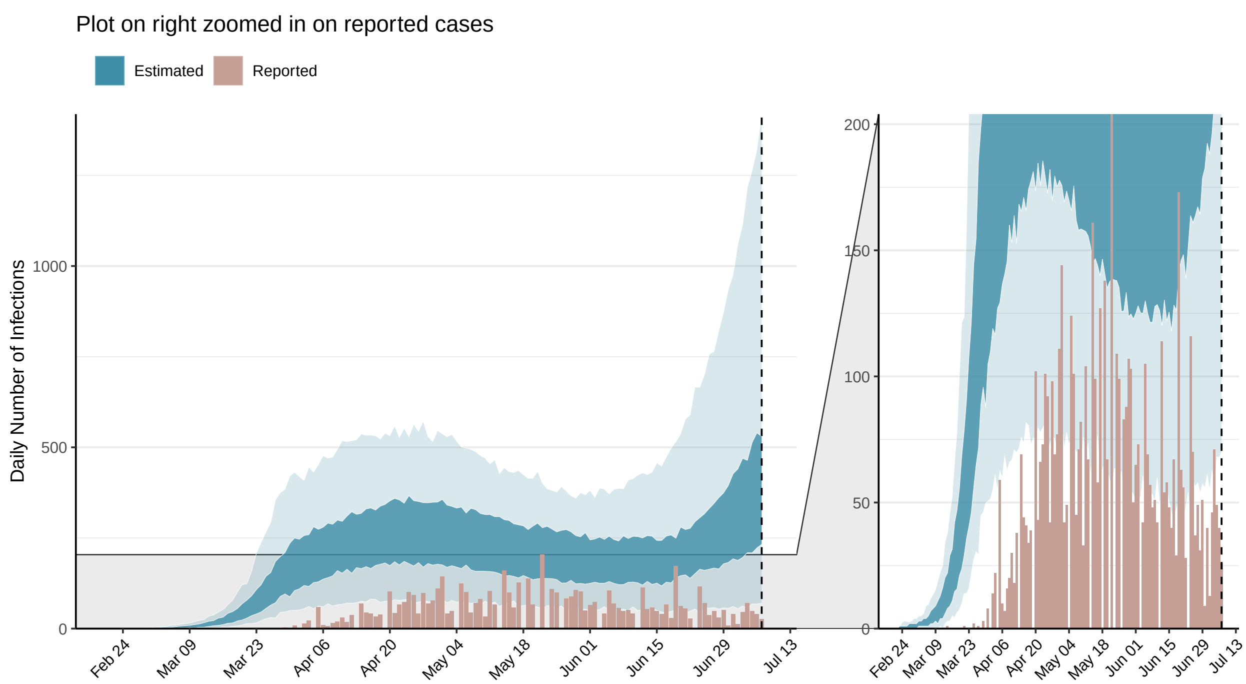

Figure 2: **Daily number of infections estimated by fitting to the current total of deaths.** Reported cases are shown in red. Model estimated infections are shown in blue (dark blue 50% interquartile range, light blue 95% quantile). The dashed line shows the current day.

By fitting to the time series of deaths, we are able to estimate a time-varying reproduction number, R_t. R_t is the the average number of secondary infections caused by a single infected person at a given time. If R_t is above 1, the rate of transmission is increasing and the number of new infections is increasing. R_t is assumed to change in relation to mobility fall in proportion. When fitting our model we assume that 100% of COVID-19 related deaths have been reported (please see our FAQ section for more information about this assumption). We also assume a fixed date at which the impact of mobility on transmission changes from pre-lockdown levels to post-lockdown levels, which may cause large changes in Rt. We are working to refine how this switch occurs and to formally calculate its shape.

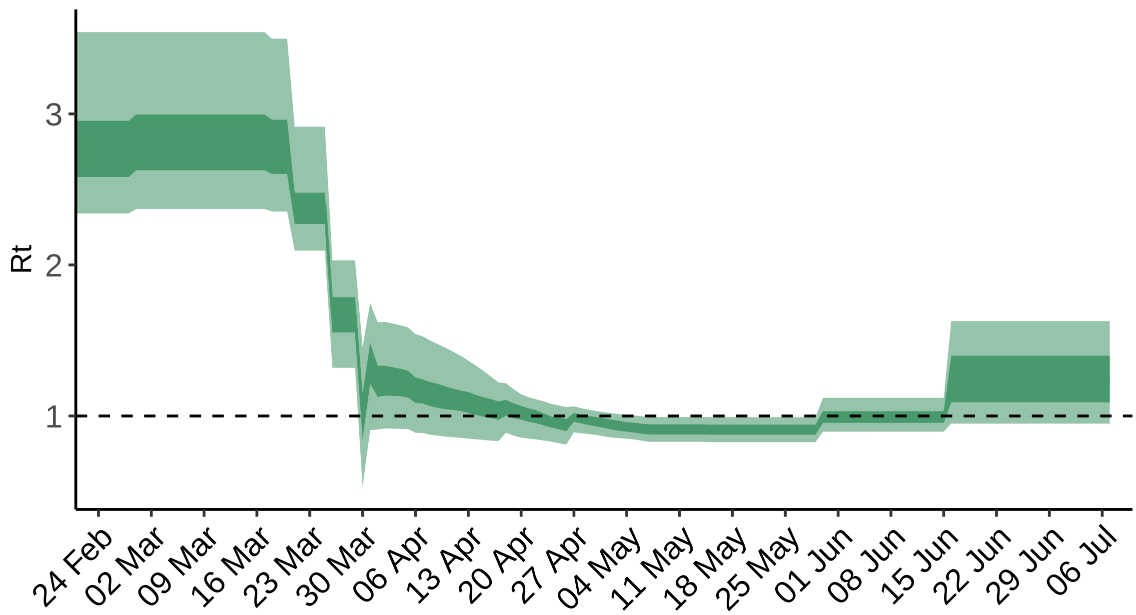

Figure 3: **Time-varying reproduction number, R_t.** R_t is the average number of secondary infections caused by a single infected person at time equal to t. $R_t < 1$ indicates a slowing epidemic in which new infections are not increasing. $R_t > 1$ indicates a growing epidemic in which new infections are increasing over time. Dark green shows the 50% CI and light green shows the 95% CI.

Using the model fit, we can forecast the expected trajectory for cumulative deaths, which is shown in the figure below. This assumes a severity pattern by age that is consistent with that observed in China, Europe and the U.S to date. This projection assumes that transmission is maintained at the current level of transmission as estimated by the final R_t value.

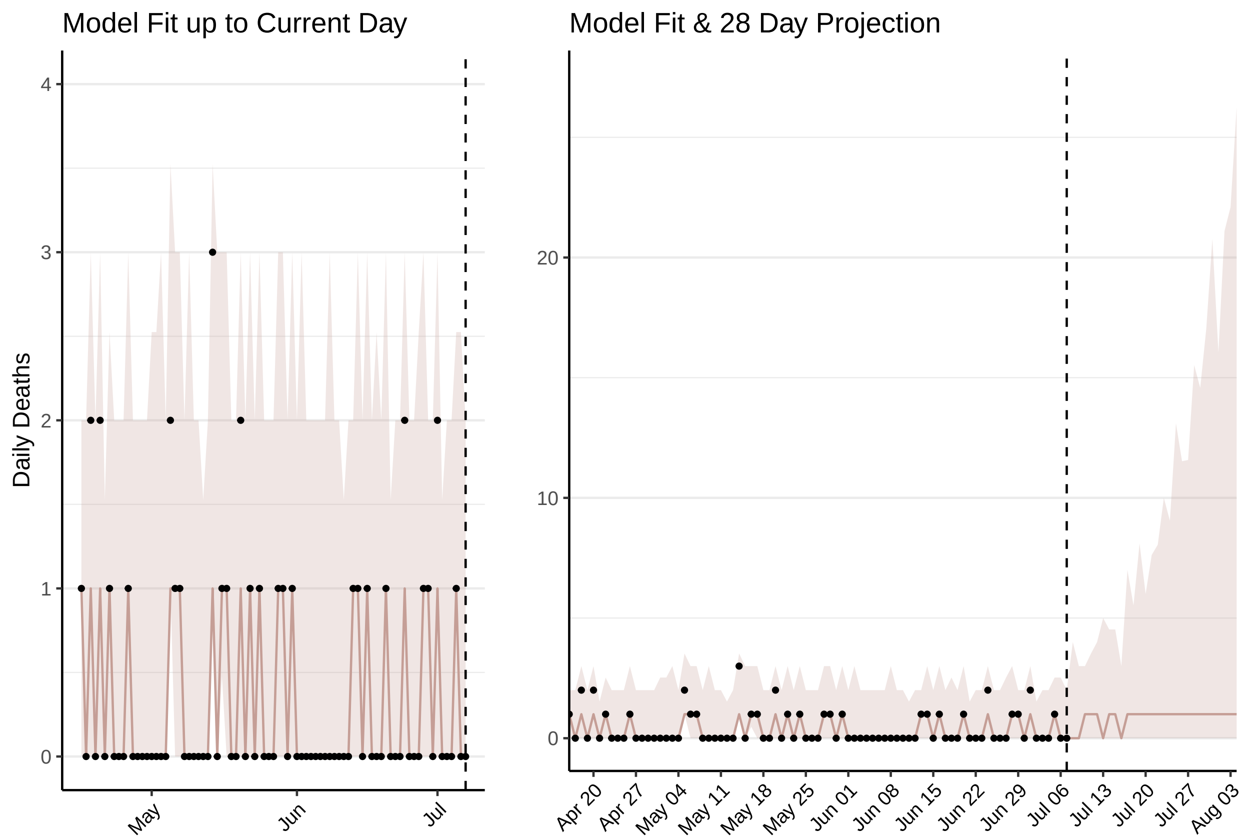

Figure 4: **Estimated daily deaths.** Projected deaths assuming the current level of interventions are maintained are shown in red (median and 95% quantile). Reported deaths are plotted in black. The plot on the left is focussed on the model fit prior to today, while the plot on the right forecasts the next 28 days.

Short-term Epidemic Scenarios

We make the following short-term projections of healthcare demand and new infections under the following three scenarios:

- **Scenario 1.** The epidemic continues to grow at the current rate.
- **Scenario 2.** Countries will further scale up interventions (either increasing current strategies or implementing new interventions) leading to a further 50% reduction in transmission.
- **Scenario 3.** Countries will relax current interventions by 50%

N.B. These scenarios currently assume that the impact of mobility on transmission will remain the same in the future as it has in the past. We are working to extend methods to estimate the impact of increases in mobility on transmission as lockdown and interventions are reversed. Consequently, projection are likely to represent an upper estimate of the healthcare demand and case load for each scenario

We estimate that over the next 4 weeks demand for hospital beds will change from 39 (95% CI: 34-44) patients requiring treatment with high-pressure oxygen at the current date to 146 (95% CI: 103-188) hospital beds being required on 2020-08-04 if no further interventions are introduced (Scenario 1). Similarly, we estimate that over the next 4 weeks demand for critical care (ICU) beds will change from 11 (95% CI: 9-12) patients requiring treatment with mechanical ventilation at the current date to 29 (95% CI: 24-34) by 2020-08-04. These projections assume that approximately 5% of all infections will require treatment with high-pressure oxygen and that approximately 30% of hospitalised cases will require treatment with mechanical ventilation (based on analysis of ongoing epidemics in Europe). **N.B. These scenarios are unlikely to show significant differences for the first week since there is a delay of approximately 10 days between infection and hospital admission. Consequently, the effectiveness of a change in policy is likely to be better captured by hospital admission data approximately 2 weeks after the policy change is implemented.**

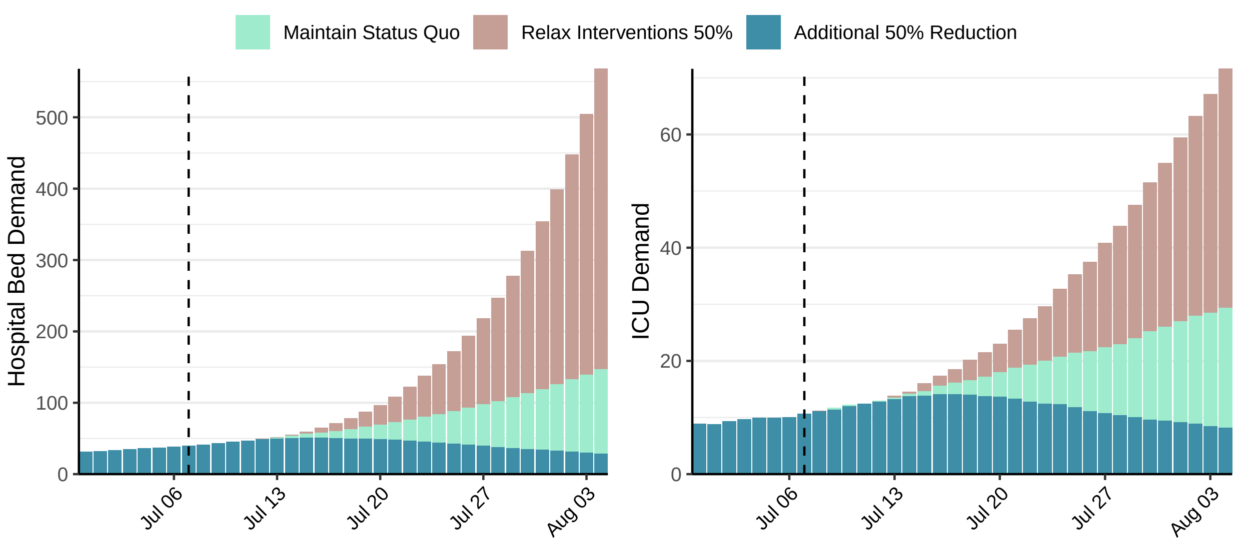

Figure 5: **Healthcare demands in the next 28 days.** Individuals needing an ICU bed are assumed to need mechanical ventilation. Projected demand for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

The impact of each scenario has a more immediate effect on the daily number of infections. The figure below shows the impact of each scenario on the estimated daily incidence of new infections. If interventions are scaled up (Scenario 2), the daily number of infections will change from 425 (95% CI: 353-498) at the current date to 111 (95% CI: 76-145) by 2020-08-04. If current interventions were relaxed by 50%, we estimate the daily number of infections will change from 425 (95% CI: 353-498) at the current date to 12,285 (95% CI: 7,898-16,673) by 2020-08-04.

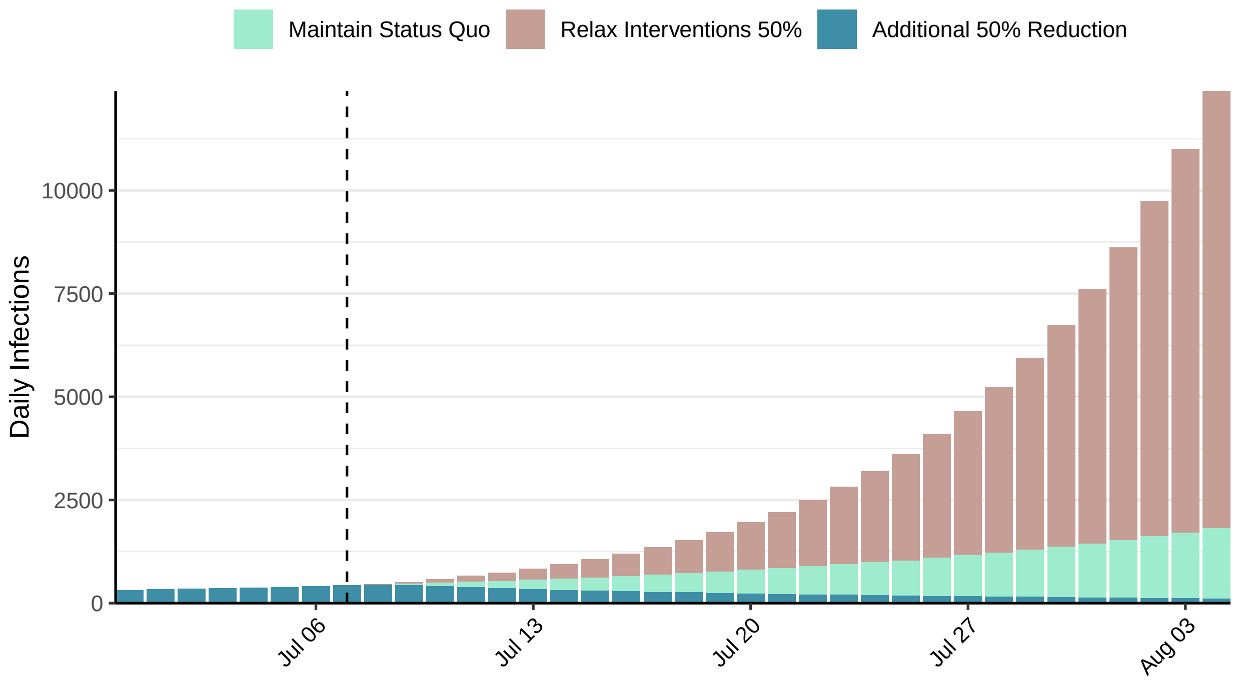

Figure 6: **Daily number of infections estimated by fitting to deaths.** Projected infections for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

To explore different scenarios, we recommend using our COVID-19 Scenario Analysis Tool - https://covidsim.org/, which can be used to simulate different intervention scenarios and explore the long term impact on healthcare demand.

Situation Report for COVID-19: Gambia, 2020-07-07

Download the report for Gambia, 2020-07-07 here. This report uses data from the European Centre for Disease Control. These data are updated daily and whilst there may be a short delay, they are generally consistent with Ministry reports. These data are then used to back-calculate an 'inferred number of COVID-19 infections' using mathematical modelling techniques (see Report 12 for further details) to estimate the number of people that have been infected and to make short-term projections for future healthcare needs.

Epidemiological Situation

Total Reported Cases	New Reported Cases	Total Reported Deaths	New Reported Deaths	Estimated R_t
61	4	3	1	1.94 (95% CI: 1.3-2.93)

The figure below shows the cumulative reported deaths as a function of the time since the 10th death was reported. Dashed lines show the expected trajectory for different doubling times of the epidemic. For example, with a doubling time of 3 days, if there are currently a total of 20 deaths reported, we would expect there to be 40 deaths in total reported in 3 days-time, 80 deaths in 6 days-time, 160 deaths in 9 days-time etc. For most epidemics, in the absence of interventions, we expect a doubling time of 3-4 days for this disease. **N.B. Gambia is not shown in the following plot as only 3 deaths have been reported to date**

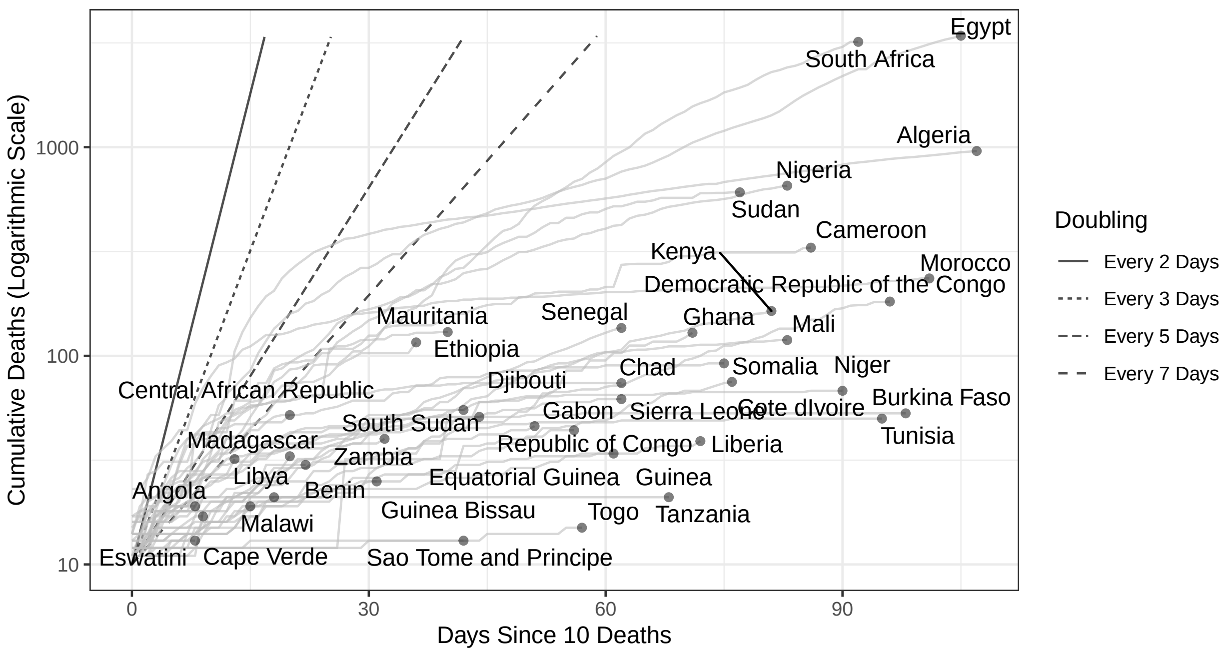

Figure 1: **Cumulative Deaths since 10 deaths.** Country not shown if fewer than 10 deaths.

COVID-19 Transmission Modelling

We assume that the deaths reported to date provide the best indication of the stage of the epidemic, as deaths are more consistently and accurately reported. Our current working estimate is that 1 death indicates that approximately 100 people will have been infected with the other 99 recovering (based on an infection fatality ratio of ~1%). These infections will have happened approximately 21 days previously – capturing a 5-day period from infection to onset of symptoms (the incubation period), 4 days from onset of symptoms to hospitalisation, and 12 days in hospital before death. With a 3-day doubling time, 100 infections that occurred 15 days ago will have generated 200 infections 12 days ago, 400 infections 9 days ago, 800 infections 6 days ago and 1,600 infections 3 days ago resulting in approximately 3,200 infections at the time the first death is observed.

To explore this, we fit our age-structured SEIR model (see Methods) to the time series of deaths in a country, in order to estimate the start date of the epidemic and the baseline R0. We assume that 100% of COVID-19 related deaths have been reported. We have also included the impact of interventions that have been put in place and their effect on human mobility and transmission based on the Google COVID-19 Community Mobility Reports. Using our mathematical model that formalises this approach, we estimate that there has been a total of 3,103 (95% CI: 2,285-3,920) infections over the past 4 weeks.

The figure below shows the estimated number of people infected over the past 4 weeks. The bar charts show, for comparison, the number of reported cases. The right-hand plot shows these data on a different scale as the estimated infections are likely to be much larger than the reported cases. **Importantly**, the estimated infections includes both asymptomatic and mild cases that would not necessarily be identified through surveillance. Consequently, the estimated infections are likely to be significantly higher than the reported cases (see our FAQ for further explanation of these differences and why the reported cases and estimated infections are unlikely to match).

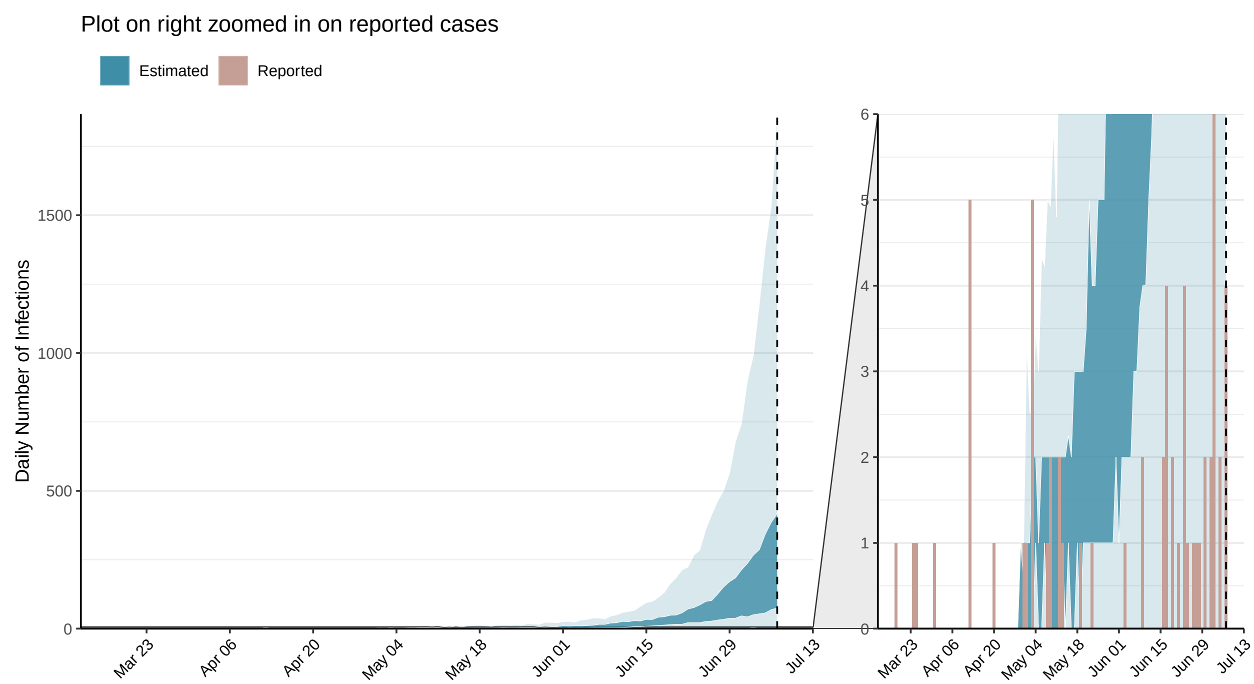

Figure 2: **Daily number of infections estimated by fitting to the current total of deaths.** Reported cases are shown in red. Model estimated infections are shown in blue (dark blue 50% interquartile range, light blue 95% quantile). The dashed line shows the current day.

By fitting to the time series of deaths, we are able to estimate a time-varying reproduction number, R_t. R_t is the the average number of secondary infections caused by a single infected person at a given time. If R_t is above 1, the rate of transmission is increasing and the number of new infections is increasing. R_t is assumed to change in relation to mobility fall in proportion. When fitting our model we assume that 100% of COVID-19 related deaths have been reported (please see our FAQ section for more information about this assumption). We also assume a fixed date at which the impact of mobility on transmission changes from pre-lockdown levels to post-lockdown levels, which may cause large changes in Rt. We are working to refine how this switch occurs and to formally calculate its shape.

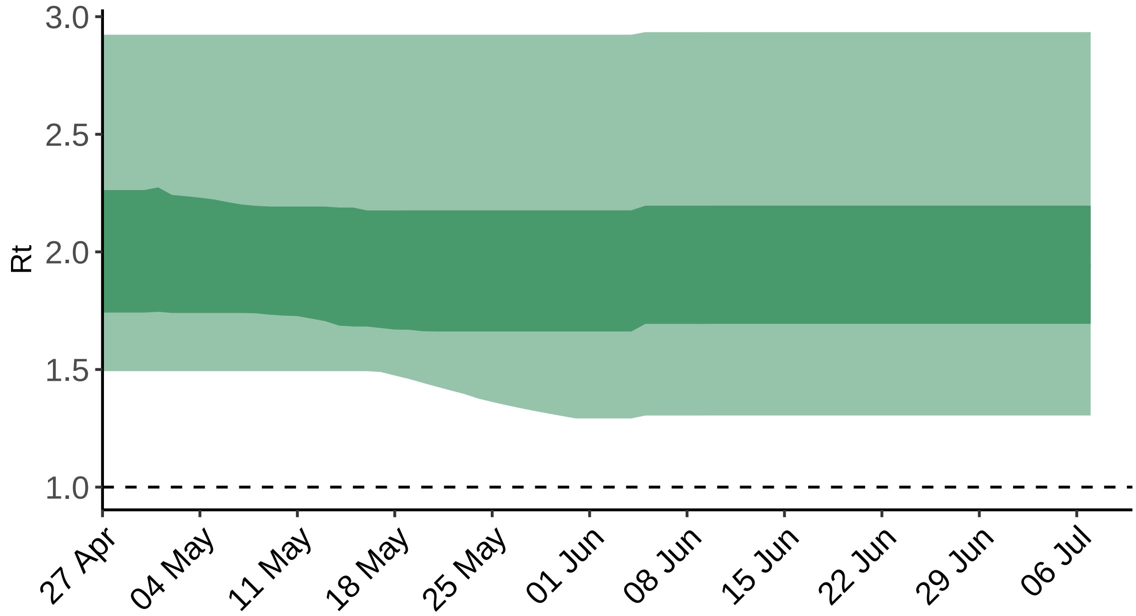

Figure 3: **Time-varying reproduction number, R_t.** R_t is the average number of secondary infections caused by a single infected person at time equal to t. $R_t < 1$ indicates a slowing epidemic in which new infections are not increasing. $R_t > 1$ indicates a growing epidemic in which new infections are increasing over time. Dark green shows the 50% CI and light green shows the 95% CI.

Using the model fit, we can forecast the expected trajectory for cumulative deaths, which is shown in the figure below. This assumes a severity pattern by age that is consistent with that observed in China, Europe and the U.S to date. This projection assumes that transmission is maintained at the current level of transmission as estimated by the final R_t value.

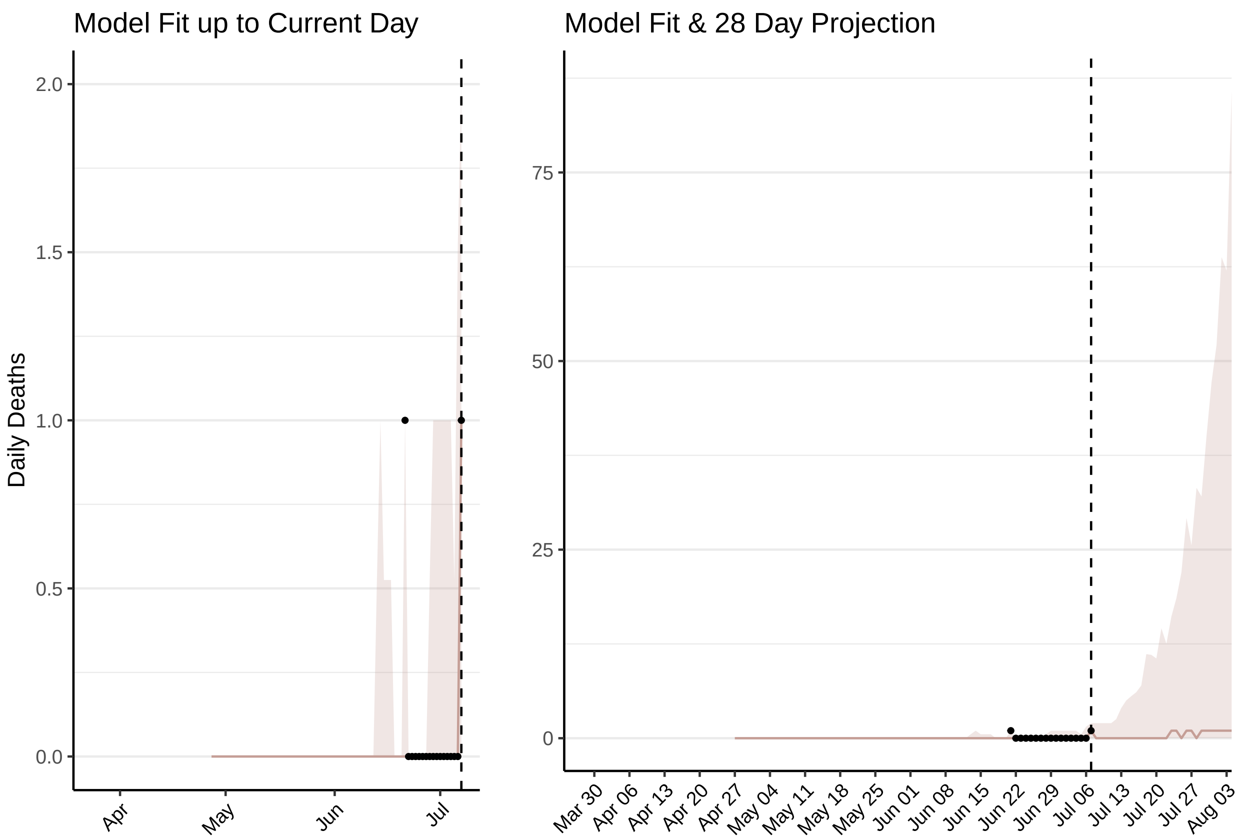

Figure 4: **Estimated daily deaths.** Projected deaths assuming the current level of interventions are maintained are shown in red (median and 95% quantile). Reported deaths are plotted in black. The plot on the left is focussed on the model fit prior to today, while the plot on the right forecasts the next 28 days.

Short-term Epidemic Scenarios

We make the following short-term projections of healthcare demand and new infections under the following three scenarios:

- **Scenario 1.** The epidemic continues to grow at the current rate.
- **Scenario 2.** Countries will further scale up interventions (either increasing current strategies or implementing new interventions) leading to a further 50% reduction in transmission.
- **Scenario 3.** Countries will relax current interventions by 50%

N.B. These scenarios currently assume that the impact of mobility on transmission will remain the same in the future as it has in the past. We are working to extend methods to estimate the impact of increases in mobility on transmission as lockdown and interventions are reversed. Consequently, projection are likely to represent an upper estimate of the healthcare demand and case load for each scenario

We estimate that over the next 4 weeks demand for hospital beds will change from 17 (95% CI: 13-22) patients requiring treatment with high-pressure oxygen at the current date to 318 (95% CI: 160-476) hospital beds being required on 2020-08-04 if no further interventions are introduced (Scenario 1). Similarly, we estimate that over the next 4 weeks demand for critical care (ICU) beds will change from 5 (95% CI: 3-6) patients requiring treatment with mechanical ventilation at the current date to 35 (95% CI: 25-45) by 2020-08-04. These projections assume that approximately 5% of all infections will require treatment with high-pressure oxygen and that approximately 30% of hospitalised cases will require treatment with mechanical ventilation (based on analysis of ongoing epidemics in Europe). **N.B. These scenarios are unlikely to show significant differences for the first week since there is a delay of approximately 10 days between infection and hospital admission. Consequently, the effectiveness of a change in policy is likely to be better captured by hospital admission data approximately 2 weeks after the policy change is implemented.**

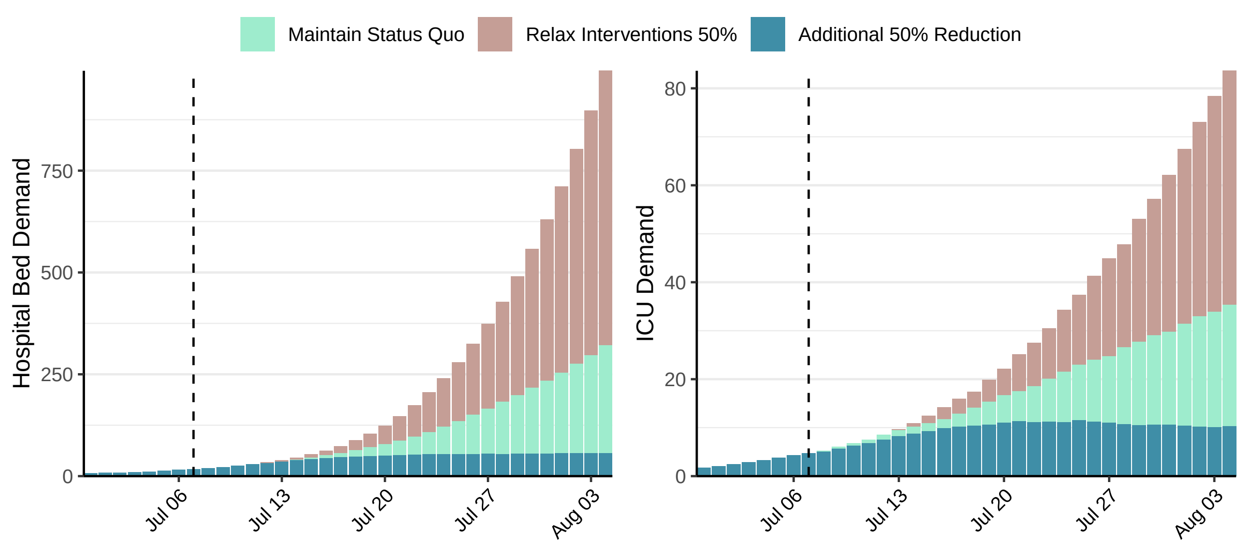

Figure 5: **Healthcare demands in the next 28 days.** Individuals needing an ICU bed are assumed to need mechanical ventilation. Projected demand for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

The impact of each scenario has a more immediate effect on the daily number of infections. The figure below shows the impact of each scenario on the estimated daily incidence of new infections. If interventions are scaled up (Scenario 2), the daily number of infections will change from 392 (95% CI: 263-522) at the current date to 456 (95% CI: 35-877) by 2020-08-04. If current interventions were relaxed by 50%, we estimate the daily number of infections will change from 392 (95% CI: 263-522) at the current date to 20,955 (95% CI: 14,635-27,274) by 2020-08-04.

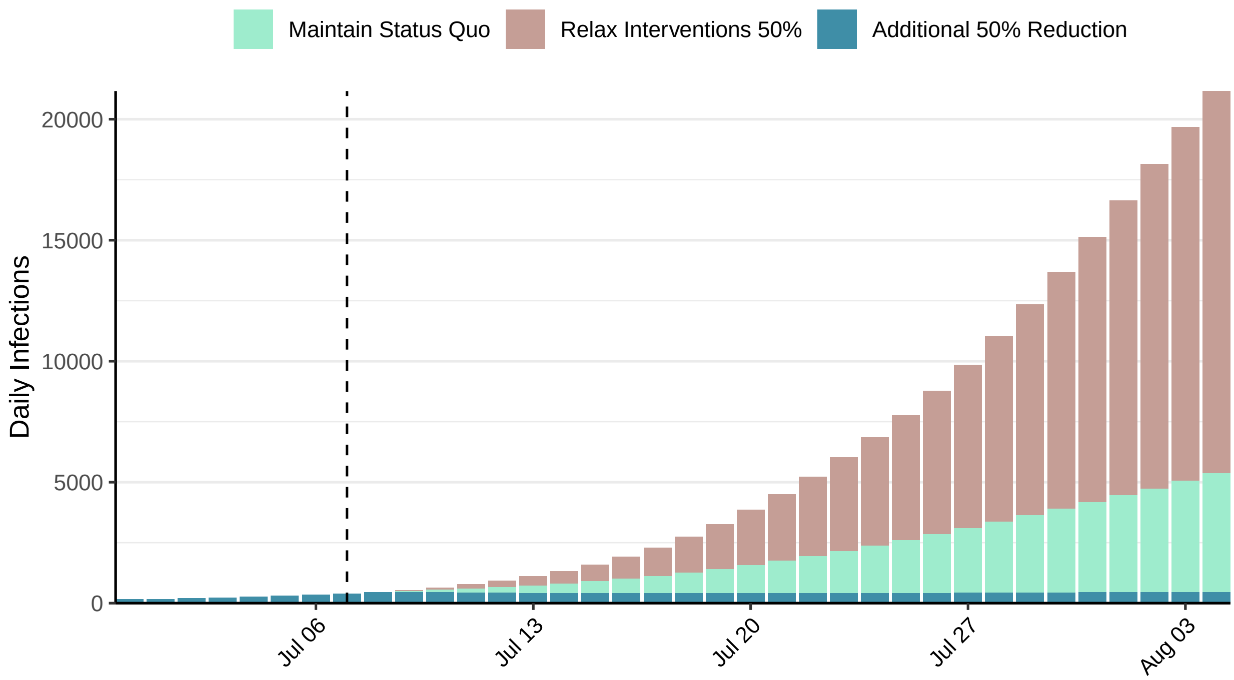

Figure 6: **Daily number of infections estimated by fitting to deaths.** Projected infections for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

To explore different scenarios, we recommend using our COVID-19 Scenario Analysis Tool - https://covidsim.org/, which can be used to simulate different intervention scenarios and explore the long term impact on healthcare demand.

Situation Report for COVID-19: Guinea-Bissau, 2020-07-07

Download the report for Guinea-Bissau, 2020-07-07 here. This report uses data from the European Centre for Disease Control. These data are updated daily and whilst there may be a short delay, they are generally consistent with Ministry reports. These data are then used to back-calculate an 'inferred number of COVID-19 infections' using mathematical modelling techniques (see Report 12 for further details) to estimate the number of people that have been infected and to make short-term projections for future healthcare needs.

Epidemiological Situation

Total Reported Cases	New Reported Cases	Total Reported Deaths	New Reported Deaths	Estimated R_t
1,765	0	25	0	1.07 (95% CI: 0.92-1.26)

The figure below shows the cumulative reported deaths as a function of the time since the 10th death was reported. Dashed lines show the expected trajectory for different doubling times of the epidemic. For example, with a doubling time of 3 days, if there are currently a total of 20 deaths reported, we would expect there to be 40 deaths in total reported in 3 days-time, 80 deaths in 6 days-time, 160 deaths in 9 days-time etc. For most epidemics, in the absence of interventions, we expect a doubling time of 3-4 days for this disease.

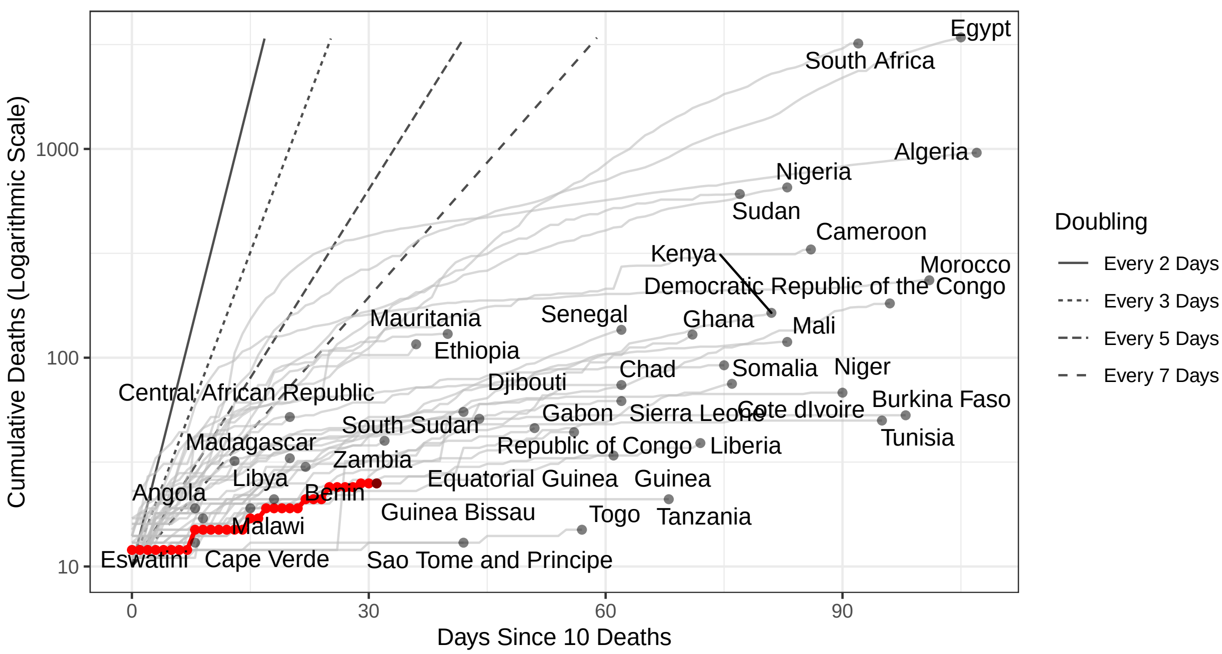

Figure 1: **Cumulative Deaths since 10 deaths.** Country not shown if fewer than 10 deaths.

COVID-19 Transmission Modelling

We assume that the deaths reported to date provide the best indication of the stage of the epidemic, as deaths are more consistently and accurately reported. Our current working estimate is that 1 death indicates that approximately 100 people will have been infected with the other 99 recovering (based on an infection fatality ratio of ~1%). These infections will have happened approximately 21 days previously – capturing a 5-day period from infection to onset of symptoms (the incubation period), 4 days from onset of symptoms to hospitalisation, and 12 days in hospital before death. With a 3-day doubling time, 100 infections that occurred 15 days ago will have generated 200 infections 12 days ago, 400 infections 9 days ago, 800 infections 6 days ago and 1,600 infections 3 days ago resulting in approximately 3,200 infections at the time the first death is observed.

To explore this, we fit our age-structured SEIR model (see Methods) to the time series of deaths in a country, in order to estimate the start date of the epidemic and the baseline R0. We assume that 100% of COVID-19 related deaths have been reported. We have also included the impact of interventions that have been put in place and their effect on human mobility and transmission based on the Google COVID-19 Community Mobility Reports. Using our mathematical model that formalises this approach, we estimate that there has been a total of 7,987 (95% CI: 6,889-9,084) infections over the past 4 weeks.

The figure below shows the estimated number of people infected over the past 4 weeks. The bar charts show, for comparison, the number of reported cases. The right-hand plot shows these data on a different scale as the estimated infections are likely to be much larger than the reported cases. **Importantly**, the estimated infections includes both asymptomatic and mild cases that would not necessarily be identified through surveillance. Consequently, the estimated infections are likely to be significantly higher than the reported cases (see our FAQ for further explanation of these differences and why the reported cases and estimated infections are unlikely to match).

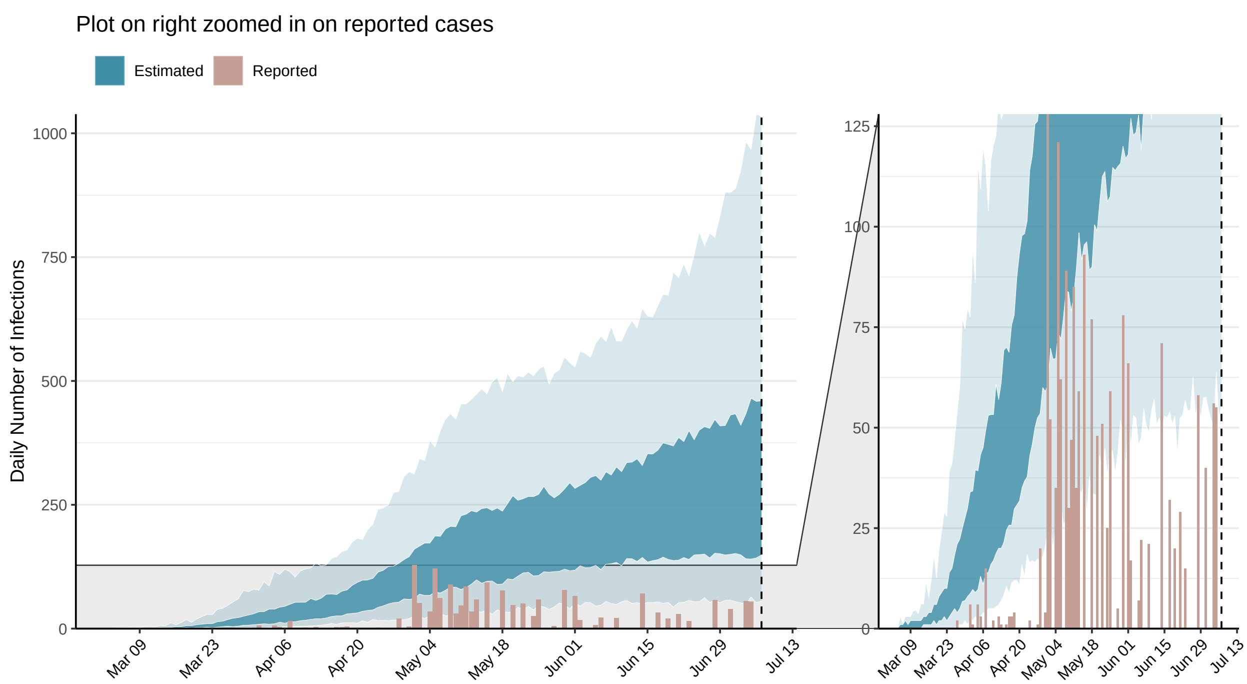

Figure 2: **Daily number of infections estimated by fitting to the current total of deaths.** Reported cases are shown in red. Model estimated infections are shown in blue (dark blue 50% interquartile range, light blue 95% quantile). The dashed line shows the current day.

By fitting to the time series of deaths, we are able to estimate a time-varying reproduction number, R_t. R_t is the the average number of secondary infections caused by a single infected person at a given time. If R_t is above 1, the rate of transmission is increasing and the number of new infections is increasing. R_t is assumed to change in relation to mobility fall in proportion. When fitting our model we assume that 100% of COVID-19 related deaths have been reported (please see our FAQ section for more information about this assumption). We also assume a fixed date at which the impact of mobility on transmission changes from pre-lockdown levels to post-lockdown levels, which may cause large changes in Rt. We are working to refine how this switch occurs and to formally calculate its shape.

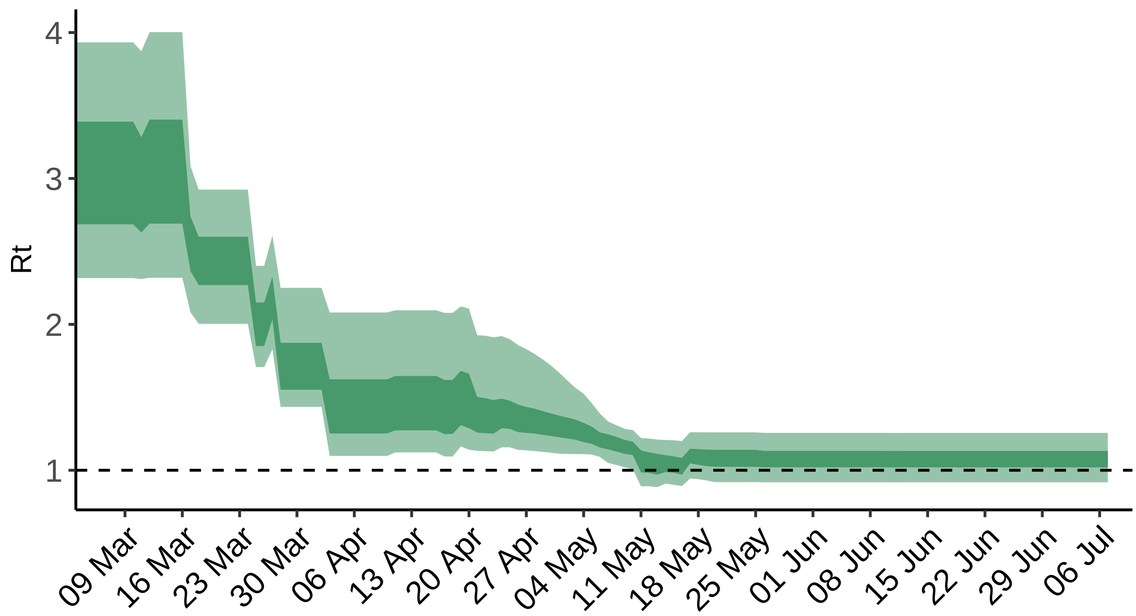

Figure 3: **Time-varying reproduction number, R_t.** R_t is the average number of secondary infections caused by a single infected person at time equal to t. $R_t < 1$ indicates a slowing epidemic in which new infections are not increasing. $R_t > 1$ indicates a growing epidemic in which new infections are increasing over time. Dark green shows the 50% CI and light green shows the 95% CI.

Using the model fit, we can forecast the expected trajectory for cumulative deaths, which is shown in the figure below. This assumes a severity pattern by age that is consistent with that observed in China, Europe and the U.S to date. This projection assumes that transmission is maintained at the current level of transmission as estimated by the final R_t value.

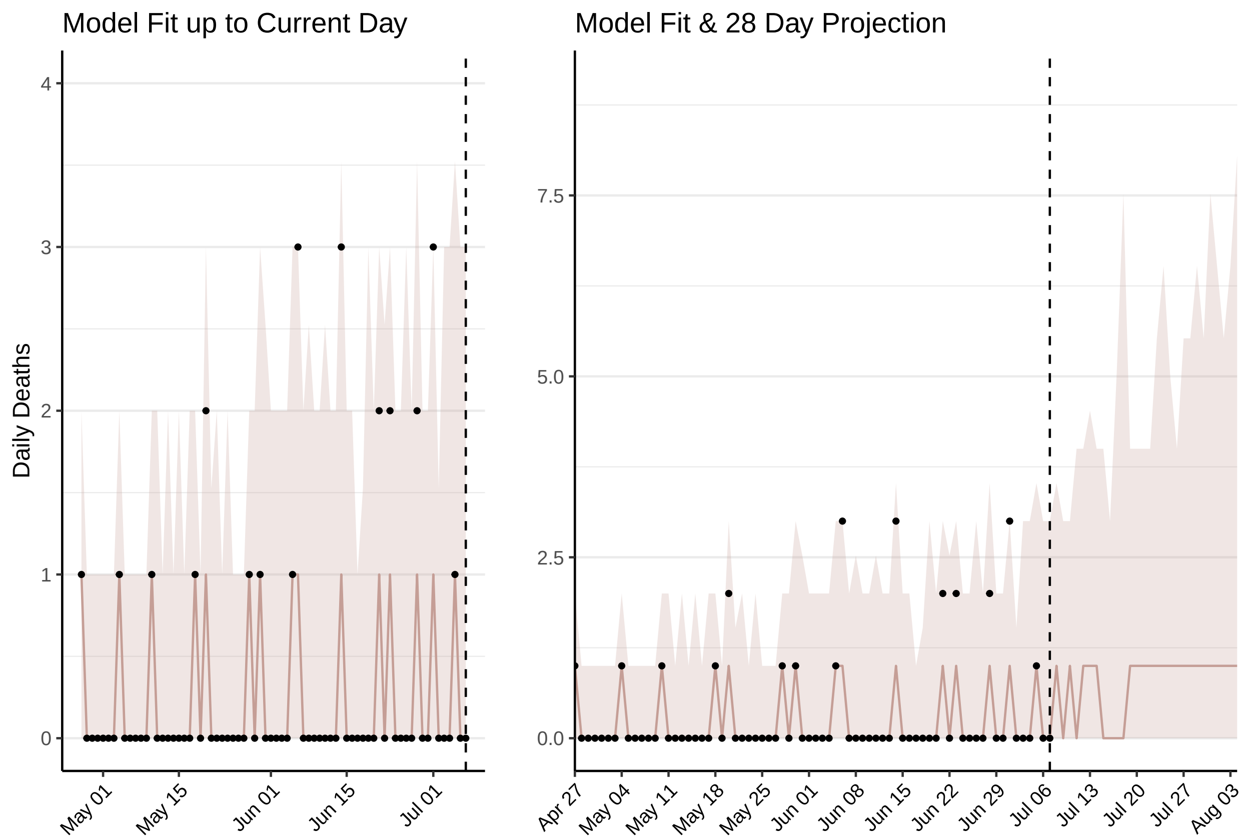

Figure 4: **Estimated daily deaths.** Projected deaths assuming the current level of interventions are maintained are shown in red (median and 95% quantile). Reported deaths are plotted in black. The plot on the left is focussed on the model fit prior to today, while the plot on the right forecasts the next 28 days.

Short-term Epidemic Scenarios

We make the following short-term projections of healthcare demand and new infections under the following three scenarios:

- **Scenario 1.** The epidemic continues to grow at the current rate.
- **Scenario 2.** Countries will further scale up interventions (either increasing current strategies or implementing new interventions) leading to a further 50% reduction in transmission.
- **Scenario 3.** Countries will relax current interventions by 50%

N.B. These scenarios currently assume that the impact of mobility on transmission will remain the same in the future as it has in the past. We are working to extend methods to estimate the impact of increases in mobility on transmission as lockdown and interventions are reversed. Consequently, projection are likely to represent an upper estimate of the healthcare demand and case load for each scenario

We estimate that over the next 4 weeks demand for hospital beds will change from 42 (95% CI: 36-48) patients requiring treatment with high-pressure oxygen at the current date to 65 (95% CI: 52-78) hospital beds being required on 2020-08-04 if no further interventions are introduced (Scenario 1). Similarly, we estimate that over the next 4 weeks demand for critical care (ICU) beds will change from 12 (95% CI: 10-14) patients requiring treatment with mechanical ventilation at the current date to 16 (95% CI: 13-18) by 2020-08-04. These projections assume that approximately 5% of all infections will require treatment with high-pressure oxygen and that approximately 30% of hospitalised cases will require treatment with mechanical ventilation (based on analysis of ongoing epidemics in Europe). **N.B. These scenarios are unlikely to show significant differences for the first week since there is a delay of approximately 10 days between infection and hospital admission. Consequently, the effectiveness of a change in policy is likely to be better captured by hospital admission data approximately 2 weeks after the policy change is implemented.**

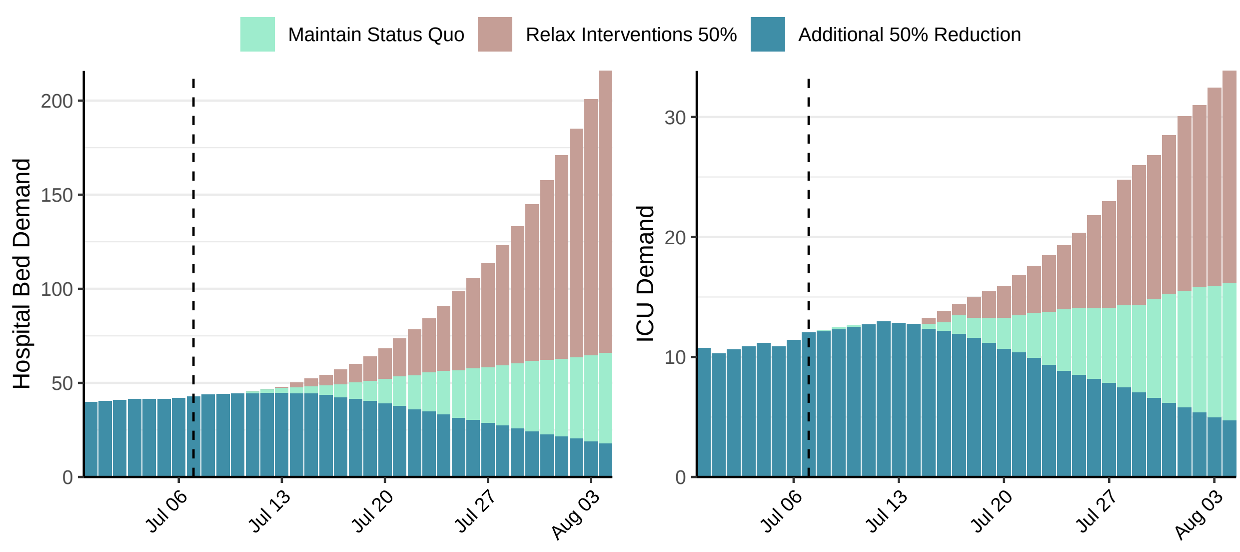

Figure 5: **Healthcare demands in the next 28 days.** Individuals needing an ICU bed are assumed to need mechanical ventilation. Projected demand for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

The impact of each scenario has a more immediate effect on the daily number of infections. The figure below shows the impact of each scenario on the estimated daily incidence of new infections. If interventions are scaled up (Scenario 2), the daily number of infections will change from 343 (95% CI: 288-397) at the current date to 42 (95% CI: 33-51) by 2020-08-04. If current interventions were relaxed by 50%, we estimate the daily number of infections will change from 343 (95% CI: 288-397) at the current date to 3,173 (95% CI: 2,480-3,865) by 2020-08-04.

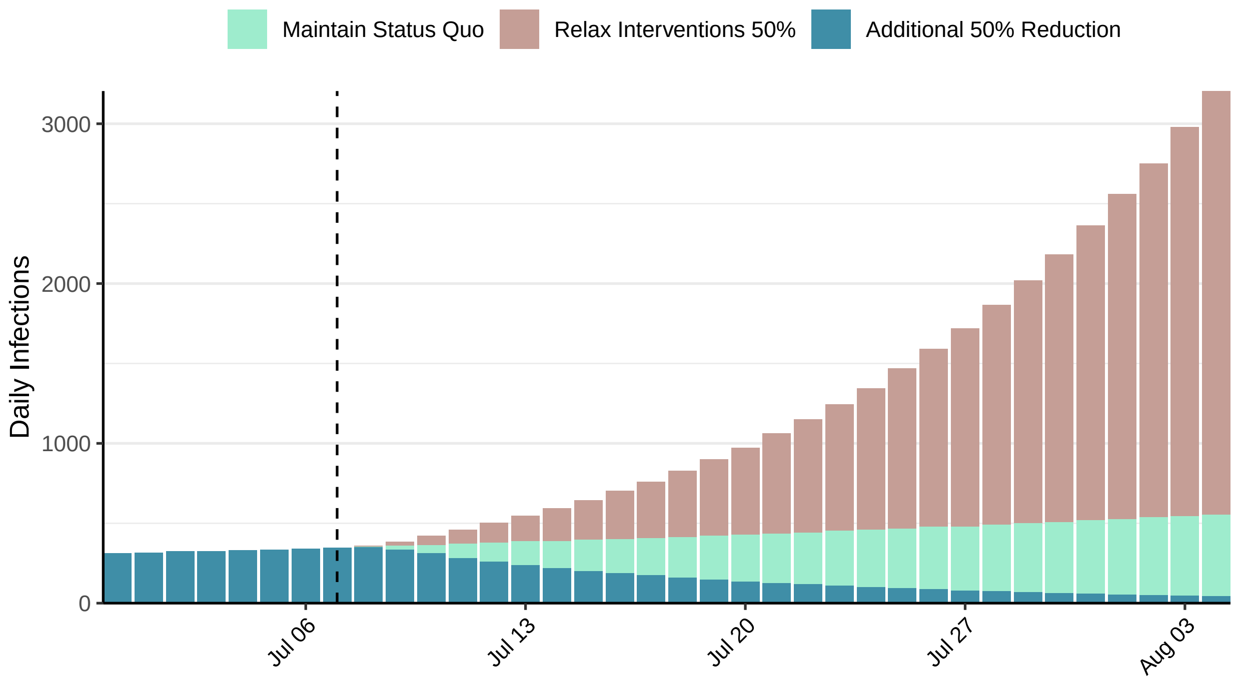

Figure 6: **Daily number of infections estimated by fitting to deaths.** Projected infections for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

To explore different scenarios, we recommend using our COVID-19 Scenario Analysis Tool - https://covidsim.org/, which can be used to simulate different intervention scenarios and explore the long term impact on healthcare demand.

Situation Report for COVID-19: Equatorial Guinea, 2020-07-07

Download the report for Equatorial Guinea, 2020-07-07 here. This report uses data from the European Centre for Disease Control. These data are updated daily and whilst there may be a short delay, they are generally consistent with Ministry reports. These data are then used to back-calculate an 'inferred number of COVID-19 infections' using mathematical modelling techniques (see Report 12 for further details) to estimate the number of people that have been infected and to make short-term projections for future healthcare needs.

Epidemiological Situation

Total Reported Cases	New Reported Cases	Total Reported Deaths	New Reported Deaths	Estimated R_t
3,071	0	51	0	1.61 (95% CI: 1.29-2.14)

The figure below shows the cumulative reported deaths as a function of the time since the 10th death was reported. Dashed lines show the expected trajectory for different doubling times of the epidemic. For example, with a doubling time of 3 days, if there are currently a total of 20 deaths reported, we would expect there to be 40 deaths in total reported in 3 days-time, 80 deaths in 6 days-time, 160 deaths in 9 days-time etc. For most epidemics, in the absence of interventions, we expect a doubling time of 3-4 days for this disease.

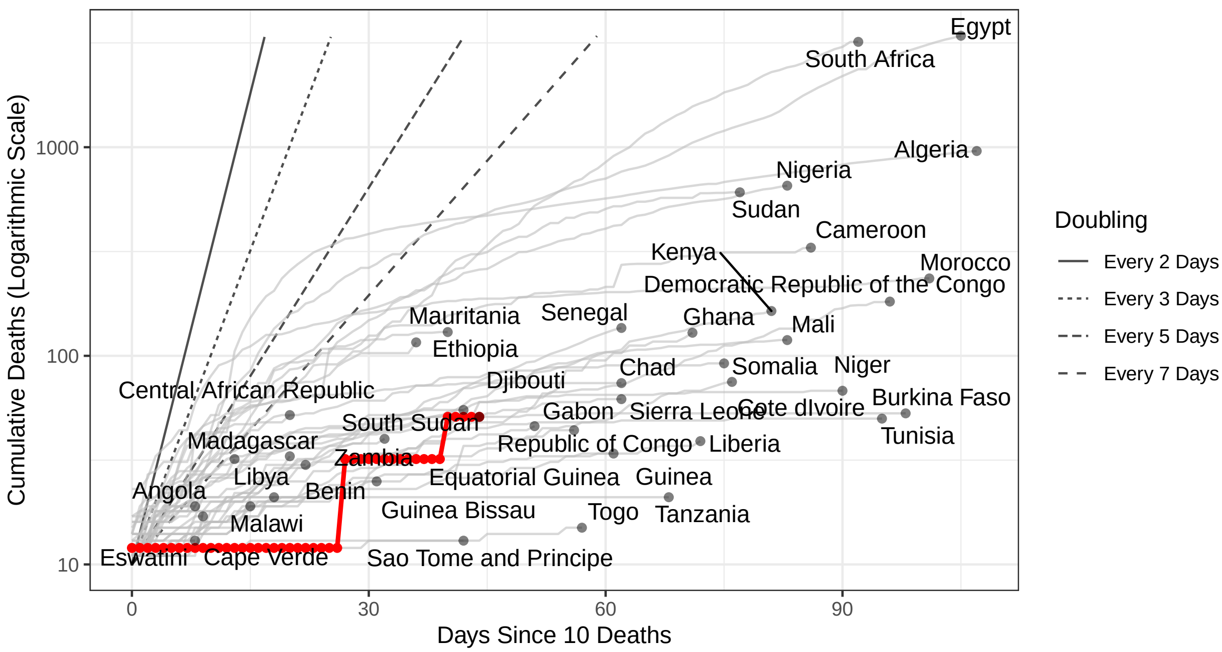

Figure 1: **Cumulative Deaths since 10 deaths.** Country not shown if fewer than 10 deaths.

COVID-19 Transmission Modelling

We assume that the deaths reported to date provide the best indication of the stage of the epidemic, as deaths are more consistently and accurately reported. Our current working estimate is that 1 death indicates that approximately 100 people will have been infected with the other 99 recovering (based on an infection fatality ratio of ~1%). These infections will have happened approximately 21 days previously – capturing a 5-day period from infection to onset of symptoms (the incubation period), 4 days from onset of symptoms to hospitalisation, and 12 days in hospital before death. With a 3-day doubling time, 100 infections that occurred 15 days ago will have generated 200 infections 12 days ago, 400 infections 9 days ago, 800 infections 6 days ago and 1,600 infections 3 days ago resulting in approximately 3,200 infections at the time the first death is observed.

To explore this, we fit our age-structured SEIR model (see Methods) to the time series of deaths in a country, in order to estimate the start date of the epidemic and the baseline R0. We assume that 100% of COVID-19 related deaths have been reported. We have also included the impact of interventions that have been put in place and their effect on human mobility and transmission based on the Google COVID-19 Community Mobility Reports. Using our mathematical model that formalises this approach, we estimate that there has been a total of 35,634 (95% CI: 31,507-39,761) infections over the past 4 weeks.

The figure below shows the estimated number of people infected over the past 4 weeks. The bar charts show, for comparison, the number of reported cases. The right-hand plot shows these data on a different scale as the estimated infections are likely to be much larger than the reported cases. **Importantly**, the estimated infections includes both asymptomatic and mild cases that would not necessarily be identified through surveillance. Consequently, the estimated infections are likely to be significantly higher than the reported cases (see our FAQ for further explanation of these differences and why the reported cases and estimated infections are unlikely to match).

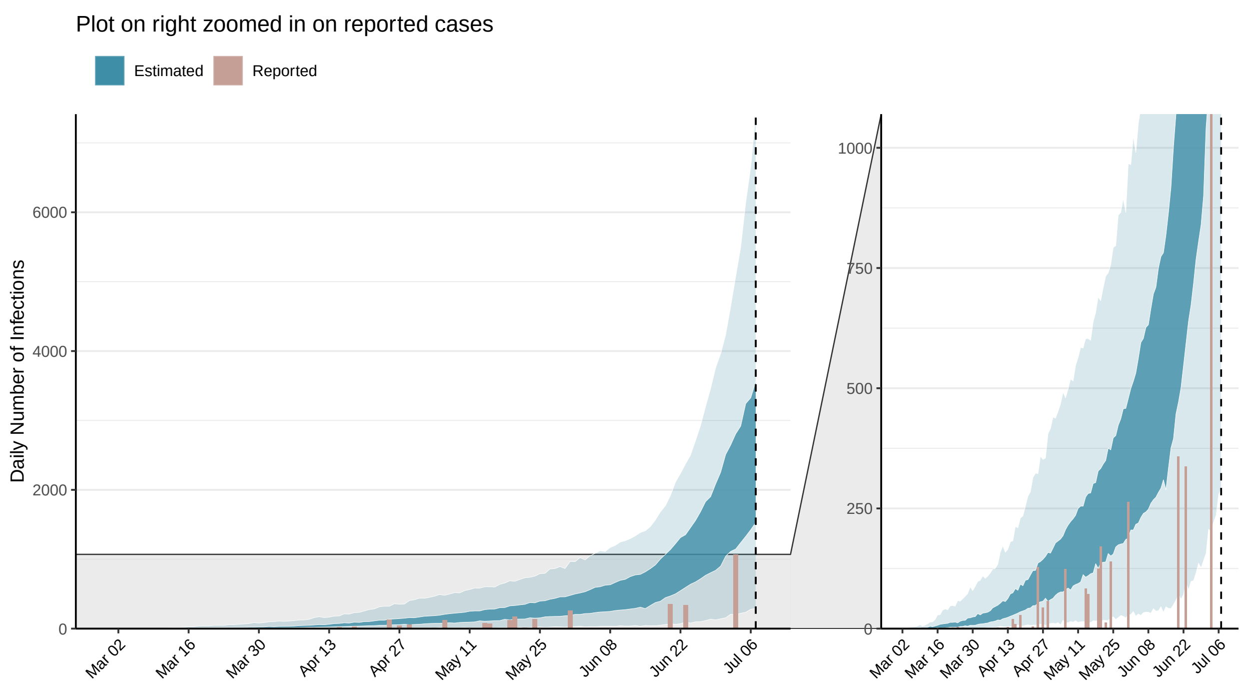

Figure 2: **Daily number of infections estimated by fitting to the current total of deaths.** Reported cases are shown in red. Model estimated infections are shown in blue (dark blue 50% interquartile range, light blue 95% quantile). The dashed line shows the current day.

By fitting to the time series of deaths, we are able to estimate a time-varying reproduction number, R_t. R_t is the the average number of secondary infections caused by a single infected person at a given time. If R_t is above 1, the rate of transmission is increasing and the number of new infections is increasing. R_t is assumed to change in relation to mobility fall in proportion. When fitting our model we assume that 100% of COVID-19 related deaths have been reported (please see our FAQ section for more information about this assumption). We also assume a fixed date at which the impact of mobility on transmission changes from pre-lockdown levels to post-lockdown levels, which may cause large changes in Rt. We are working to refine how this switch occurs and to formally calculate its shape.

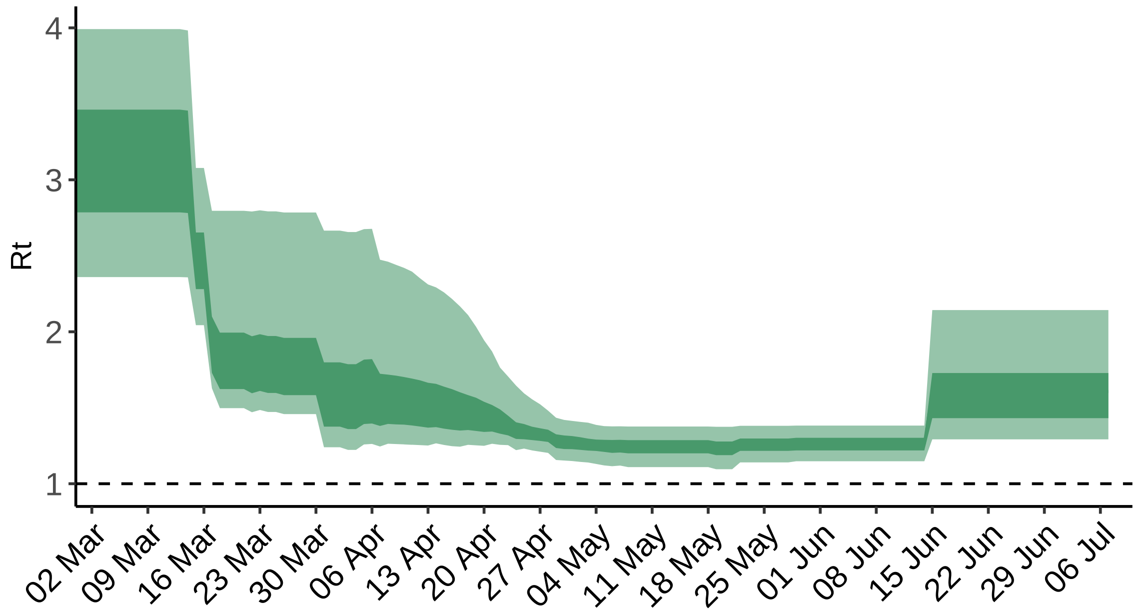

Figure 3: **Time-varying reproduction number, R_t.** R_t is the average number of secondary infections caused by a single infected person at time equal to t. $R_t < 1$ indicates a slowing epidemic in which new infections are not increasing. $R_t > 1$ indicates a growing epidemic in which new infections are increasing over time. Dark green shows the 50% CI and light green shows the 95% CI.

Using the model fit, we can forecast the expected trajectory for cumulative deaths, which is shown in the figure below. This assumes a severity pattern by age that is consistent with that observed in China, Europe and the U.S to date. This projection assumes that transmission is maintained at the current level of transmission as estimated by the final R_t value. **N.B. Equatorial Guinea is forecast to be close to or surpassing our best estimates for healthcare capacity in the next 28 days.** Estimates of deaths in the next 28 days may be inaccurate due to our working assumptions for mortality in individuals who do not receive appropriate treatment. See our methods for more information.

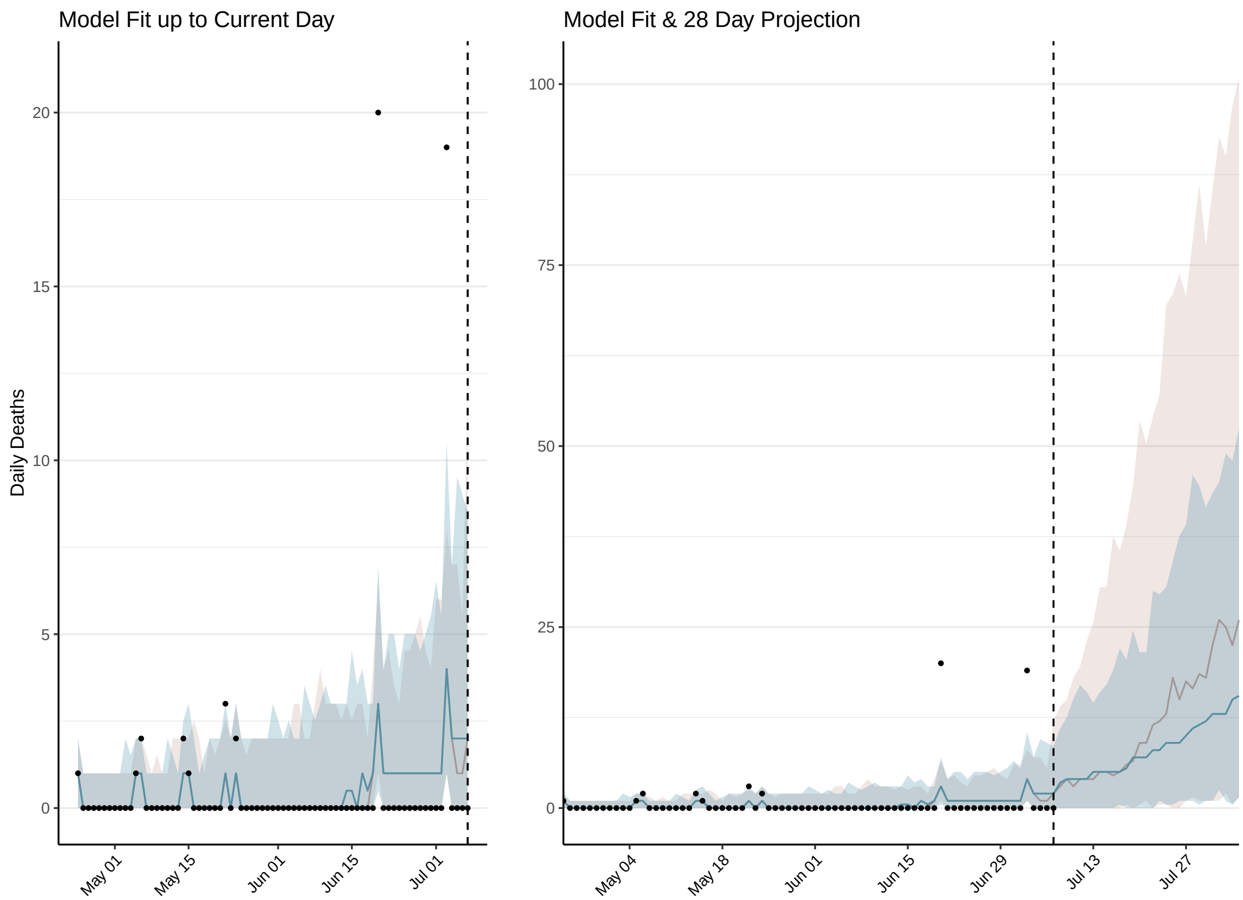

Figure 4: **Estimated daily deaths.** Projected deaths assuming the current level of interventions are maintained are shown in red (median and 95% quantile). Reported deaths are plotted in black. The plot on the left is focussed on the model fit prior to today, while the plot on the right forecasts the next 28 days. The forecasted deaths in blue assumes healthcare capacity has been surged to ensure sufficient supply of ICU and hospital beds. The red curve assumes no surging in healthcare capacity and subsequently projects increased deaths.

Short-term Epidemic Scenarios

We make the following short-term projections of healthcare demand and new infections under the following three scenarios:

- **Scenario 1.** The epidemic continues to grow at the current rate.
- **Scenario 2.** Countries will further scale up interventions (either increasing current strategies or implementing new interventions) leading to a further 50% reduction in transmission.
- **Scenario 3.** Countries will relax current interventions by 50%

N.B. These scenarios currently assume that the impact of mobility on transmission will remain the same in the future as it has in the past. We are working to extend methods to estimate the impact of increases in mobility on transmission as lockdown and interventions are reversed. Consequently, projection are likely to represent an upper estimate of the healthcare demand and case load for each scenario

We estimate that over the next 4 weeks demand for hospital beds will change from 203 (95% CI: 179-227) patients requiring treatment with high-pressure oxygen at the current date to 1,171 (95% CI: 999-1,344) hospital beds being required on 2020-08-04 if no further interventions are introduced (Scenario 1). Similarly, we estimate that over the next 4 weeks demand for critical care (ICU) beds will change from 51 (95% CI: 45-56) patients requiring treatment with mechanical ventilation at the current date to 128 (95% CI: 119-136) by 2020-08-04. These projections assume that approximately 5% of all infections will require treatment with high-pressure oxygen and that approximately 30% of hospitalised cases will require treatment with mechanical ventilation (based on analysis of ongoing epidemics in Europe). **N.B. These scenarios are unlikely to show significant differences for the first week since there is a delay of approximately 10 days between infection and hospital admission. Consequently, the effectiveness of a change in policy is likely to be better captured by hospital admission data approximately 2 weeks after the policy change is implemented.**

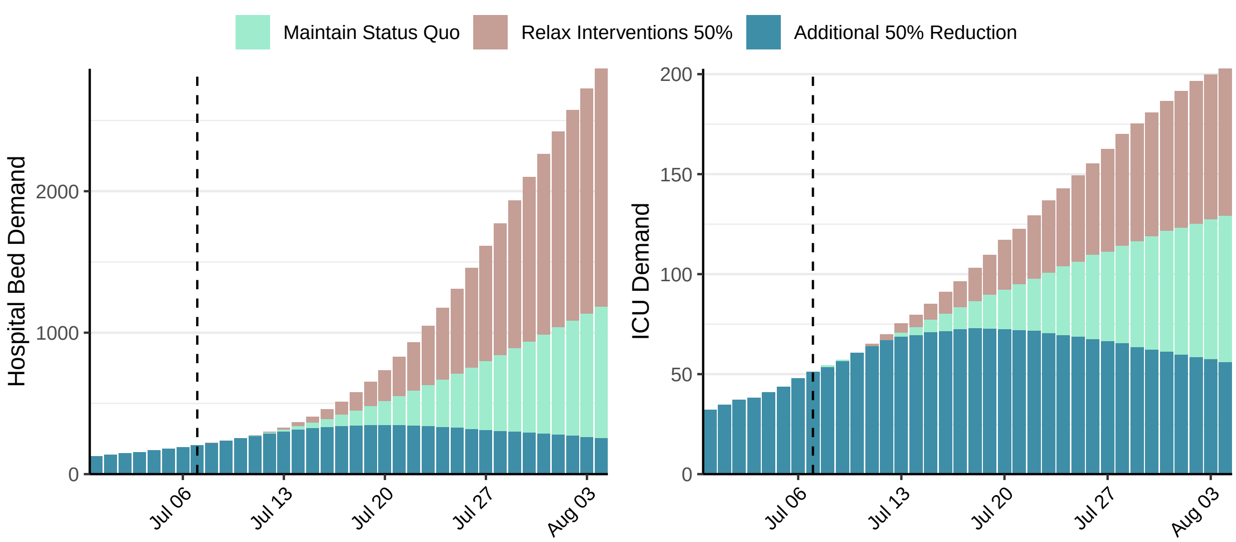

Figure 5: **Healthcare demands in the next 28 days.** Individuals needing an ICU bed are assumed to need mechanical ventilation. Projected demand for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

The impact of each scenario has a more immediate effect on the daily number of infections. The figure below shows the impact of each scenario on the estimated daily incidence of new infections. If interventions are scaled up (Scenario 2), the daily number of infections will change from 2,820 (95% CI: 2,452-3,189) at the current date to 1,154 (95% CI: 922-1,386) by 2020-08-04. If current interventions were relaxed by 50%, we estimate the daily number of infections will change from 2,820 (95% CI: 2,452-3,189) at the current date to 32,327 (95% CI: 30,202-34,451) by 2020-08-04.

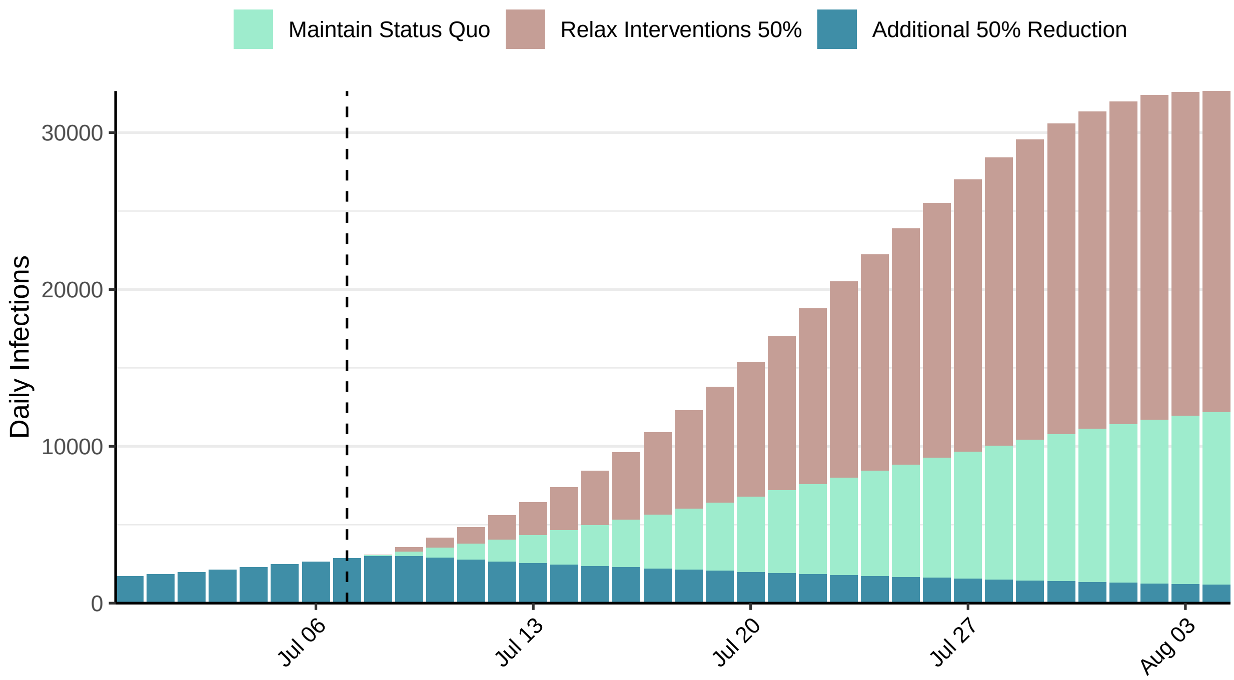

Figure 6: **Daily number of infections estimated by fitting to deaths.** Projected infections for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

To explore different scenarios, we recommend using our COVID-19 Scenario Analysis Tool - https://covidsim.org/, which can be used to simulate different intervention scenarios and explore the long term impact on healthcare demand.

Situation Report for COVID-19: Guatemala, 2020-07-07

Download the report for Guatemala, 2020-07-07 here. This report uses data from the European Centre for Disease Control. These data are updated daily and whilst there may be a short delay, they are generally consistent with Ministry reports. These data are then used to back-calculate an 'inferred number of COVID-19 infections' using mathematical modelling techniques (see Report 12 for further details) to estimate the number of people that have been infected and to make short-term projections for future healthcare needs.

Epidemiological Situation

Total Reported Cases	New Reported Cases	Total Reported Deaths	New Reported Deaths	Estimated R_t
23,972	724	981	34	1.39 (95% CI: 1.34-1.45)

The figure below shows the cumulative reported deaths as a function of the time since the 10th death was reported. Dashed lines show the expected trajectory for different doubling times of the epidemic. For example, with a doubling time of 3 days, if there are currently a total of 20 deaths reported, we would expect there to be 40 deaths in total reported in 3 days-time, 80 deaths in 6 days-time, 160 deaths in 9 days-time etc. For most epidemics, in the absence of interventions, we expect a doubling time of 3-4 days for this disease.

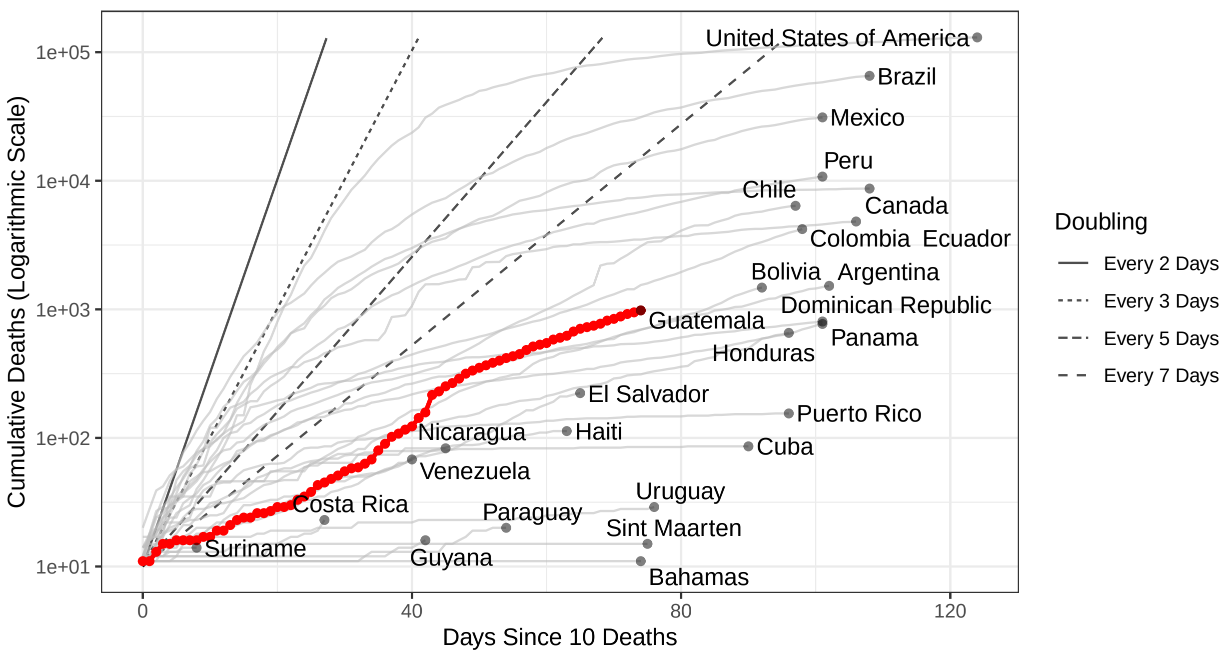

Figure 1: **Cumulative Deaths since 10 deaths.** Country not shown if fewer than 10 deaths.

COVID-19 Transmission Modelling

We assume that the deaths reported to date provide the best indication of the stage of the epidemic, as deaths are more consistently and accurately reported. Our current working estimate is that 1 death indicates that approximately 100 people will have been infected with the other 99 recovering (based on an infection fatality ratio of ~1%). These infections will have happened approximately 21 days previously – capturing a 5-day period from infection to onset of symptoms (the incubation period), 4 days from onset of symptoms to hospitalisation, and 12 days in hospital before death. With a 3-day doubling time, 100 infections that occurred 15 days ago will have generated 200 infections 12 days ago, 400 infections 9 days ago, 800 infections 6 days ago and 1,600 infections 3 days ago resulting in approximately 3,200 infections at the time the first death is observed.

To explore this, we fit our age-structured SEIR model (see Methods) to the time series of deaths in a country, in order to estimate the start date of the epidemic and the baseline R0. We assume that 100% of COVID-19 related deaths have been reported. We have also included the impact of interventions that have been put in place and their effect on human mobility and transmission based on the Google COVID-19 Community Mobility Reports. Using our mathematical model that formalises this approach, we estimate that there has been a total of 560,994 (95% CI: 481,124-640,863) infections over the past 4 weeks.

The figure below shows the estimated number of people infected over the past 4 weeks. The bar charts show, for comparison, the number of reported cases. The right-hand plot shows these data on a different scale as the estimated infections are likely to be much larger than the reported cases. **Importantly**, the estimated infections includes both asymptomatic and mild cases that would not necessarily be identified through surveillance. Consequently, the estimated infections are likely to be significantly higher than the reported cases (see our FAQ for further explanation of these differences and why the reported cases and estimated infections are unlikely to match).

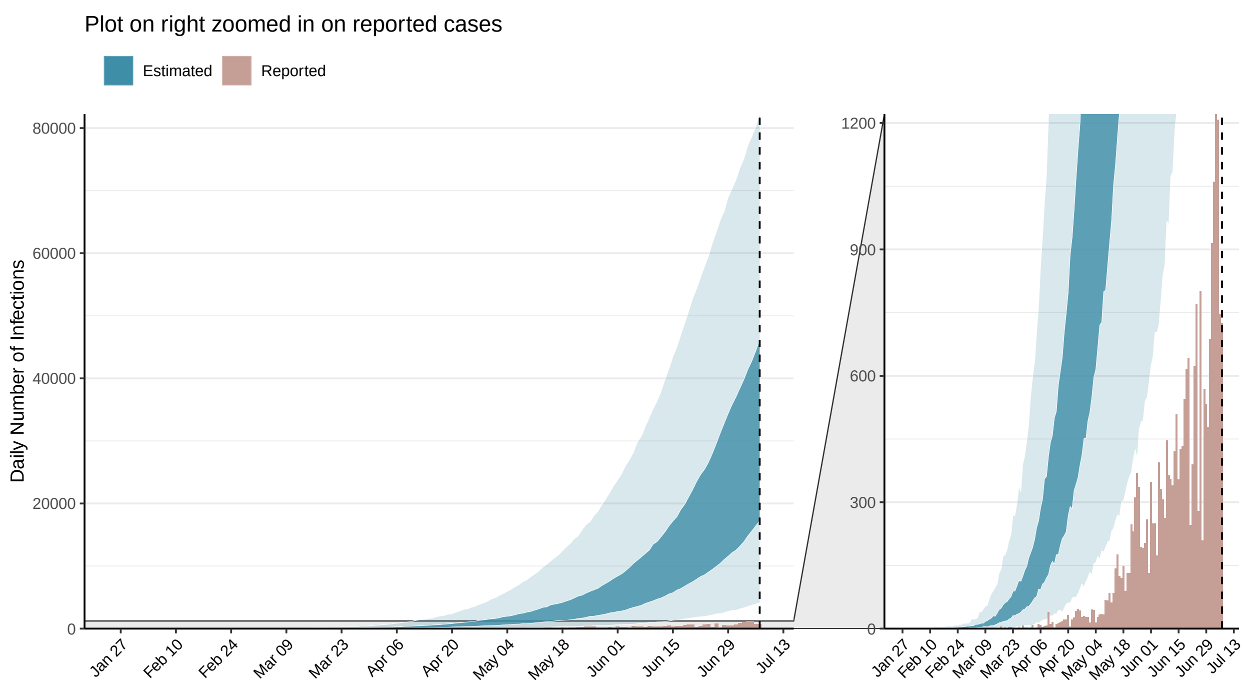

Figure 2: **Daily number of infections estimated by fitting to the current total of deaths.** Reported cases are shown in red. Model estimated infections are shown in blue (dark blue 50% interquartile range, light blue 95% quantile). The dashed line shows the current day.

By fitting to the time series of deaths, we are able to estimate a time-varying reproduction number, R_t. R_t is the the average number of secondary infections caused by a single infected person at a given time. If R_t is above 1, the rate of transmission is increasing and the number of new infections is increasing. R_t is assumed to change in relation to mobility fall in proportion. When fitting our model we assume that 100% of COVID-19 related deaths have been reported (please see our FAQ section for more information about this assumption). We also assume a fixed date at which the impact of mobility on transmission changes from pre-lockdown levels to post-lockdown levels, which may cause large changes in Rt. We are working to refine how this switch occurs and to formally calculate its shape.

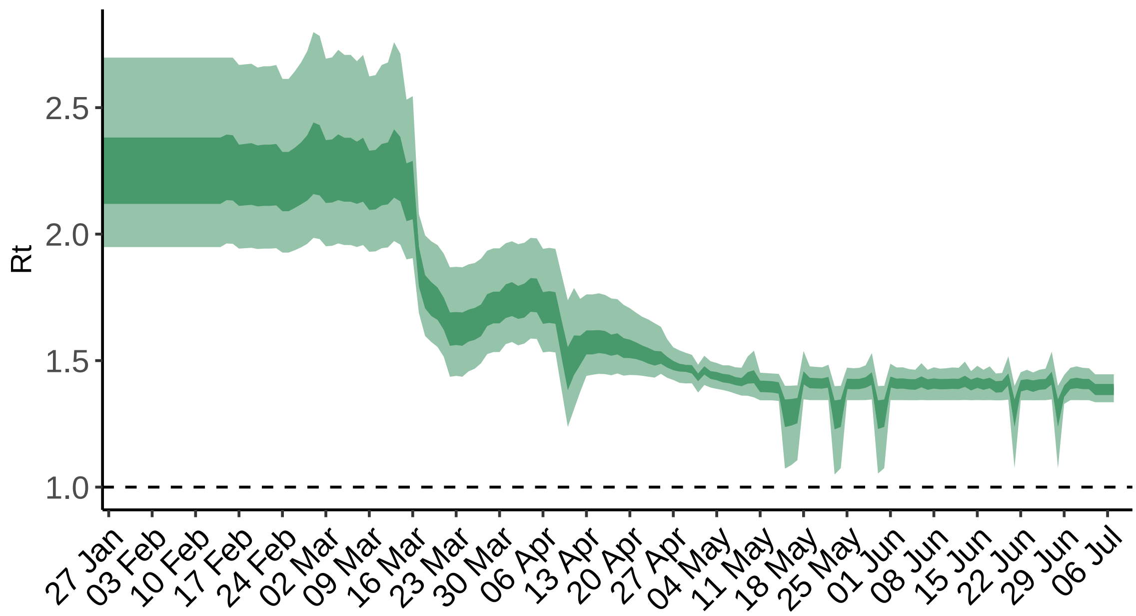

Figure 3: **Time-varying reproduction number, R_t.** R_t is the average number of secondary infections caused by a single infected person at time equal to t. $R_t < 1$ indicates a slowing epidemic in which new infections are not increasing. $R_t > 1$ indicates a growing epidemic in which new infections are increasing over time. Dark green shows the 50% CI and light green shows the 95% CI.

Using the model fit, we can forecast the expected trajectory for cumulative deaths, which is shown in the figure below. This assumes a severity pattern by age that is consistent with that observed in China, Europe and the U.S to date. This projection assumes that transmission is maintained at the current level of transmission as estimated by the final R_t value. **N.B. Guatemala is forecast to be close to or surpassing our best estimates for healthcare capacity in the next 28 days.** Estimates of deaths in the next 28 days may be inaccurate due to our working assumptions for mortality in individuals who do not receive appropriate treatment. See our methods for more information.

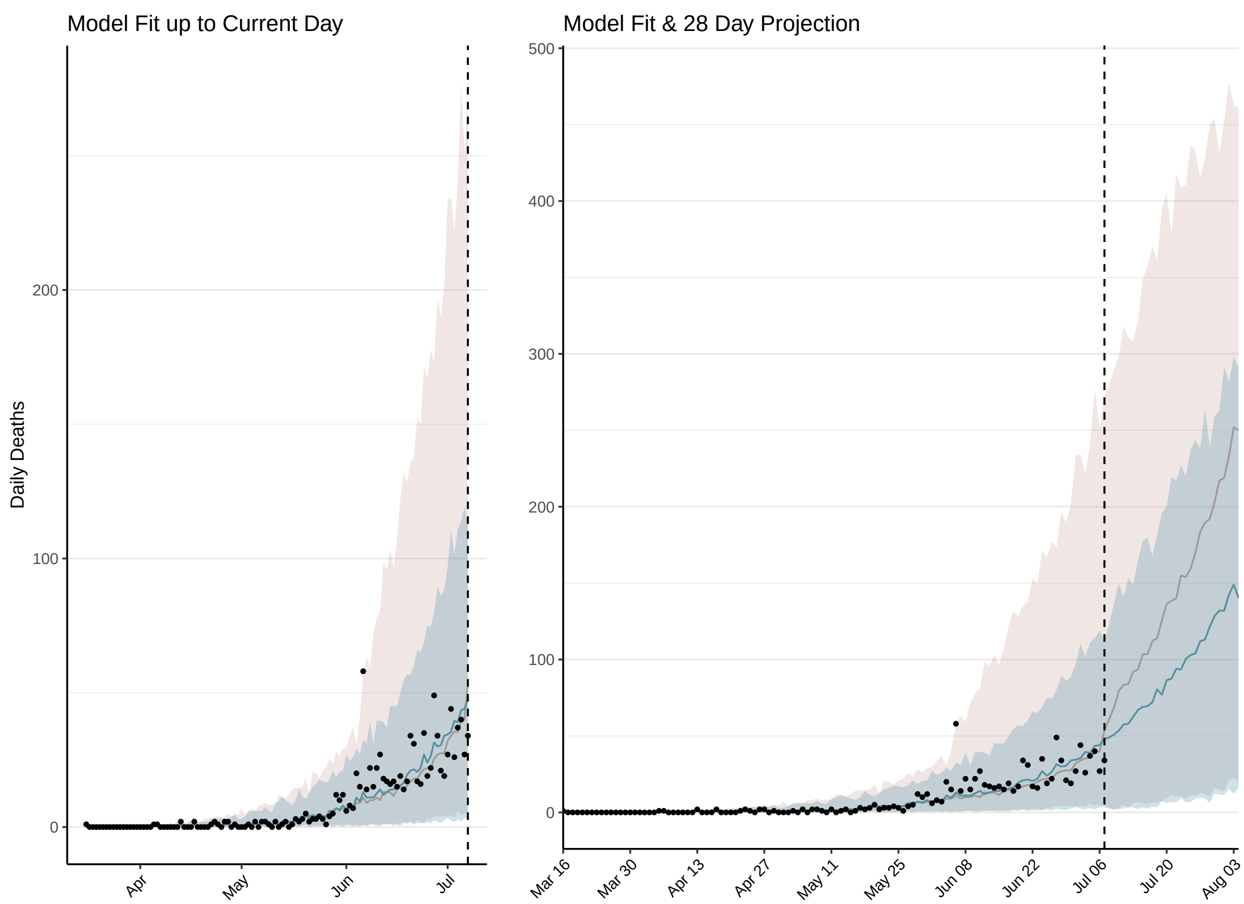

Figure 4: **Estimated daily deaths.** Projected deaths assuming the current level of interventions are maintained are shown in red (median and 95% quantile). Reported deaths are plotted in black. The plot on the left is focussed on the model fit prior to today, while the plot on the right forecasts the next 28 days. The forecasted deaths in blue assumes healthcare capacity has been surged to ensure sufficient supply of ICU and hospital beds. The red curve assumes no surging in healthcare capacity and subsequently projects increased deaths.

Short-term Epidemic Scenarios

We make the following short-term projections of healthcare demand and new infections under the following three scenarios:

- **Scenario 1.** The epidemic continues to grow at the current rate.
- **Scenario 2.** Countries will further scale up interventions (either increasing current strategies or implementing new interventions) leading to a further 50% reduction in transmission.
- **Scenario 3.** Countries will relax current interventions by 50%

N.B. These scenarios currently assume that the impact of mobility on transmission will remain the same in the future as it has in the past. We are working to extend methods to estimate the impact of increases in mobility on transmission as lockdown and interventions are reversed. Consequently, projection are likely to represent an upper estimate of the healthcare demand and case load for each scenario

We estimate that over the next 4 weeks demand for hospital beds will change from 2,703 (95% CI: 2,318-3,089) patients requiring treatment with high-pressure oxygen at the current date to 7,194 (95% CI: 6,486-7,903) hospital beds being required on 2020-08-04 if no further interventions are introduced (Scenario 1). Similarly, we estimate that over the next 4 weeks demand for critical care (ICU) beds will change from 513 (95% CI: 469-557) patients requiring treatment with mechanical ventilation at the current date to 780 (95% CI: 739-820) by 2020-08-04. These projections assume that approximately 5% of all infections will require treatment with high-pressure oxygen and that approximately 30% of hospitalised cases will require treatment with mechanical ventilation (based on analysis of ongoing epidemics in Europe). **N.B. These scenarios are unlikely to show significant differences for the first week since there is a delay of approximately 10 days between infection and hospital admission. Consequently, the effectiveness of a change in policy is likely to be better captured by hospital admission data approximately 2 weeks after the policy change is implemented.**

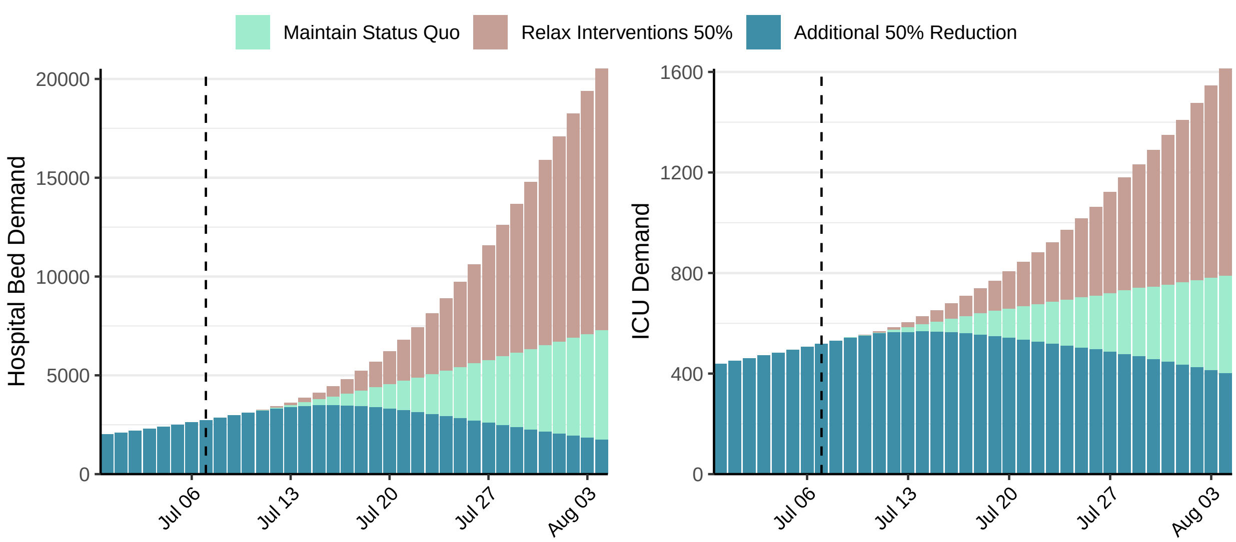

Figure 5: **Healthcare demands in the next 28 days.** Individuals needing an ICU bed are assumed to need mechanical ventilation. Projected demand for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

The impact of each scenario has a more immediate effect on the daily number of infections. The figure below shows the impact of each scenario on the estimated daily incidence of new infections. If interventions are scaled up (Scenario 2), the daily number of infections will change from 33,214 (95% CI: 28,979-37,449) at the current date to 6,044 (95% CI: 5,476-6,612) by 2020-08-04. If current interventions were relaxed by 50%, we estimate the daily number of infections will change from 33,214 (95% CI: 28,979-37,449) at the current date to 279,143 (95% CI: 263,703-294,584) by 2020-08-04.

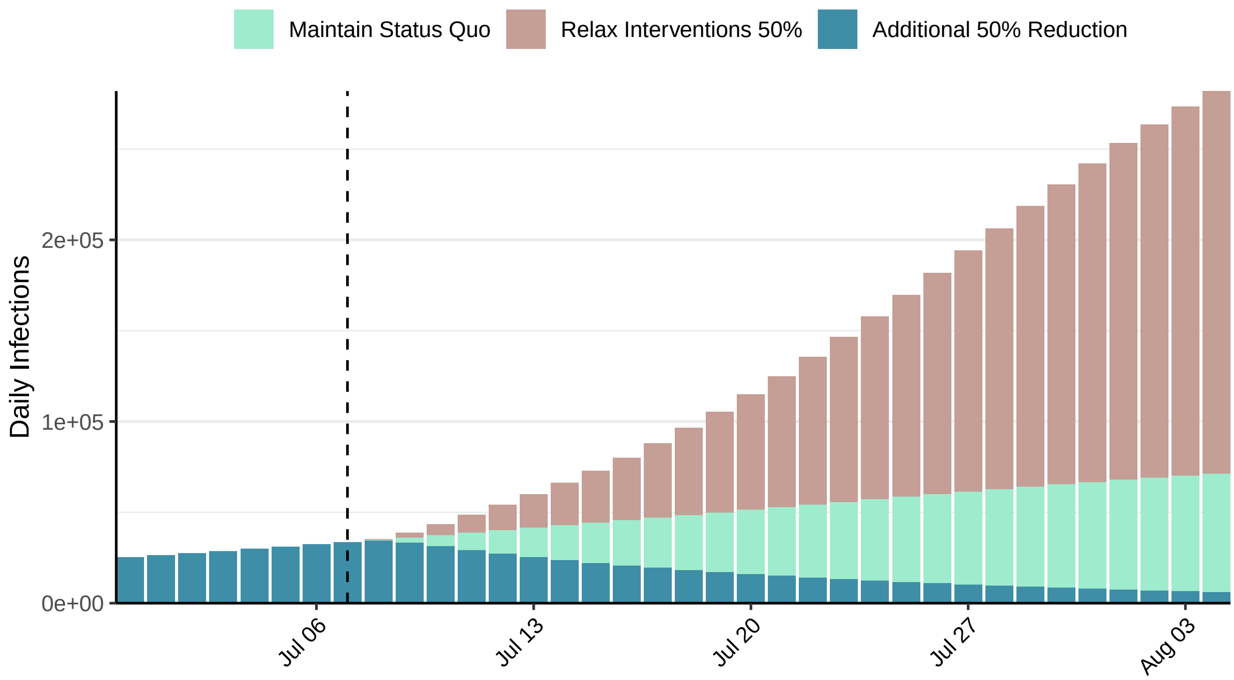

Figure 6: **Daily number of infections estimated by fitting to deaths.** Projected infections for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

To explore different scenarios, we recommend using our COVID-19 Scenario Analysis Tool - https://covidsim.org/, which can be used to simulate different intervention scenarios and explore the long term impact on healthcare demand.

Situation Report for COVID-19: Guyana, 2020-07-07

Download the report for Guyana, 2020-07-07 here. This report uses data from the European Centre for Disease Control. These data are updated daily and whilst there may be a short delay, they are generally consistent with Ministry reports. These data are then used to back-calculate an 'inferred number of COVID-19 infections' using mathematical modelling techniques (see Report 12 for further details) to estimate the number of people that have been infected and to make short-term projections for future healthcare needs.

Epidemiological Situation

Total Reported Cases	New Reported Cases	Total Reported Deaths	New Reported Deaths	Estimated R_t
278	5	16	1	0.87 (95% CI: 0.76-0.98)

The figure below shows the cumulative reported deaths as a function of the time since the 10th death was reported. Dashed lines show the expected trajectory for different doubling times of the epidemic. For example, with a doubling time of 3 days, if there are currently a total of 20 deaths reported, we would expect there to be 40 deaths in total reported in 3 days-time, 80 deaths in 6 days-time, 160 deaths in 9 days-time etc. For most epidemics, in the absence of interventions, we expect a doubling time of 3-4 days for this disease.

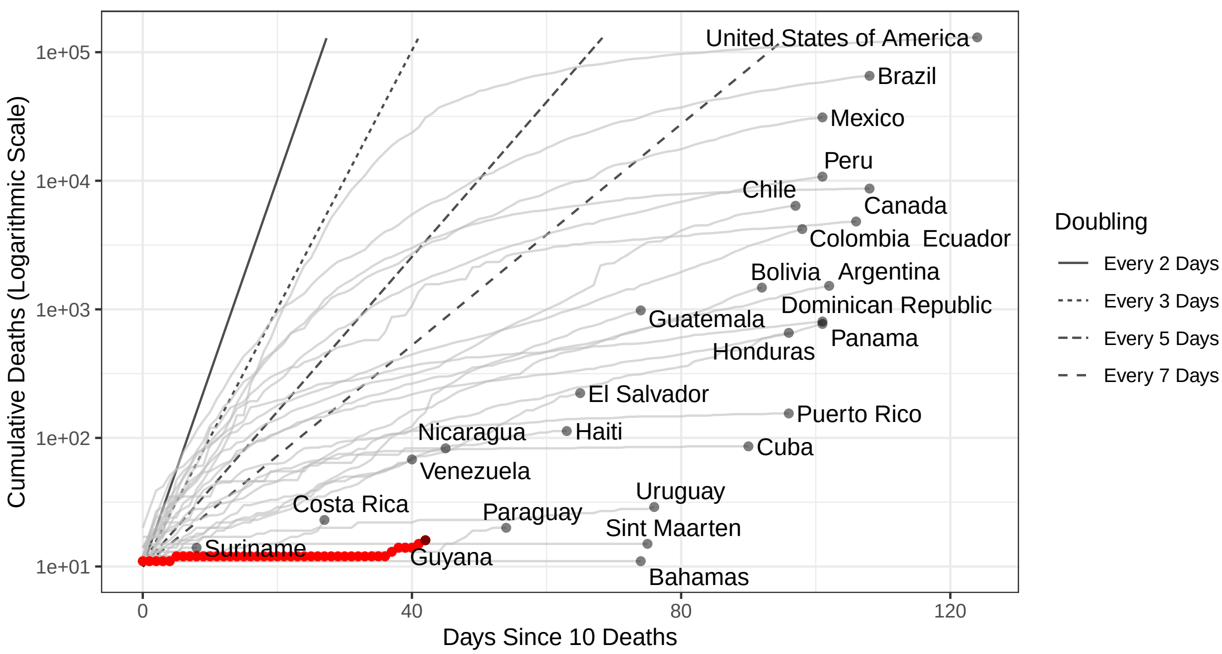

Figure 1: **Cumulative Deaths since 10 deaths.** Country not shown if fewer than 10 deaths.

COVID-19 Transmission Modelling

We assume that the deaths reported to date provide the best indication of the stage of the epidemic, as deaths are more consistently and accurately reported. Our current working estimate is that 1 death indicates that approximately 100 people will have been infected with the other 99 recovering (based on an infection fatality ratio of ~1%). These infections will have happened approximately 21 days previously – capturing a 5-day period from infection to onset of symptoms (the incubation period), 4 days from onset of symptoms to hospitalisation, and 12 days in hospital before death. With a 3-day doubling time, 100 infections that occurred 15 days ago will have generated 200 infections 12 days ago, 400 infections 9 days ago, 800 infections 6 days ago and 1,600 infections 3 days ago resulting in approximately 3,200 infections at the time the first death is observed.

To explore this, we fit our age-structured SEIR model (see Methods) to the time series of deaths in a country, in order to estimate the start date of the epidemic and the baseline R0. We assume that 100% of COVID-19 related deaths have been reported. We have also included the impact of interventions that have been put in place and their effect on human mobility and transmission based on the Google COVID-19 Community Mobility Reports. Using our mathematical model that formalises this approach, we estimate that there has been a total of 1,194 (95% CI: 992-1,395) infections over the past 4 weeks.

The figure below shows the estimated number of people infected over the past 4 weeks. The bar charts show, for comparison, the number of reported cases. The right-hand plot shows these data on a different scale as the estimated infections are likely to be much larger than the reported cases. **Importantly**, the estimated infections includes both asymptomatic and mild cases that would not necessarily be identified through surveillance. Consequently, the estimated infections are likely to be significantly higher than the reported cases (see our FAQ for further explanation of these differences and why the reported cases and estimated infections are unlikely to match).

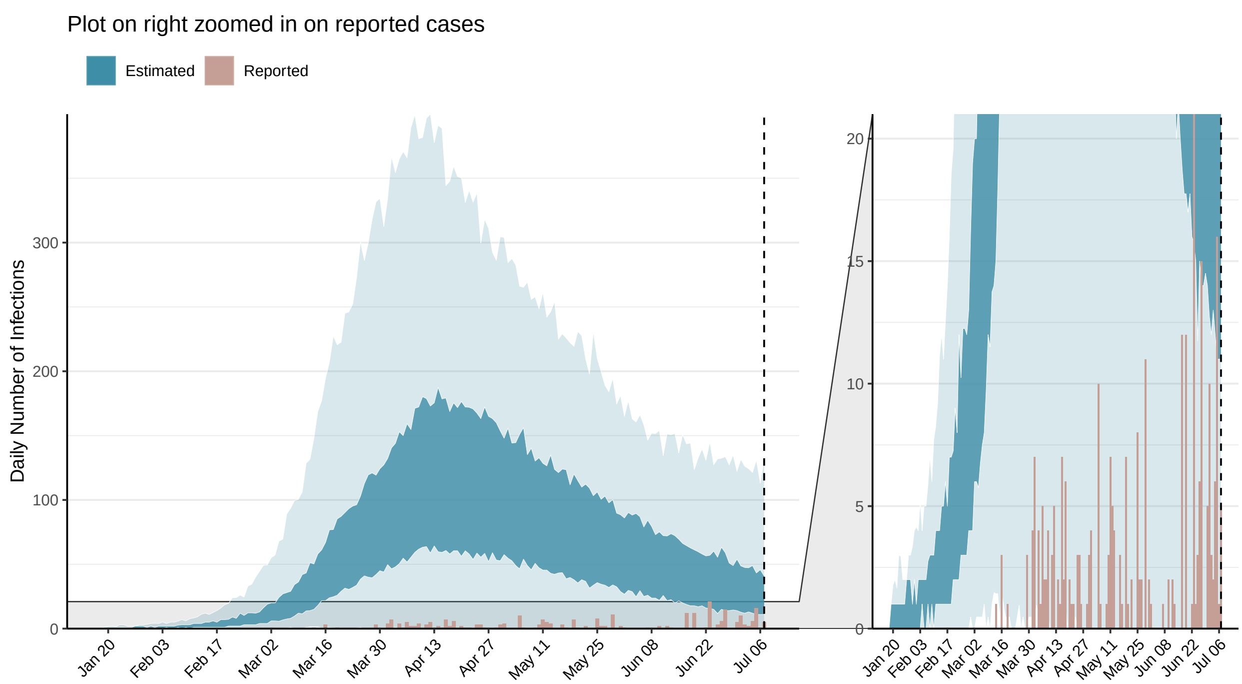

Figure 2: **Daily number of infections estimated by fitting to the current total of deaths.** Reported cases are shown in red. Model estimated infections are shown in blue (dark blue 50% interquartile range, light blue 95% quantile). The dashed line shows the current day.

By fitting to the time series of deaths, we are able to estimate a time-varying reproduction number, R_t. R_t is the the average number of secondary infections caused by a single infected person at a given time. If R_t is above 1, the rate of transmission is increasing and the number of new infections is increasing. R_t is assumed to change in relation to mobility fall in proportion. When fitting our model we assume that 100% of COVID-19 related deaths have been reported (please see our FAQ section for more information about this assumption). We also assume a fixed date at which the impact of mobility on transmission changes from pre-lockdown levels to post-lockdown levels, which may cause large changes in Rt. We are working to refine how this switch occurs and to formally calculate its shape.

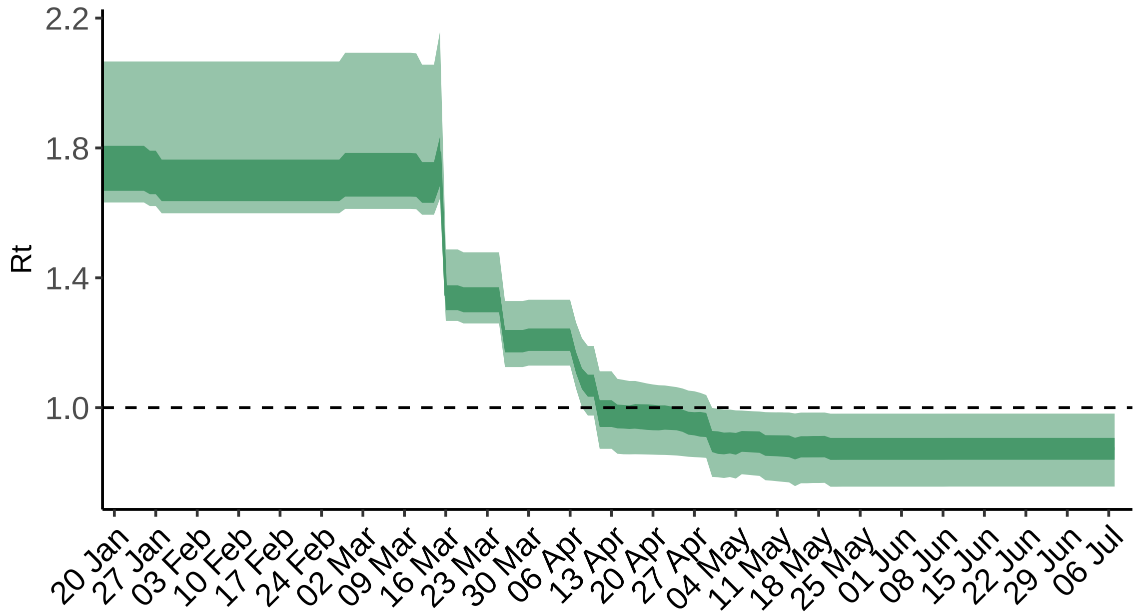

Figure 3: **Time-varying reproduction number, R_t.** R_t is the average number of secondary infections caused by a single infected person at time equal to t. $R_t < 1$ indicates a slowing epidemic in which new infections are not increasing. $R_t > 1$ indicates a growing epidemic in which new infections are increasing over time. Dark green shows the 50% CI and light green shows the 95% CI.

Using the model fit, we can forecast the expected trajectory for cumulative deaths, which is shown in the figure below. This assumes a severity pattern by age that is consistent with that observed in China, Europe and the U.S to date. This projection assumes that transmission is maintained at the current level of transmission as estimated by the final R_t value.

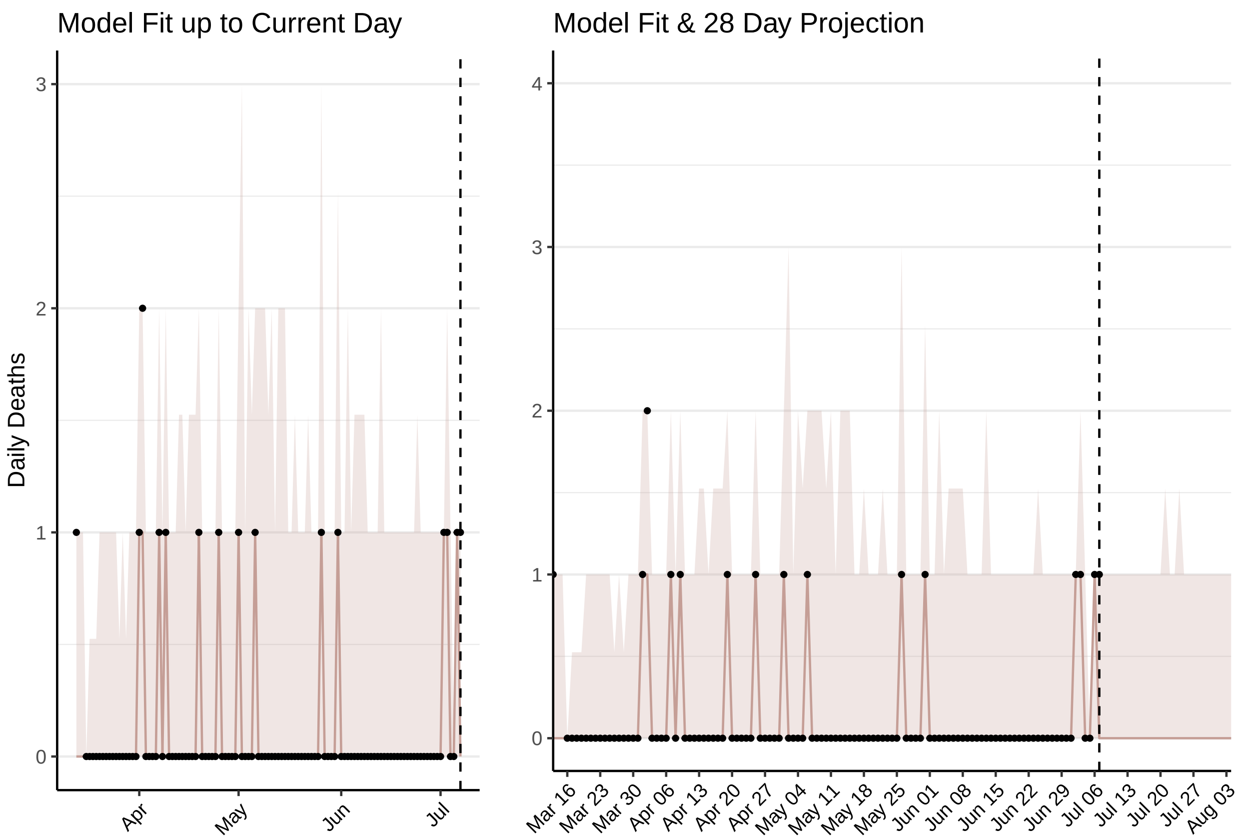

Figure 4: **Estimated daily deaths.** Projected deaths assuming the current level of interventions are maintained are shown in red (median and 95% quantile). Reported deaths are plotted in black. The plot on the left is focussed on the model fit prior to today, while the plot on the right forecasts the next 28 days.

Short-term Epidemic Scenarios

We make the following short-term projections of healthcare demand and new infections under the following three scenarios:

- **Scenario 1.** The epidemic continues to grow at the current rate.
- **Scenario 2.** Countries will further scale up interventions (either increasing current strategies or implementing new interventions) leading to a further 50% reduction in transmission.
- **Scenario 3.** Countries will relax current interventions by 50%

N.B. These scenarios currently assume that the impact of mobility on transmission will remain the same in the future as it has in the past. We are working to extend methods to estimate the impact of increases in mobility on transmission as lockdown and interventions are reversed. Consequently, projection are likely to represent an upper estimate of the healthcare demand and case load for each scenario

We estimate that over the next 4 weeks demand for hospital beds will change from 6 (95% CI: 5-7) patients requiring treatment with high-pressure oxygen at the current date to 4 (95% CI: 3-5) hospital beds being required on 2020-08-04 if no further interventions are introduced (Scenario 1). Similarly, we estimate that over the next 4 weeks demand for critical care (ICU) beds will change from 1 (95% CI: 1-2) patients requiring treatment with mechanical ventilation at the current date to 1 (95% CI: 1-2) by 2020-08-04. These projections assume that approximately 5% of all infections will require treatment with high-pressure oxygen and that approximately 30% of hospitalised cases will require treatment with mechanical ventilation (based on analysis of ongoing epidemics in Europe). **N.B. These scenarios are unlikely to show significant differences for the first week since there is a delay of approximately 10 days between infection and hospital admission. Consequently, the effectiveness of a change in policy is likely to be better captured by hospital admission data approximately 2 weeks after the policy change is implemented.**

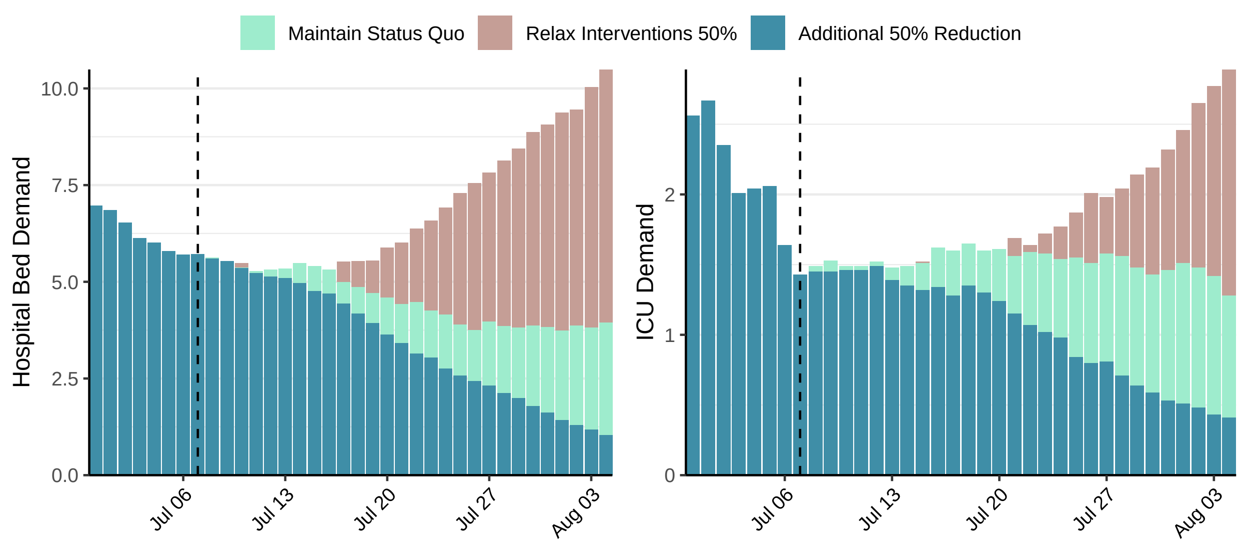

Figure 5: **Healthcare demands in the next 28 days.** Individuals needing an ICU bed are assumed to need mechanical ventilation. Projected demand for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

The impact of each scenario has a more immediate effect on the daily number of infections. The figure below shows the impact of each scenario on the estimated daily incidence of new infections. If interventions are scaled up (Scenario 2), the daily number of infections will change from 34 (95% CI: 27-40) at the current date to 2 (95% CI: 1-2) by 2020-08-04. If current interventions were relaxed by 50%, we estimate the daily number of infections will change from 34 (95% CI: 27-40) at the current date to 119 (95% CI: 90-148) by 2020-08-04.

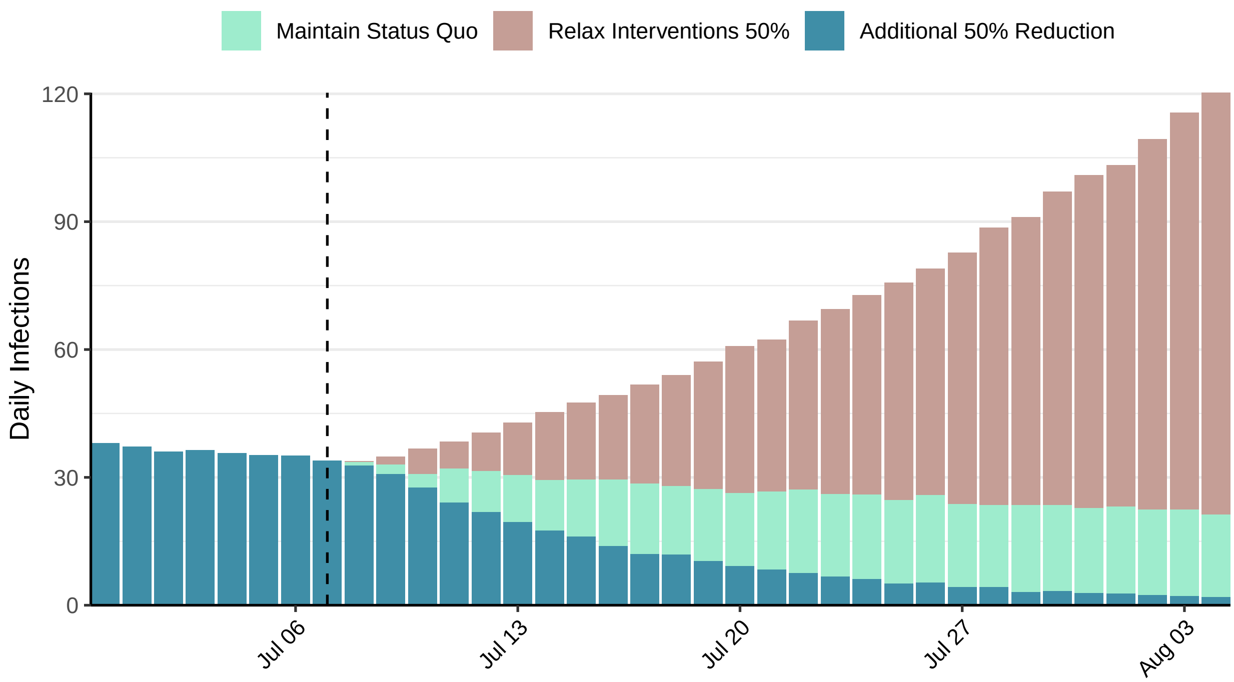

Figure 6: **Daily number of infections estimated by fitting to deaths.** Projected infections for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

To explore different scenarios, we recommend using our COVID-19 Scenario Analysis Tool - https://covidsim.org/, which can be used to simulate different intervention scenarios and explore the long term impact on healthcare demand.

Situation Report for COVID-19: Honduras, 2020-07-07

Download the report for Honduras, 2020-07-07 here. This report uses data from the European Centre for Disease Control. These data are updated daily and whilst there may be a short delay, they are generally consistent with Ministry reports. These data are then used to back-calculate an 'inferred number of COVID-19 infections' using mathematical modelling techniques (see Report 12 for further details) to estimate the number of people that have been infected and to make short-term projections for future healthcare needs.

Epidemiological Situation

Total Reported Cases	New Reported Cases	Total Reported Deaths	New Reported Deaths	Estimated R_t
24,665	722	656	17	1.26 (95% CI: 1.14-1.33)

The figure below shows the cumulative reported deaths as a function of the time since the 10th death was reported. Dashed lines show the expected trajectory for different doubling times of the epidemic. For example, with a doubling time of 3 days, if there are currently a total of 20 deaths reported, we would expect there to be 40 deaths in total reported in 3 days-time, 80 deaths in 6 days-time, 160 deaths in 9 days-time etc. For most epidemics, in the absence of interventions, we expect a doubling time of 3-4 days for this disease.

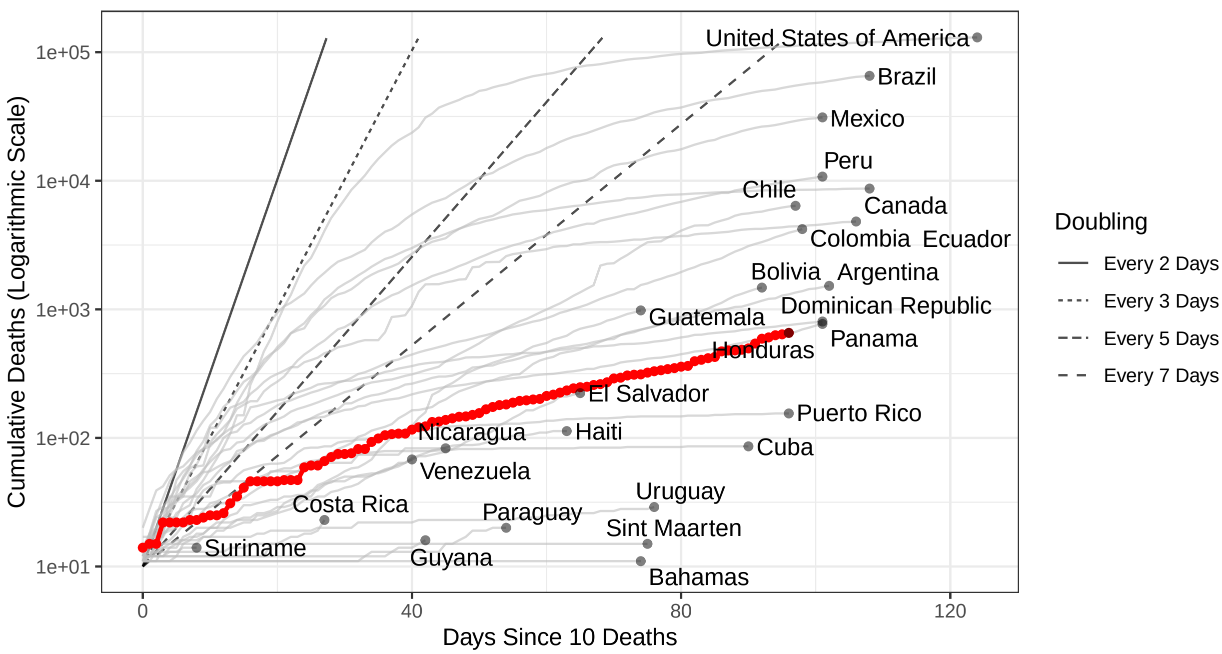

Figure 1: **Cumulative Deaths since 10 deaths.** Country not shown if fewer than 10 deaths.

COVID-19 Transmission Modelling

We assume that the deaths reported to date provide the best indication of the stage of the epidemic, as deaths are more consistently and accurately reported. Our current working estimate is that 1 death indicates that approximately 100 people will have been infected with the other 99 recovering (based on an infection fatality ratio of ~1%). These infections will have happened approximately 21 days previously – capturing a 5-day period from infection to onset of symptoms (the incubation period), 4 days from onset of symptoms to hospitalisation, and 12 days in hospital before death. With a 3-day doubling time, 100 infections that occurred 15 days ago will have generated 200 infections 12 days ago, 400 infections 9 days ago, 800 infections 6 days ago and 1,600 infections 3 days ago resulting in approximately 3,200 infections at the time the first death is observed.

To explore this, we fit our age-structured SEIR model (see Methods) to the time series of deaths in a country, in order to estimate the start date of the epidemic and the baseline R0. We assume that 100% of COVID-19 related deaths have been reported. We have also included the impact of interventions that have been put in place and their effect on human mobility and transmission based on the Google COVID-19 Community Mobility Reports. Using our mathematical model that formalises this approach, we estimate that there has been a total of 316,882 (95% CI: 295,920-337,845) infections over the past 4 weeks.

The figure below shows the estimated number of people infected over the past 4 weeks. The bar charts show, for comparison, the number of reported cases. The right-hand plot shows these data on a different scale as the estimated infections are likely to be much larger than the reported cases. **Importantly**, the estimated infections includes both asymptomatic and mild cases that would not necessarily be identified through surveillance. Consequently, the estimated infections are likely to be significantly higher than the reported cases (see our FAQ for further explanation of these differences and why the reported cases and estimated infections are unlikely to match).

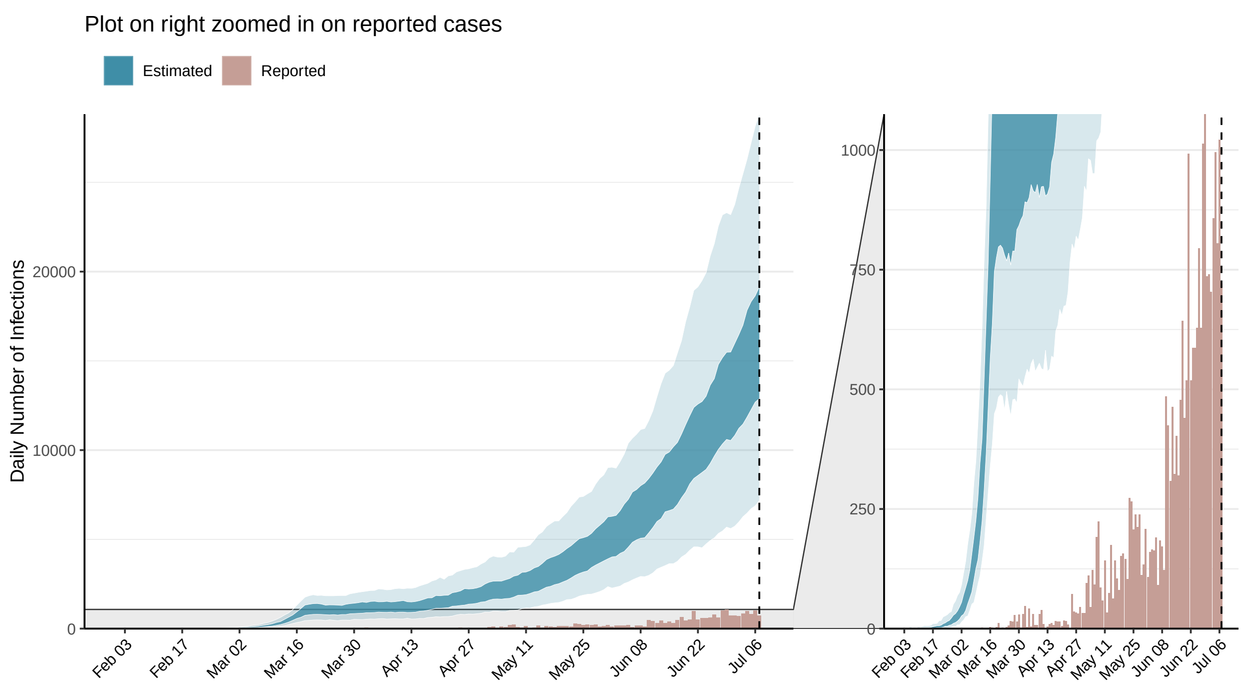

Figure 2: **Daily number of infections estimated by fitting to the current total of deaths.** Reported cases are shown in red. Model estimated infections are shown in blue (dark blue 50% interquartile range, light blue 95% quantile). The dashed line shows the current day.

By fitting to the time series of deaths, we are able to estimate a time-varying reproduction number, R_t. R_t is the the average number of secondary infections caused by a single infected person at a given time. If R_t is above 1, the rate of transmission is increasing and the number of new infections is increasing. R_t is assumed to change in relation to mobility fall in proportion. When fitting our model we assume that 100% of COVID-19 related deaths have been reported (please see our FAQ section for more information about this assumption). We also assume a fixed date at which the impact of mobility on transmission changes from pre-lockdown levels to post-lockdown levels, which may cause large changes in Rt. We are working to refine how this switch occurs and to formally calculate its shape.

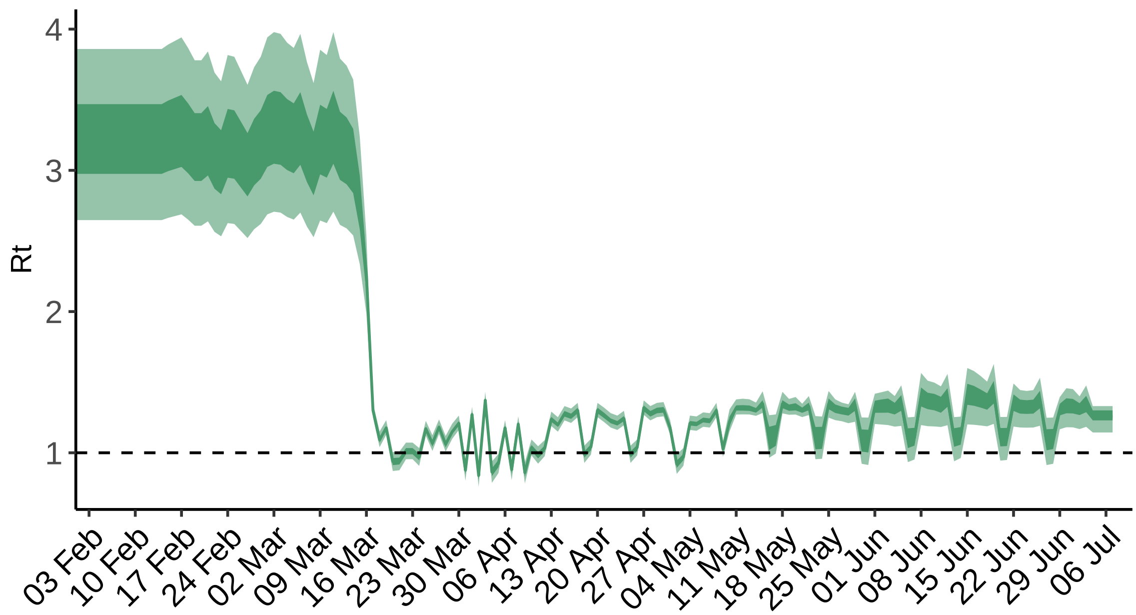

Figure 3: **Time-varying reproduction number, R_t.** R_t is the average number of secondary infections caused by a single infected person at time equal to t. $R_t < 1$ indicates a slowing epidemic in which new infections are not increasing. $R_t > 1$ indicates a growing epidemic in which new infections are increasing over time. Dark green shows the 50% CI and light green shows the 95% CI.

Using the model fit, we can forecast the expected trajectory for cumulative deaths, which is shown in the figure below. This assumes a severity pattern by age that is consistent with that observed in China, Europe and the U.S to date. This projection assumes that transmission is maintained at the current level of transmission as estimated by the final R_t value. **N.B. Honduras is forecast to be close to or surpassing our best estimates for healthcare capacity in the next 28 days.** Estimates of deaths in the next 28 days may be inaccurate due to our working assumptions for mortality in individuals who do not receive appropriate treatment. See our methods for more information.

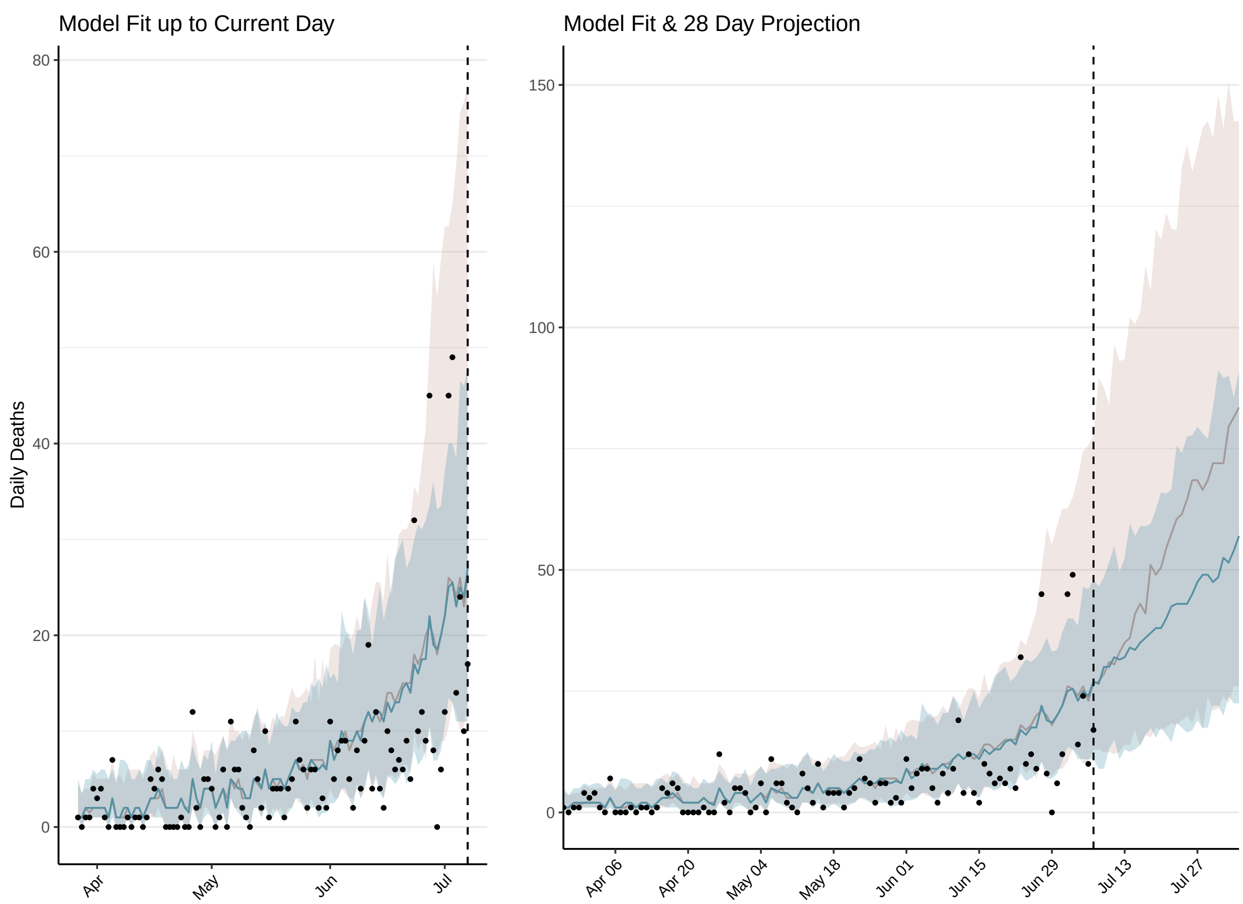

Figure 4: **Estimated daily deaths.** Projected deaths assuming the current level of interventions are maintained are shown in red (median and 95% quantile). Reported deaths are plotted in black. The plot on the left is focussed on the model fit prior to today, while the plot on the right forecasts the next 28 days. The forecasted deaths in blue assumes healthcare capacity has been surged to ensure sufficient supply of ICU and hospital beds. The red curve assumes no surging in healthcare capacity and subsequently projects increased deaths.

Short-term Epidemic Scenarios

We make the following short-term projections of healthcare demand and new infections under the following three scenarios:

- **Scenario 1.** The epidemic continues to grow at the current rate.
- **Scenario 2.** Countries will further scale up interventions (either increasing current strategies or implementing new interventions) leading to a further 50% reduction in transmission.
- **Scenario 3.** Countries will relax current interventions by 50%

N.B. These scenarios currently assume that the impact of mobility on transmission will remain the same in the future as it has in the past. We are working to extend methods to estimate the impact of increases in mobility on transmission as lockdown and interventions are reversed. Consequently, projection are likely to represent an upper estimate of the healthcare demand and case load for each scenario

We estimate that over the next 4 weeks demand for hospital beds will change from 1,572 (95% CI: 1,466-1,679) patients requiring treatment with high-pressure oxygen at the current date to 3,005 (95% CI: 2,808-3,201) hospital beds being required on 2020-08-04 if no further interventions are introduced (Scenario 1). Similarly, we estimate that over the next 4 weeks demand for critical care (ICU) beds will change from 417 (95% CI: 393-440) patients requiring treatment with mechanical ventilation at the current date to 568 (95% CI: 551-586) by 2020-08-04. These projections assume that approximately 5% of all infections will require treatment with high-pressure oxygen and that approximately 30% of hospitalised cases will require treatment with mechanical ventilation (based on analysis of ongoing epidemics in Europe). **N.B. These scenarios are unlikely to show significant differences for the first week since there is a delay of approximately 10 days between infection and hospital admission. Consequently, the effectiveness of a change in policy is likely to be better captured by hospital admission data approximately 2 weeks after the policy change is implemented.**

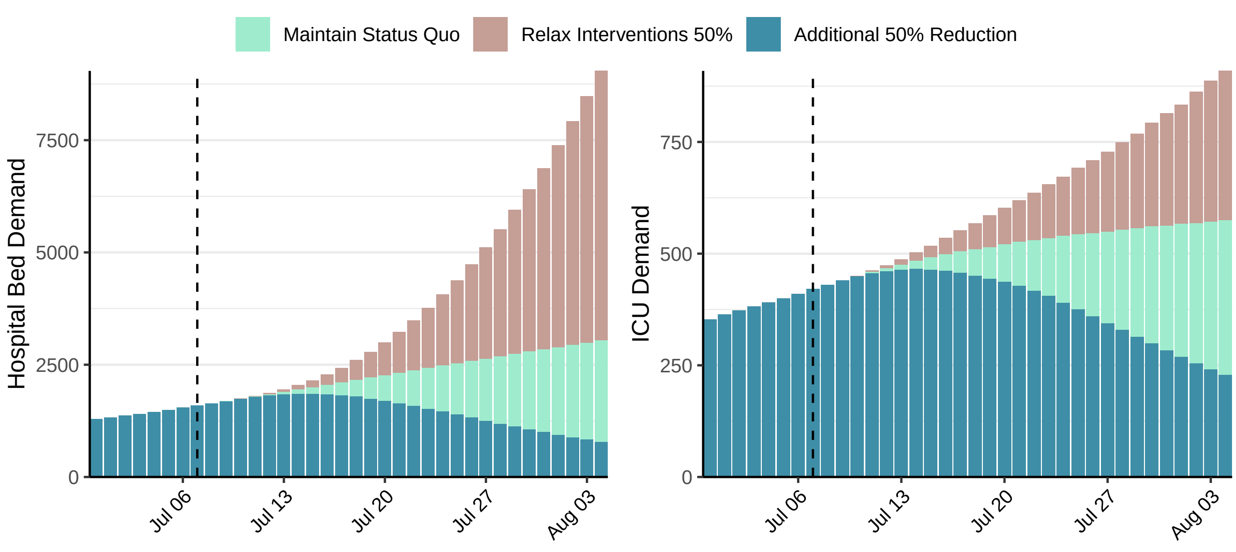

Figure 5: **Healthcare demands in the next 28 days.** Individuals needing an ICU bed are assumed to need mechanical ventilation. Projected demand for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

The impact of each scenario has a more immediate effect on the daily number of infections. The figure below shows the impact of each scenario on the estimated daily incidence of new infections. If interventions are scaled up (Scenario 2), the daily number of infections will change from 16,330 (95% CI: 15,226-17,435) at the current date to 2,206 (95% CI: 2,058-2,355) by 2020-08-04. If current interventions were relaxed by 50%, we estimate the daily number of infections will change from 16,330 (95% CI: 15,226-17,435) at the current date to 112,387 (95% CI: 106,912-117,862) by 2020-08-04.

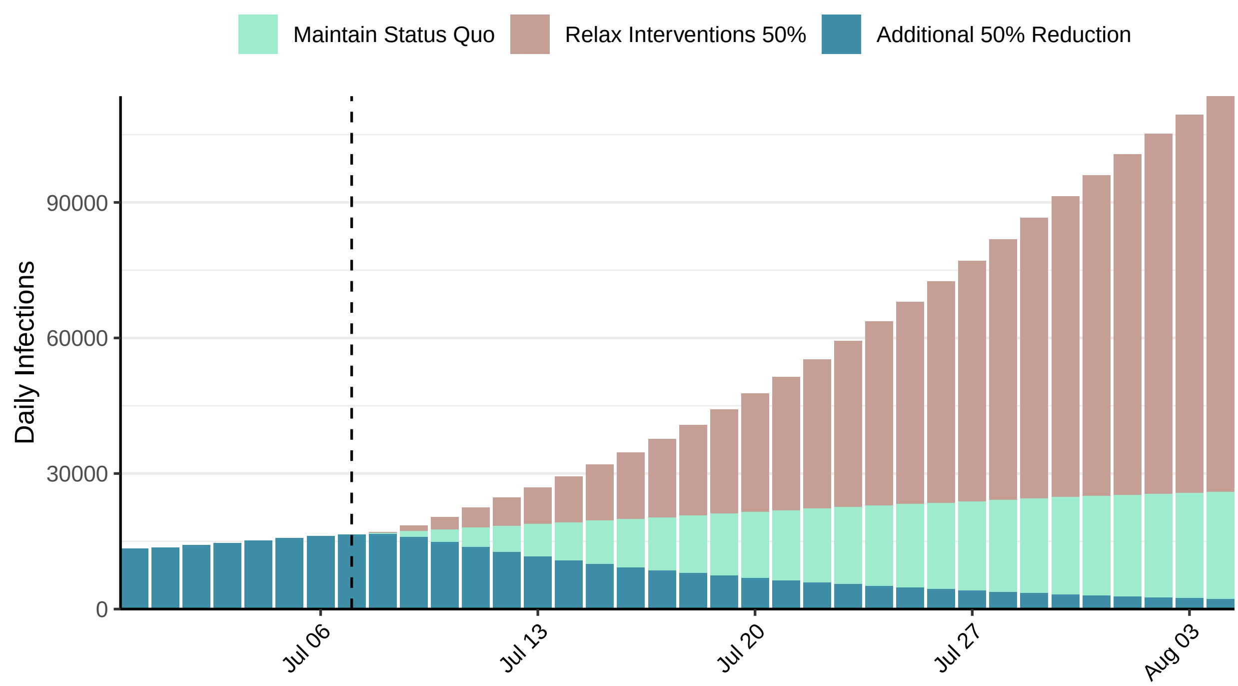

Figure 6: **Daily number of infections estimated by fitting to deaths.** Projected infections for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

To explore different scenarios, we recommend using our COVID-19 Scenario Analysis Tool - https://covidsim.org/, which can be used to simulate different intervention scenarios and explore the long term impact on healthcare demand.

Situation Report for COVID-19: Haiti, 2020-07-07

Download the report for Haiti, 2020-07-07 here. This report uses data from the European Centre for Disease Control. These data are updated daily and whilst there may be a short delay, they are generally consistent with Ministry reports. These data are then used to back-calculate an 'inferred number of COVID-19 infections' using mathematical modelling techniques (see Report 12 for further details) to estimate the number of people that have been infected and to make short-term projections for future healthcare needs.

Epidemiological Situation

Total Reported Cases	New Reported Cases	Total Reported Deaths	New Reported Deaths	Estimated R_t
6,371	38	113	0	1.15 (95% CI: 1.06-1.25)

The figure below shows the cumulative reported deaths as a function of the time since the 10th death was reported. Dashed lines show the expected trajectory for different doubling times of the epidemic. For example, with a doubling time of 3 days, if there are currently a total of 20 deaths reported, we would expect there to be 40 deaths in total reported in 3 days-time, 80 deaths in 6 days-time, 160 deaths in 9 days-time etc. For most epidemics, in the absence of interventions, we expect a doubling time of 3-4 days for this disease.

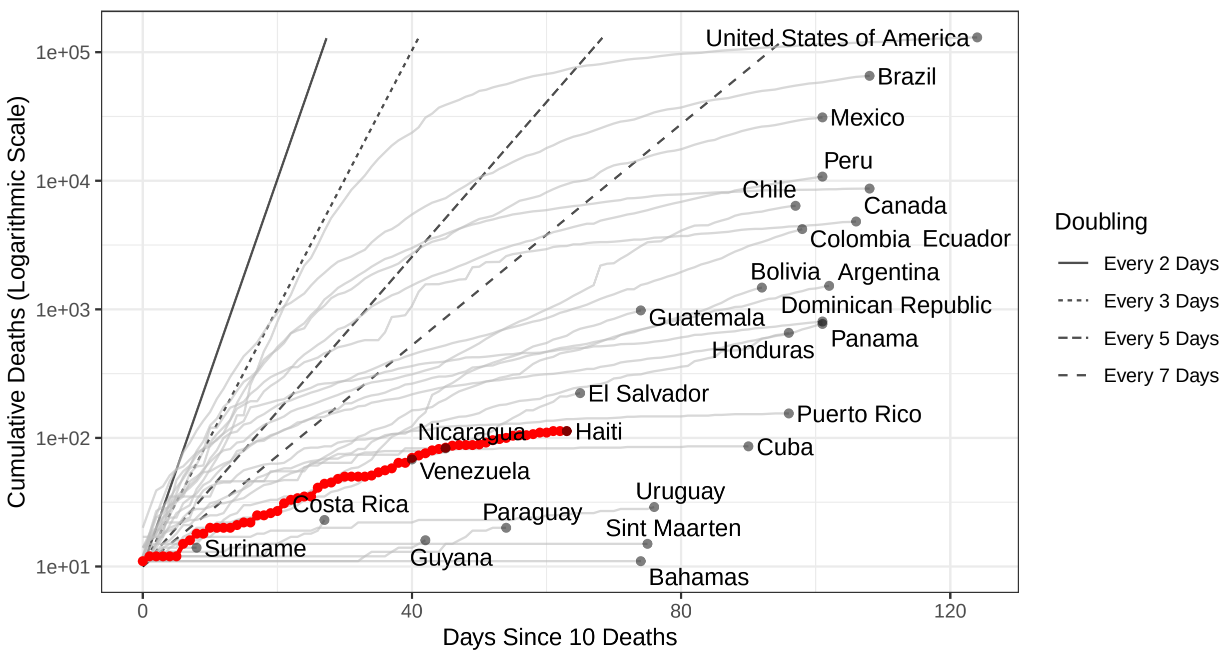

Figure 1: **Cumulative Deaths since 10 deaths.** Country not shown if fewer than 10 deaths.

COVID-19 Transmission Modelling

We assume that the deaths reported to date provide the best indication of the stage of the epidemic, as deaths are more consistently and accurately reported. Our current working estimate is that 1 death indicates that approximately 100 people will have been infected with the other 99 recovering (based on an infection fatality ratio of ~1%). These infections will have happened approximately 21 days previously – capturing a 5-day period from infection to onset of symptoms (the incubation period), 4 days from onset of symptoms to hospitalisation, and 12 days in hospital before death. With a 3-day doubling time, 100 infections that occurred 15 days ago will have generated 200 infections 12 days ago, 400 infections 9 days ago, 800 infections 6 days ago and 1,600 infections 3 days ago resulting in approximately 3,200 infections at the time the first death is observed.

To explore this, we fit our age-structured SEIR model (see Methods) to the time series of deaths in a country, in order to estimate the start date of the epidemic and the baseline R0. We assume that 100% of COVID-19 related deaths have been reported. We have also included the impact of interventions that have been put in place and their effect on human mobility and transmission based on the Google COVID-19 Community Mobility Reports. Using our mathematical model that formalises this approach, we estimate that there has been a total of 45,113 (95% CI: 39,501-50,725) infections over the past 4 weeks.

The figure below shows the estimated number of people infected over the past 4 weeks. The bar charts show, for comparison, the number of reported cases. The right-hand plot shows these data on a different scale as the estimated infections are likely to be much larger than the reported cases. **Importantly**, the estimated infections includes both asymptomatic and mild cases that would not necessarily be identified through surveillance. Consequently, the estimated infections are likely to be significantly higher than the reported cases (see our FAQ for further explanation of these differences and why the reported cases and estimated infections are unlikely to match).

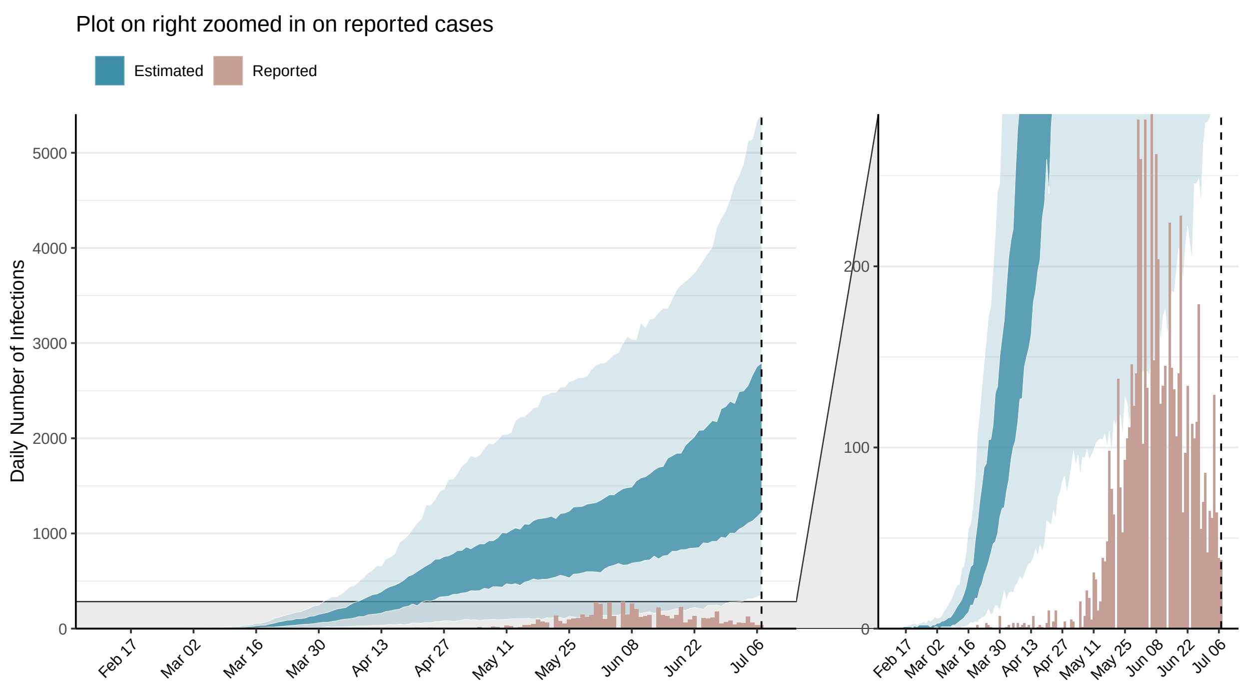

Figure 2: **Daily number of infections estimated by fitting to the current total of deaths.** Reported cases are shown in red. Model estimated infections are shown in blue (dark blue 50% interquartile range, light blue 95% quantile). The dashed line shows the current day.

By fitting to the time series of deaths, we are able to estimate a time-varying reproduction number, R_t. R_t is the the average number of secondary infections caused by a single infected person at a given time. If R_t is above 1, the rate of transmission is increasing and the number of new infections is increasing. R_t is assumed to change in relation to mobility fall in proportion. When fitting our model we assume that 100% of COVID-19 related deaths have been reported (please see our FAQ section for more information about this assumption). We also assume a fixed date at which the impact of mobility on transmission changes from pre-lockdown levels to post-lockdown levels, which may cause large changes in Rt. We are working to refine how this switch occurs and to formally calculate its shape.

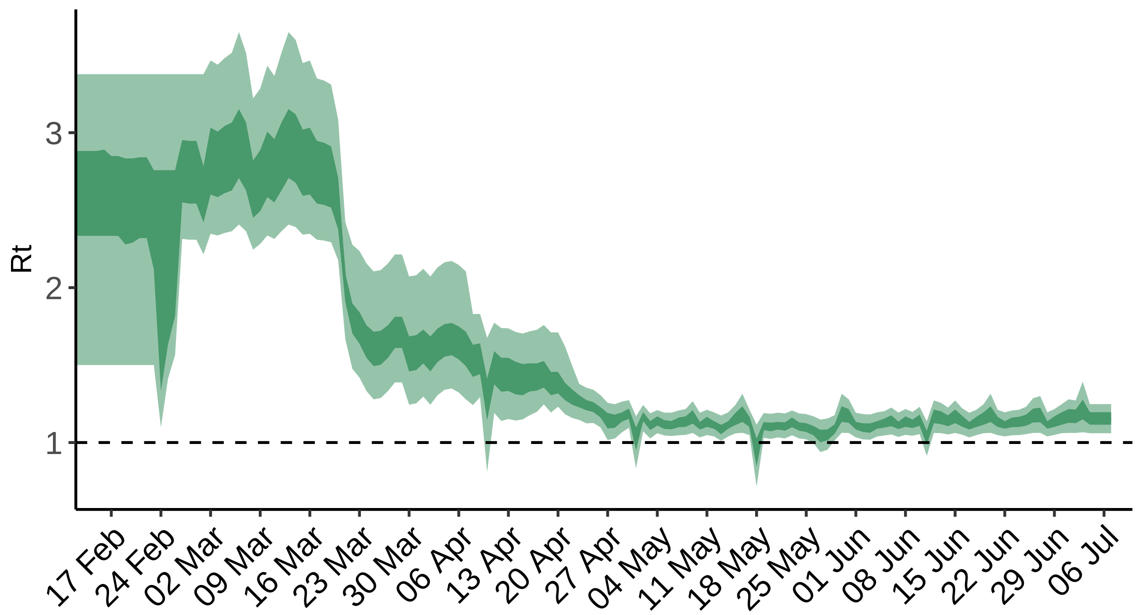

Figure 3: **Time-varying reproduction number, R_t.** R_t is the average number of secondary infections caused by a single infected person at time equal to t. $R_t < 1$ indicates a slowing epidemic in which new infections are not increasing. $R_t > 1$ indicates a growing epidemic in which new infections are increasing over time. Dark green shows the 50% CI and light green shows the 95% CI.

Using the model fit, we can forecast the expected trajectory for cumulative deaths, which is shown in the figure below. This assumes a severity pattern by age that is consistent with that observed in China, Europe and the U.S to date. This projection assumes that transmission is maintained at the current level of transmission as estimated by the final R_t value.

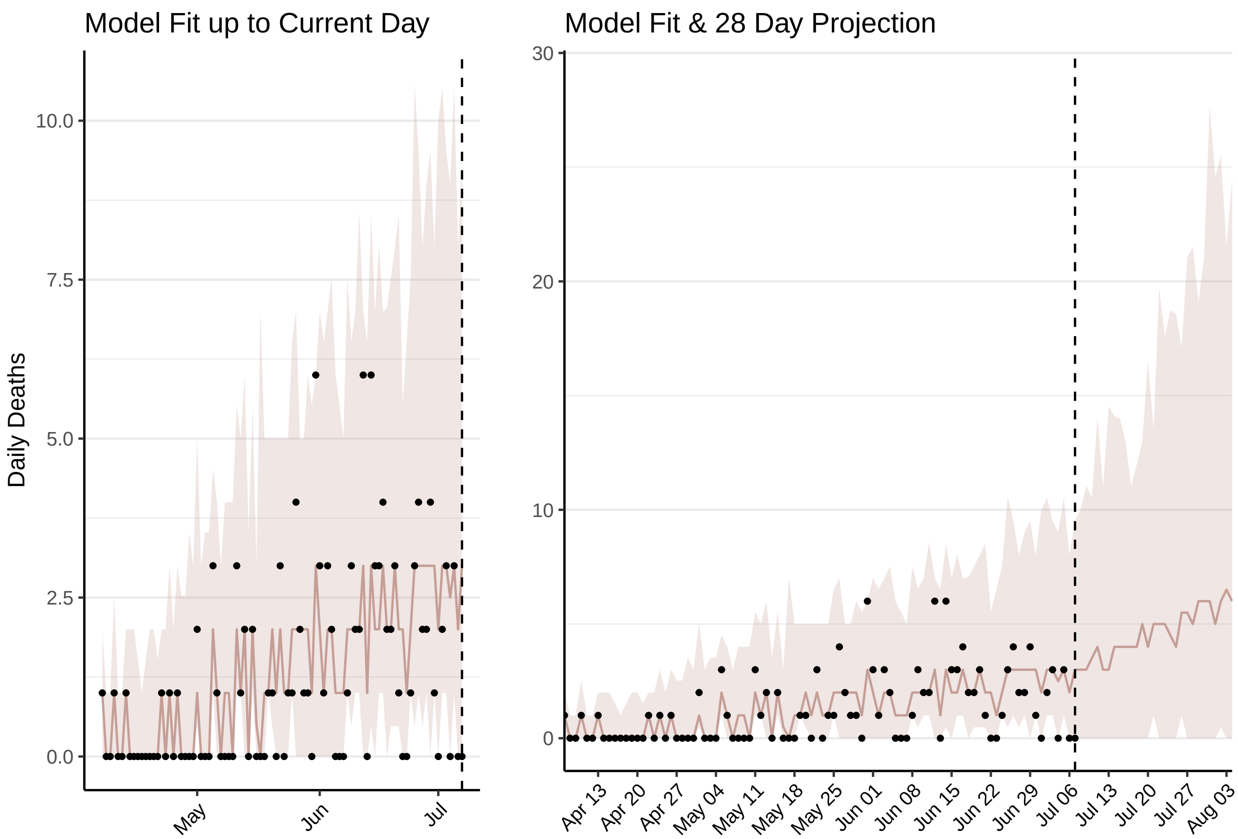

Figure 4: **Estimated daily deaths.** Projected deaths assuming the current level of interventions are maintained are shown in red (median and 95% quantile). Reported deaths are plotted in black. The plot on the left is focussed on the model fit prior to today, while the plot on the right forecasts the next 28 days.

Short-term Epidemic Scenarios

We make the following short-term projections of healthcare demand and new infections under the following three scenarios:

- **Scenario 1.** The epidemic continues to grow at the current rate.
- **Scenario 2.** Countries will further scale up interventions (either increasing current strategies or implementing new interventions) leading to a further 50% reduction in transmission.
- **Scenario 3.** Countries will relax current interventions by 50%

N.B. These scenarios currently assume that the impact of mobility on transmission will remain the same in the future as it has in the past. We are working to extend methods to estimate the impact of increases in mobility on transmission as lockdown and interventions are reversed. Consequently, projection are likely to represent an upper estimate of the healthcare demand and case load for each scenario

We estimate that over the next 4 weeks demand for hospital beds will change from 218 (95% CI: 190-245) patients requiring treatment with high-pressure oxygen at the current date to 395 (95% CI: 344-447) hospital beds being required on 2020-08-04 if no further interventions are introduced (Scenario 1). Similarly, we estimate that over the next 4 weeks demand for critical care (ICU) beds will change from 58 (95% CI: 51-66) patients requiring treatment with mechanical ventilation at the current date to 104 (95% CI: 92-116) by 2020-08-04. These projections assume that approximately 5% of all infections will require treatment with high-pressure oxygen and that approximately 30% of hospitalised cases will require treatment with mechanical ventilation (based on analysis of ongoing epidemics in Europe). **N.B. These scenarios are unlikely to show significant differences for the first week since there is a delay of approximately 10 days between infection and hospital admission. Consequently, the effectiveness of a change in policy is likely to be better captured by hospital admission data approximately 2 weeks after the policy change is implemented.**

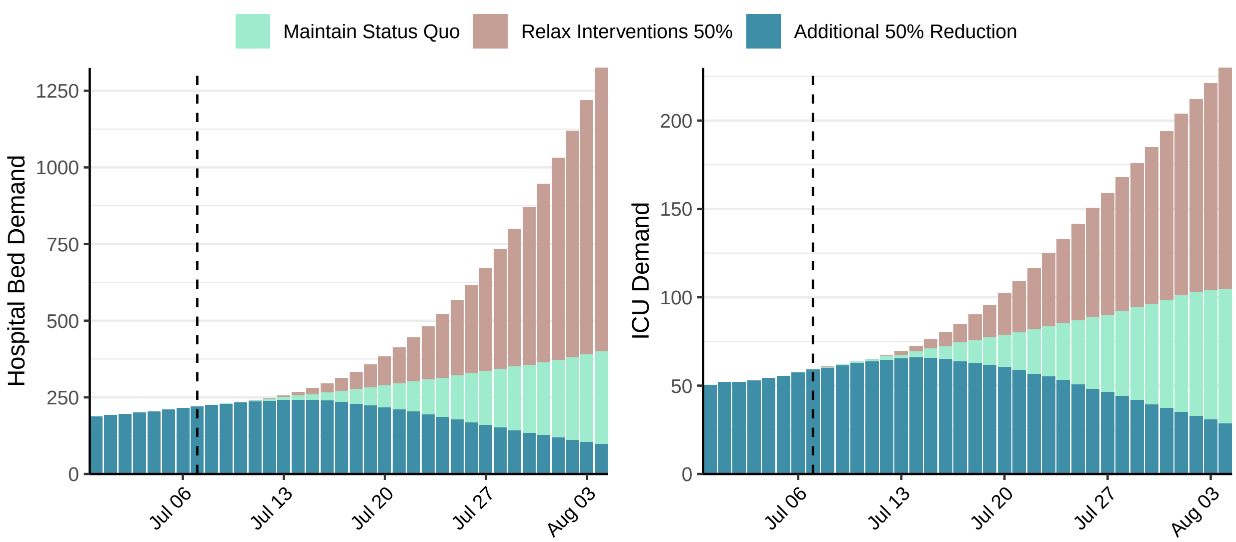

Figure 5: **Healthcare demands in the next 28 days.** Individuals needing an ICU bed are assumed to need mechanical ventilation. Projected demand for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

The impact of each scenario has a more immediate effect on the daily number of infections. The figure below shows the impact of each scenario on the estimated daily incidence of new infections. If interventions are scaled up (Scenario 2), the daily number of infections will change from 2,123 (95% CI: 1,857-2,389) at the current date to 293 (95% CI: 255-331) by 2020-08-04. If current interventions were relaxed by 50%, we estimate the daily number of infections will change from 2,123 (95% CI: 1,857-2,389) at the current date to 22,882 (95% CI: 19,968-25,796) by 2020-08-04.

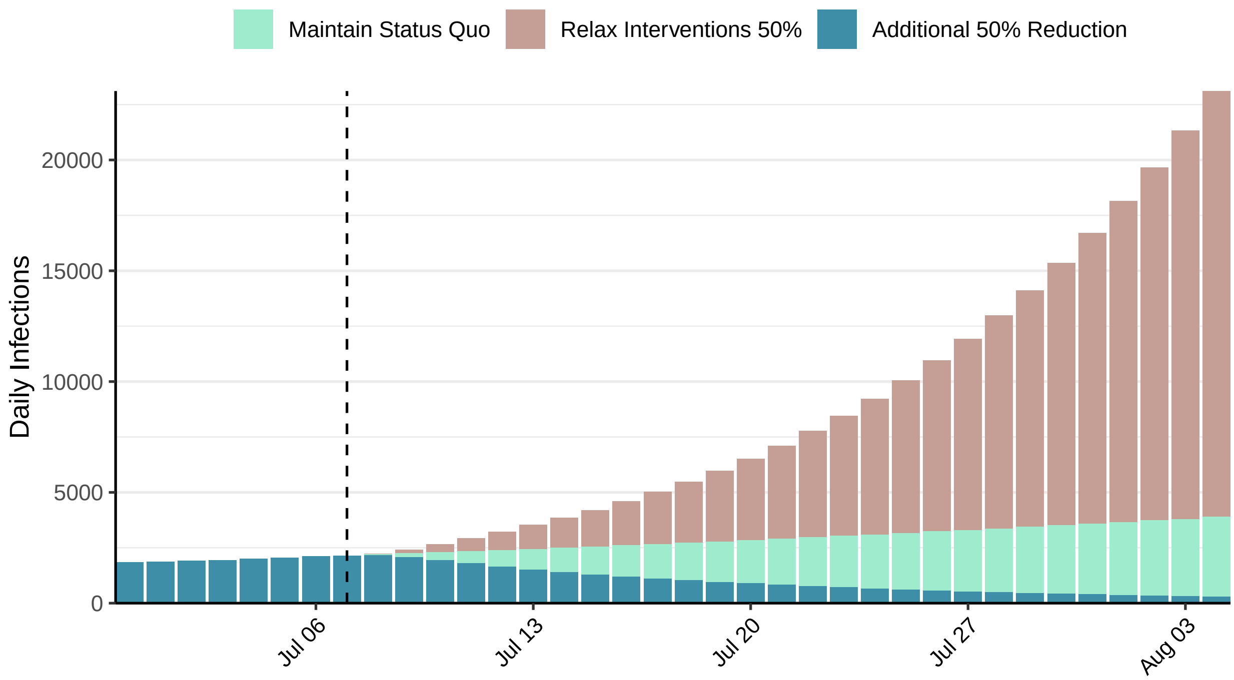

Figure 6: **Daily number of infections estimated by fitting to deaths.** Projected infections for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

To explore different scenarios, we recommend using our COVID-19 Scenario Analysis Tool - https://covidsim.org/, which can be used to simulate different intervention scenarios and explore the long term impact on healthcare demand.

Situation Report for COVID-19: Indonesia, 2020-07-07

Download the report for Indonesia, 2020-07-07 here. This report uses data from the European Centre for Disease Control. These data are updated daily and whilst there may be a short delay, they are generally consistent with Ministry reports. These data are then used to back-calculate an 'inferred number of COVID-19 infections' using mathematical modelling techniques (see Report 12 for further details) to estimate the number of people that have been infected and to make short-term projections for future healthcare needs.

Epidemiological Situation

Total Reported Cases	New Reported Cases	Total Reported Deaths	New Reported Deaths	Estimated R_t
64,958	1,209	3,241	70	1.28 (95% CI: 1.14-1.41)

The figure below shows the cumulative reported deaths as a function of the time since the 10th death was reported. Dashed lines show the expected trajectory for different doubling times of the epidemic. For example, with a doubling time of 3 days, if there are currently a total of 20 deaths reported, we would expect there to be 40 deaths in total reported in 3 days-time, 80 deaths in 6 days-time, 160 deaths in 9 days-time etc. For most epidemics, in the absence of interventions, we expect a doubling time of 3-4 days for this disease.

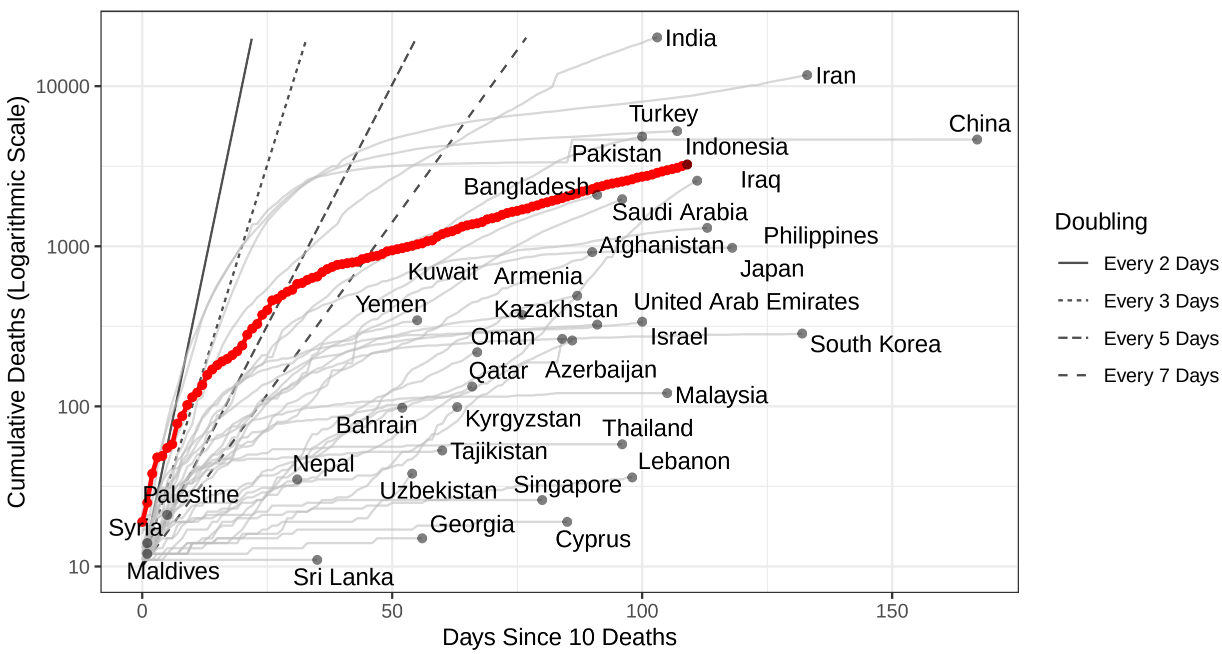

Figure 1: **Cumulative Deaths since 10 deaths.** Country not shown if fewer than 10 deaths.

COVID-19 Transmission Modelling

We assume that the deaths reported to date provide the best indication of the stage of the epidemic, as deaths are more consistently and accurately reported. Our current working estimate is that 1 death indicates that approximately 100 people will have been infected with the other 99 recovering (based on an infection fatality ratio of ~1%). These infections will have happened approximately 21 days previously – capturing a 5-day period from infection to onset of symptoms (the incubation period), 4 days from onset of symptoms to hospitalisation, and 12 days in hospital before death. With a 3-day doubling time, 100 infections that occurred 15 days ago will have generated 200 infections 12 days ago, 400 infections 9 days ago, 800 infections 6 days ago and 1,600 infections 3 days ago resulting in approximately 3,200 infections at the time the first death is observed.

To explore this, we fit our age-structured SEIR model (see Methods) to the time series of deaths in a country, in order to estimate the start date of the epidemic and the baseline R0. We assume that 100% of COVID-19 related deaths have been reported. We have also included the impact of interventions that have been put in place and their effect on human mobility and transmission based on the Google COVID-19 Community Mobility Reports. Using our mathematical model that formalises this approach, we estimate that there has been a total of 537,766 (95% CI: 495,481-580,050) infections over the past 4 weeks.

The figure below shows the estimated number of people infected over the past 4 weeks. The bar charts show, for comparison, the number of reported cases. The right-hand plot shows these data on a different scale as the estimated infections are likely to be much larger than the reported cases. **Importantly**, the estimated infections includes both asymptomatic and mild cases that would not necessarily be identified through surveillance. Consequently, the estimated infections are likely to be significantly higher than the reported cases (see our FAQ for further explanation of these differences and why the reported cases and estimated infections are unlikely to match).

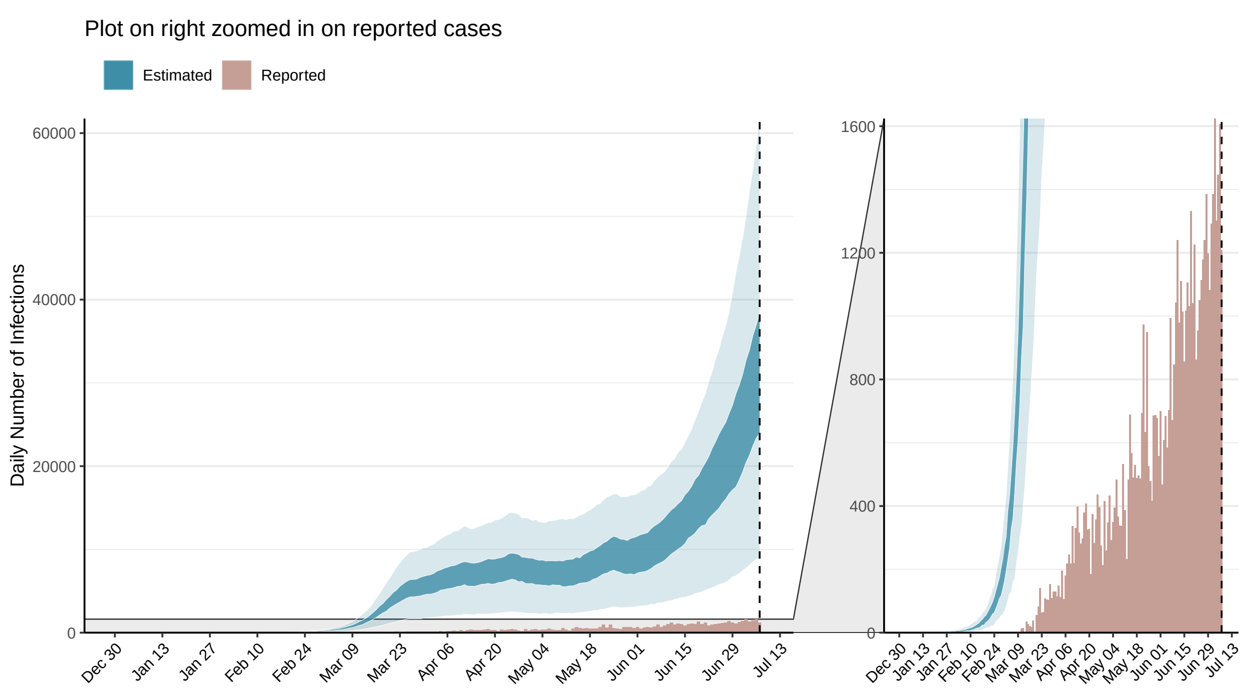

Figure 2: **Daily number of infections estimated by fitting to the current total of deaths.** Reported cases are shown in red. Model estimated infections are shown in blue (dark blue 50% interquartile range, light blue 95% quantile). The dashed line shows the current day.

By fitting to the time series of deaths, we are able to estimate a time-varying reproduction number, R_t. R_t is the the average number of secondary infections caused by a single infected person at a given time. If R_t is above 1, the rate of transmission is increasing and the number of new infections is increasing. R_t is assumed to change in relation to mobility fall in proportion. When fitting our model we assume that 100% of COVID-19 related deaths have been reported (please see our FAQ section for more information about this assumption). We also assume a fixed date at which the impact of mobility on transmission changes from pre-lockdown levels to post-lockdown levels, which may cause large changes in Rt. We are working to refine how this switch occurs and to formally calculate its shape.

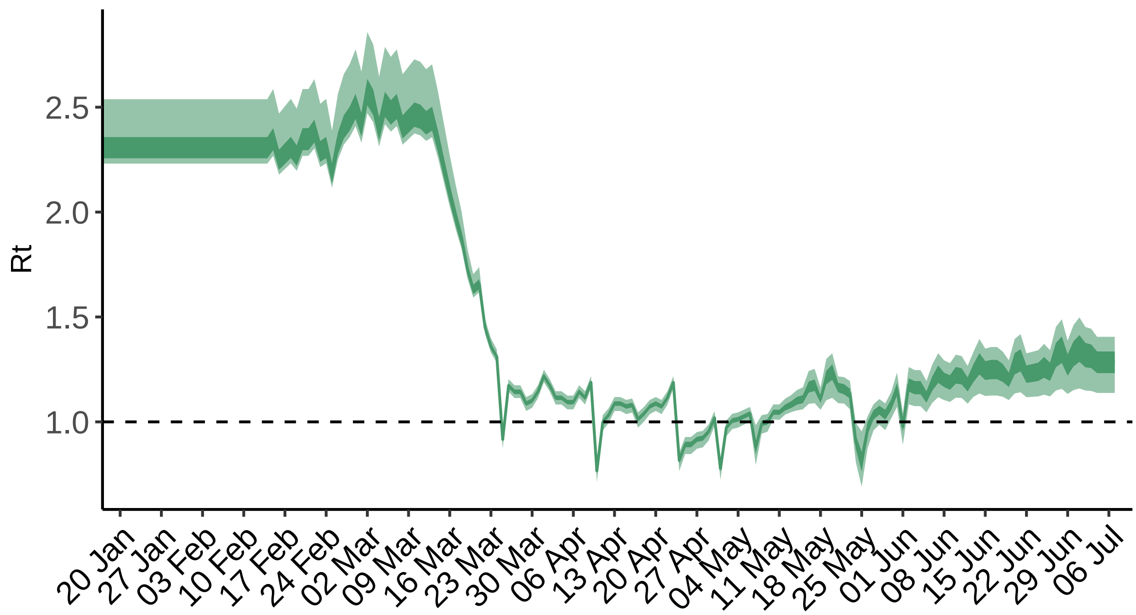

Figure 3: **Time-varying reproduction number, R_t.** R_t is the average number of secondary infections caused by a single infected person at time equal to t. $R_t < 1$ indicates a slowing epidemic in which new infections are not increasing. $R_t > 1$ indicates a growing epidemic in which new infections are increasing over time. Dark green shows the 50% CI and light green shows the 95% CI.

Using the model fit, we can forecast the expected trajectory for cumulative deaths, which is shown in the figure below. This assumes a severity pattern by age that is consistent with that observed in China, Europe and the U.S to date. This projection assumes that transmission is maintained at the current level of transmission as estimated by the final R_t value.

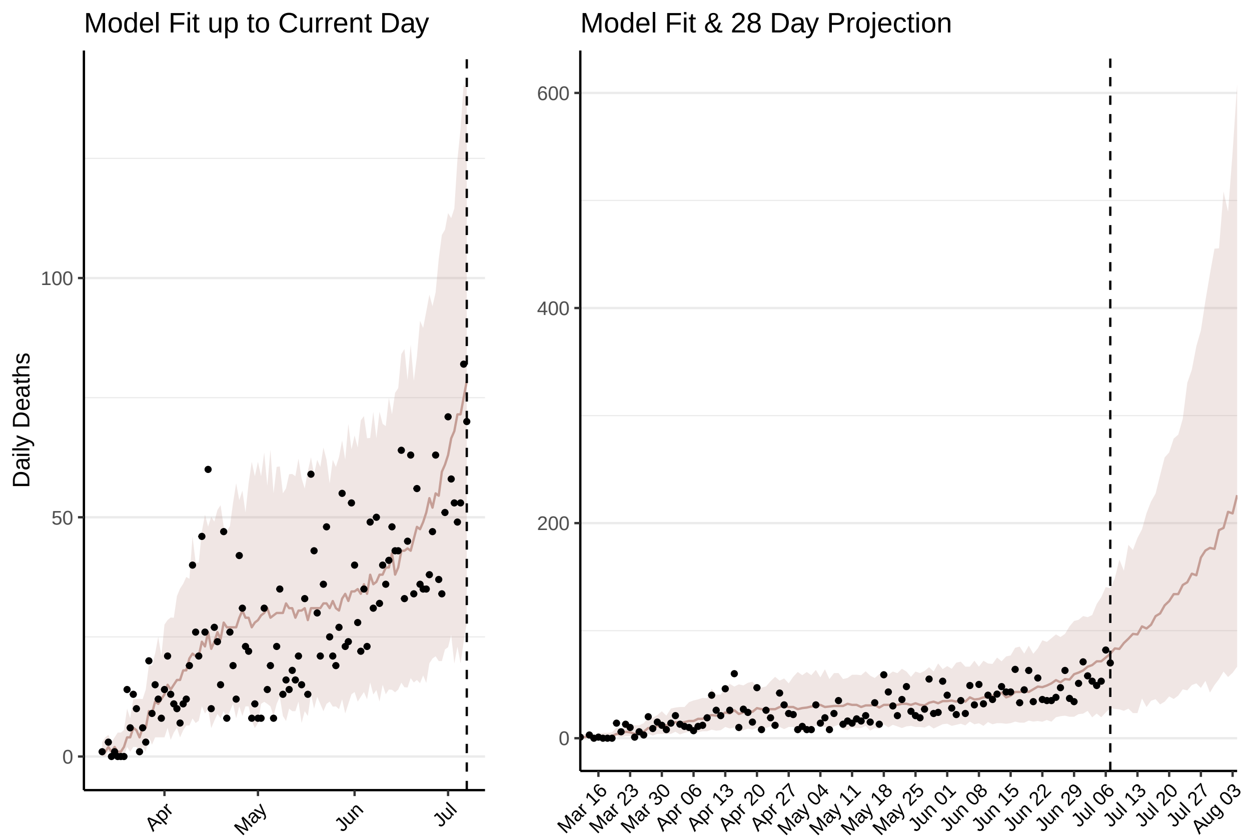

Figure 4: **Estimated daily deaths.** Projected deaths assuming the current level of interventions are maintained are shown in red (median and 95% quantile). Reported deaths are plotted in black. The plot on the left is focussed on the model fit prior to today, while the plot on the right forecasts the next 28 days.

Short-term Epidemic Scenarios

We make the following short-term projections of healthcare demand and new infections under the following three scenarios:

- **Scenario 1.** The epidemic continues to grow at the current rate.
- **Scenario 2.** Countries will further scale up interventions (either increasing current strategies or implementing new interventions) leading to a further 50% reduction in transmission.
- **Scenario 3.** Countries will relax current interventions by 50%

N.B. These scenarios currently assume that the impact of mobility on transmission will remain the same in the future as it has in the past. We are working to extend methods to estimate the impact of increases in mobility on transmission as lockdown and interventions are reversed. Consequently, projection are likely to represent an upper estimate of the healthcare demand and case load for each scenario

We estimate that over the next 4 weeks demand for hospital beds will change from 4,731 (95% CI: 4,354-5,107) patients requiring treatment with high-pressure oxygen at the current date to 14,889 (95% CI: 13,243-16,534) hospital beds being required on 2020-08-04 if no further interventions are introduced (Scenario 1). Similarly, we estimate that over the next 4 weeks demand for critical care (ICU) beds will change from 1,242 (95% CI: 1,145-1,340) patients requiring treatment with mechanical ventilation at the current date to 3,875 (95% CI: 3,465-4,285) by 2020-08-04. These projections assume that approximately 5% of all infections will require treatment with high-pressure oxygen and that approximately 30% of hospitalised cases will require treatment with mechanical ventilation (based on analysis of ongoing epidemics in Europe). **N.B. These scenarios are unlikely to show significant differences for the first week since there is a delay of approximately 10 days between infection and hospital admission. Consequently, the effectiveness of a change in policy is likely to be better captured by hospital admission data approximately 2 weeks after the policy change is implemented.**

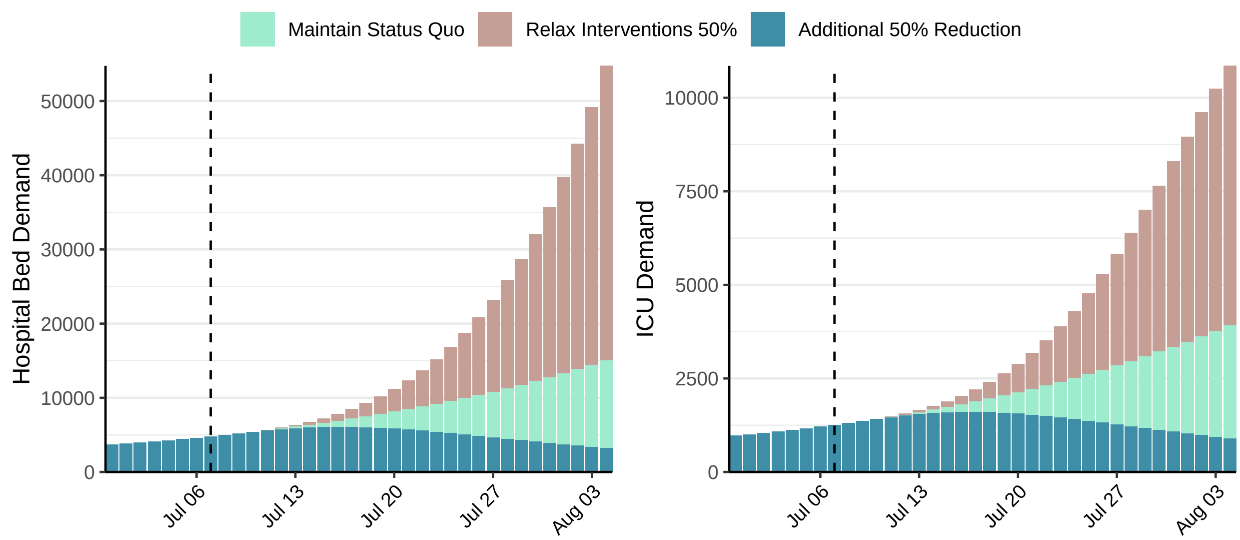

Figure 5: **Healthcare demands in the next 28 days.** Individuals needing an ICU bed are assumed to need mechanical ventilation. Projected demand for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

The impact of each scenario has a more immediate effect on the daily number of infections. The figure below shows the impact of each scenario on the estimated daily incidence of new infections. If interventions are scaled up (Scenario 2), the daily number of infections will change from 31,393 (95% CI: 28,631-34,154) at the current date to 6,763 (95% CI: 5,971-7,556) by 2020-08-04. If current interventions were relaxed by 50%, we estimate the daily number of infections will change from 31,393 (95% CI: 28,631-34,154) at the current date to 633,345 (95% CI: 555,431-711,260) by 2020-08-04.

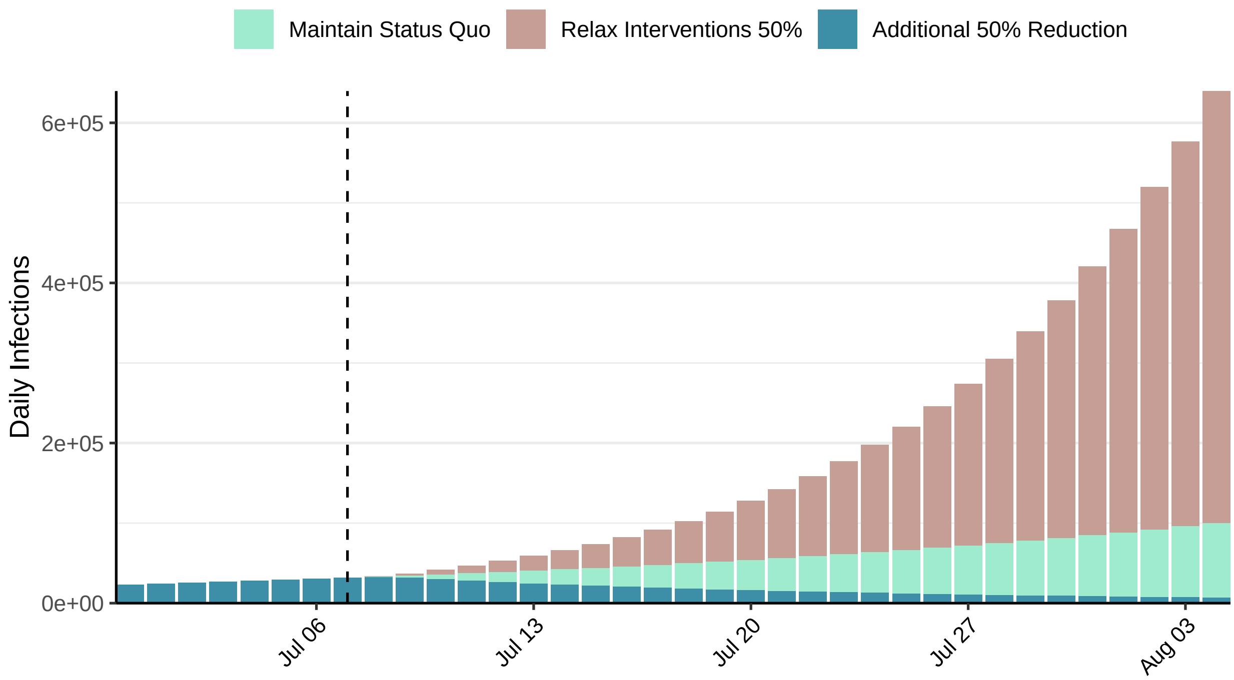

Figure 6: **Daily number of infections estimated by fitting to deaths.** Projected infections for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

To explore different scenarios, we recommend using our COVID-19 Scenario Analysis Tool - https://covidsim.org/, which can be used to simulate different intervention scenarios and explore the long term impact on healthcare demand.

Situation Report for COVID-19: India, 2020-07-07

Download the report for India, 2020-07-07 here. This report uses data from the European Centre for Disease Control. These data are updated daily and whilst there may be a short delay, they are generally consistent with Ministry reports. These data are then used to back-calculate an 'inferred number of COVID-19 infections' using mathematical modelling techniques (see Report 12 for further details) to estimate the number of people that have been infected and to make short-term projections for future healthcare needs.

Epidemiological Situation

Total Reported Cases	New Reported Cases	Total Reported Deaths	New Reported Deaths	Estimated R_t
719,665	22,252	20,160	467	1.24 (95% CI: 1.18-1.33)

The figure below shows the cumulative reported deaths as a function of the time since the 10th death was reported. Dashed lines show the expected trajectory for different doubling times of the epidemic. For example, with a doubling time of 3 days, if there are currently a total of 20 deaths reported, we would expect there to be 40 deaths in total reported in 3 days-time, 80 deaths in 6 days-time, 160 deaths in 9 days-time etc. For most epidemics, in the absence of interventions, we expect a doubling time of 3-4 days for this disease.

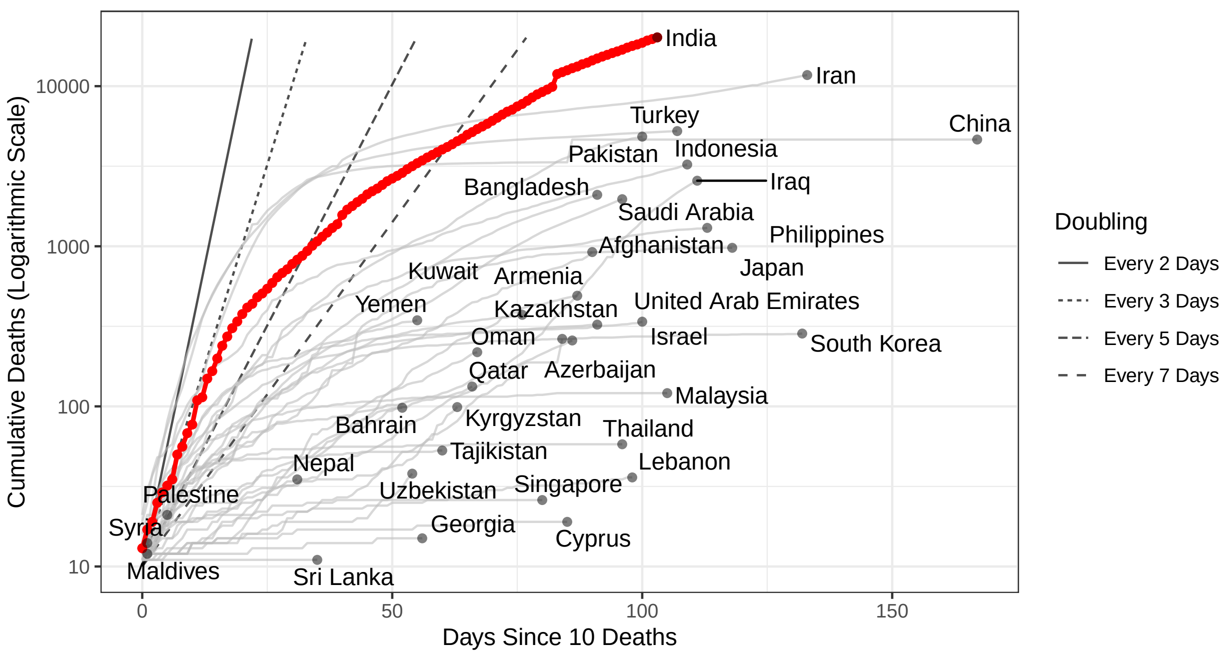

Figure 1: **Cumulative Deaths since 10 deaths.** Country not shown if fewer than 10 deaths.

COVID-19 Transmission Modelling

We assume that the deaths reported to date provide the best indication of the stage of the epidemic, as deaths are more consistently and accurately reported. Our current working estimate is that 1 death indicates that approximately 100 people will have been infected with the other 99 recovering (based on an infection fatality ratio of ~1%). These infections will have happened approximately 21 days previously – capturing a 5-day period from infection to onset of symptoms (the incubation period), 4 days from onset of symptoms to hospitalisation, and 12 days in hospital before death. With a 3-day doubling time, 100 infections that occurred 15 days ago will have generated 200 infections 12 days ago, 400 infections 9 days ago, 800 infections 6 days ago and 1,600 infections 3 days ago resulting in approximately 3,200 infections at the time the first death is observed.

To explore this, we fit our age-structured SEIR model (see Methods) to the time series of deaths in a country, in order to estimate the start date of the epidemic and the baseline R0. We assume that 100% of COVID-19 related deaths have been reported. We have also included the impact of interventions that have been put in place and their effect on human mobility and transmission based on the Google COVID-19 Community Mobility Reports. Using our mathematical model that formalises this approach, we estimate that there has been a total of 7,204,652 (95% CI: 6,375,475-8,033,829) infections over the past 4 weeks.

The figure below shows the estimated number of people infected over the past 4 weeks. The bar charts show, for comparison, the number of reported cases. The right-hand plot shows these data on a different scale as the estimated infections are likely to be much larger than the reported cases. **Importantly**, the estimated infections includes both asymptomatic and mild cases that would not necessarily be identified through surveillance. Consequently, the estimated infections are likely to be significantly higher than the reported cases (see our FAQ for further explanation of these differences and why the reported cases and estimated infections are unlikely to match).

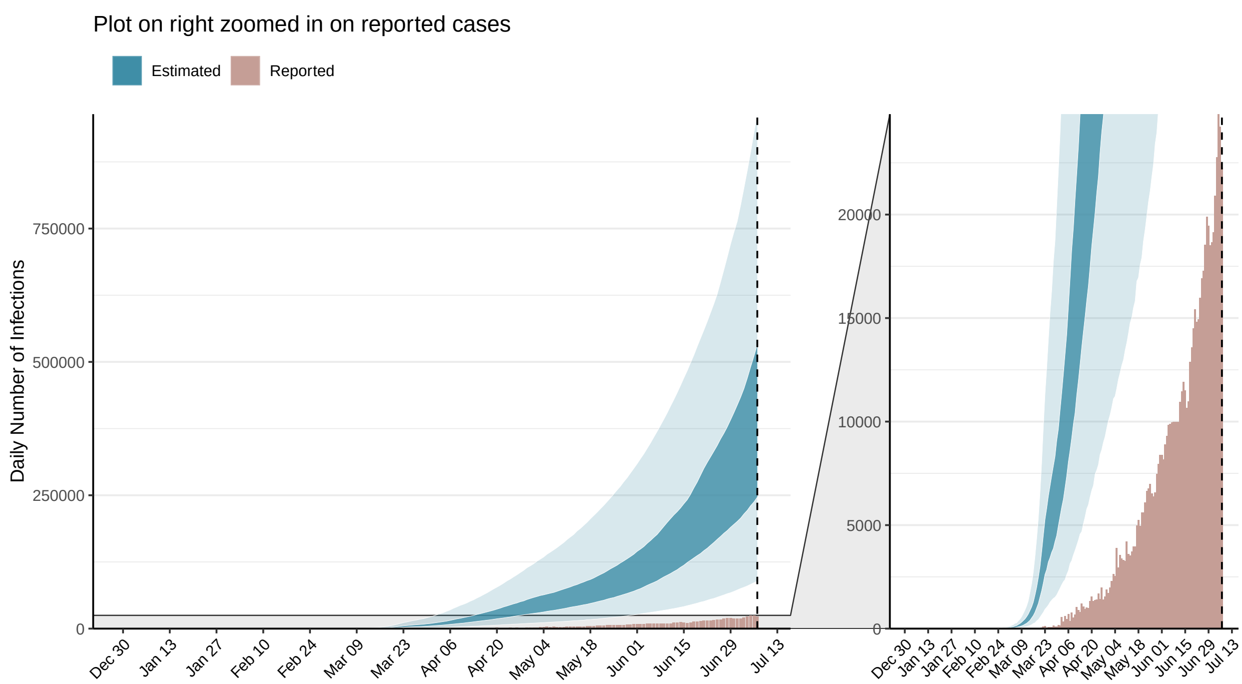

Figure 2: **Daily number of infections estimated by fitting to the current total of deaths.** Reported cases are shown in red. Model estimated infections are shown in blue (dark blue 50% interquartile range, light blue 95% quantile). The dashed line shows the current day.

By fitting to the time series of deaths, we are able to estimate a time-varying reproduction number, R_t. R_t is the the average number of secondary infections caused by a single infected person at a given time. If R_t is above 1, the rate of transmission is increasing and the number of new infections is increasing. R_t is assumed to change in relation to mobility fall in proportion. When fitting our model we assume that 100% of COVID-19 related deaths have been reported (please see our FAQ section for more information about this assumption). We also assume a fixed date at which the impact of mobility on transmission changes from pre-lockdown levels to post-lockdown levels, which may cause large changes in Rt. We are working to refine how this switch occurs and to formally calculate its shape.

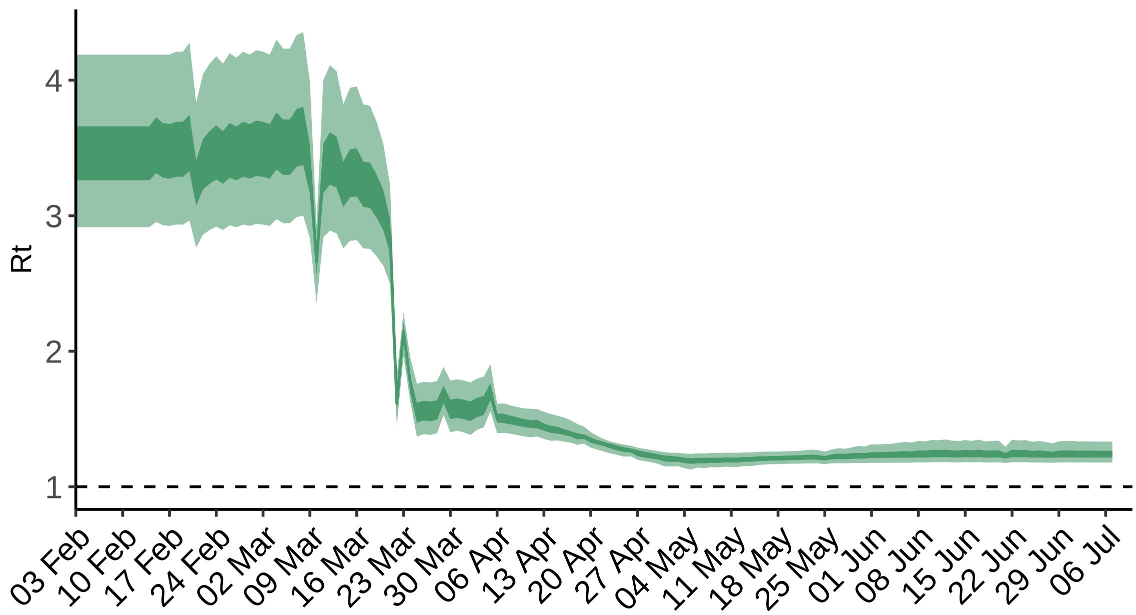

Figure 3: **Time-varying reproduction number, R_t.** R_t is the average number of secondary infections caused by a single infected person at time equal to t. $R_t < 1$ indicates a slowing epidemic in which new infections are not increasing. $R_t > 1$ indicates a growing epidemic in which new infections are increasing over time. Dark green shows the 50% CI and light green shows the 95% CI.

Using the model fit, we can forecast the expected trajectory for cumulative deaths, which is shown in the figure below. This assumes a severity pattern by age that is consistent with that observed in China, Europe and the U.S to date. This projection assumes that transmission is maintained at the current level of transmission as estimated by the final R_t value.

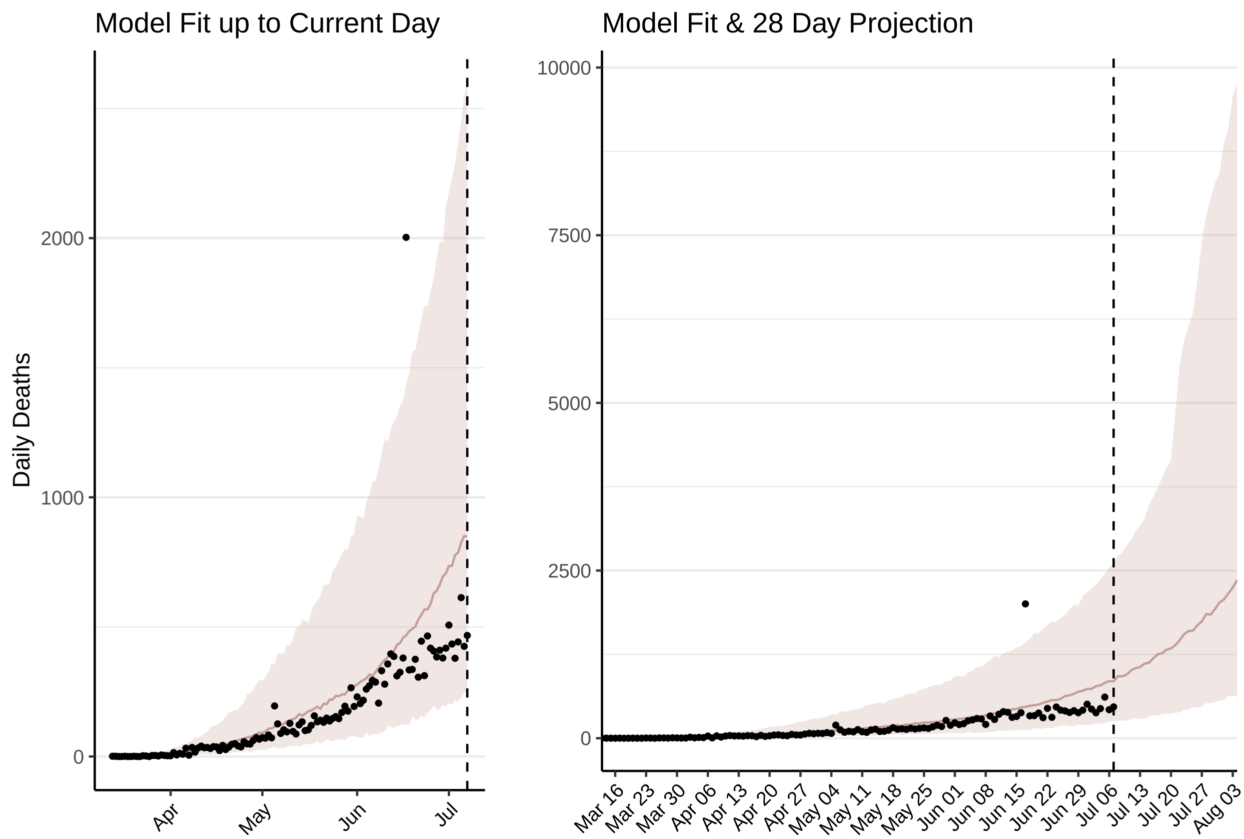

Figure 4: **Estimated daily deaths.** Projected deaths assuming the current level of interventions are maintained are shown in red (median and 95% quantile). Reported deaths are plotted in black. The plot on the left is focussed on the model fit prior to today, while the plot on the right forecasts the next 28 days.

Short-term Epidemic Scenarios

We make the following short-term projections of healthcare demand and new infections under the following three scenarios:

- **Scenario 1.** The epidemic continues to grow at the current rate.
- **Scenario 2.** Countries will further scale up interventions (either increasing current strategies or implementing new interventions) leading to a further 50% reduction in transmission.
- **Scenario 3.** Countries will relax current interventions by 50%

N.B. These scenarios currently assume that the impact of mobility on transmission will remain the same in the future as it has in the past. We are working to extend methods to estimate the impact of increases in mobility on transmission as lockdown and interventions are reversed. Consequently, projection are likely to represent an upper estimate of the healthcare demand and case load for each scenario

We estimate that over the next 4 weeks demand for hospital beds will change from 54,621 (95% CI: 48,323-60,920) patients requiring treatment with high-pressure oxygen at the current date to 138,544 (95% CI: 122,286-154,802) hospital beds being required on 2020-08-04 if no further interventions are introduced (Scenario 1). Similarly, we estimate that over the next 4 weeks demand for critical care (ICU) beds will change from 16,798 (95% CI: 14,862-18,735) patients requiring treatment with mechanical ventilation at the current date to 40,271 (95% CI: 36,313-44,229) by 2020-08-04. These projections assume that approximately 5% of all infections will require treatment with high-pressure oxygen and that approximately 30% of hospitalised cases will require treatment with mechanical ventilation (based on analysis of ongoing epidemics in Europe). **N.B. These scenarios are unlikely to show significant differences for the first week since there is a delay of approximately 10 days between infection and hospital admission. Consequently, the effectiveness of a change in policy is likely to be better captured by hospital admission data approximately 2 weeks after the policy change is implemented.**

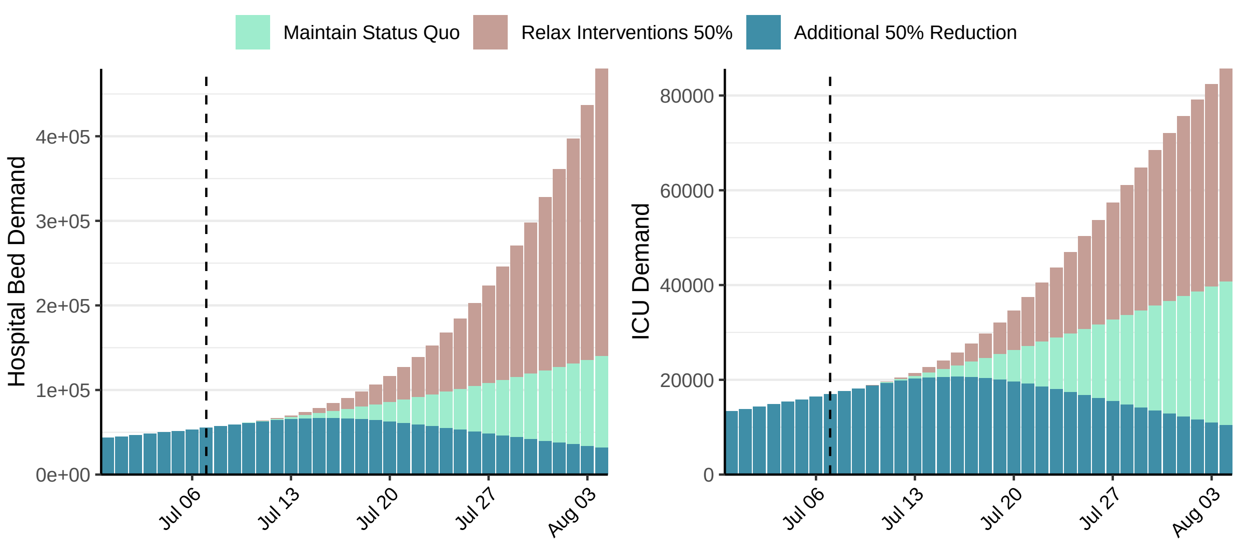

Figure 5: **Healthcare demands in the next 28 days.** Individuals needing an ICU bed are assumed to need mechanical ventilation. Projected demand for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

The impact of each scenario has a more immediate effect on the daily number of infections. The figure below shows the impact of each scenario on the estimated daily incidence of new infections. If interventions are scaled up (Scenario 2), the daily number of infections will change from 391,822 (95% CI: 346,725-436,918) at the current date to 70,684 (95% CI: 62,123-79,245) by 2020-08-04. If current interventions were relaxed by 50%, we estimate the daily number of infections will change from 391,822 (95% CI: 346,725-436,918) at the current date to 5,803,001 (95% CI: 5,155,989-6,450,013) by 2020-08-04.

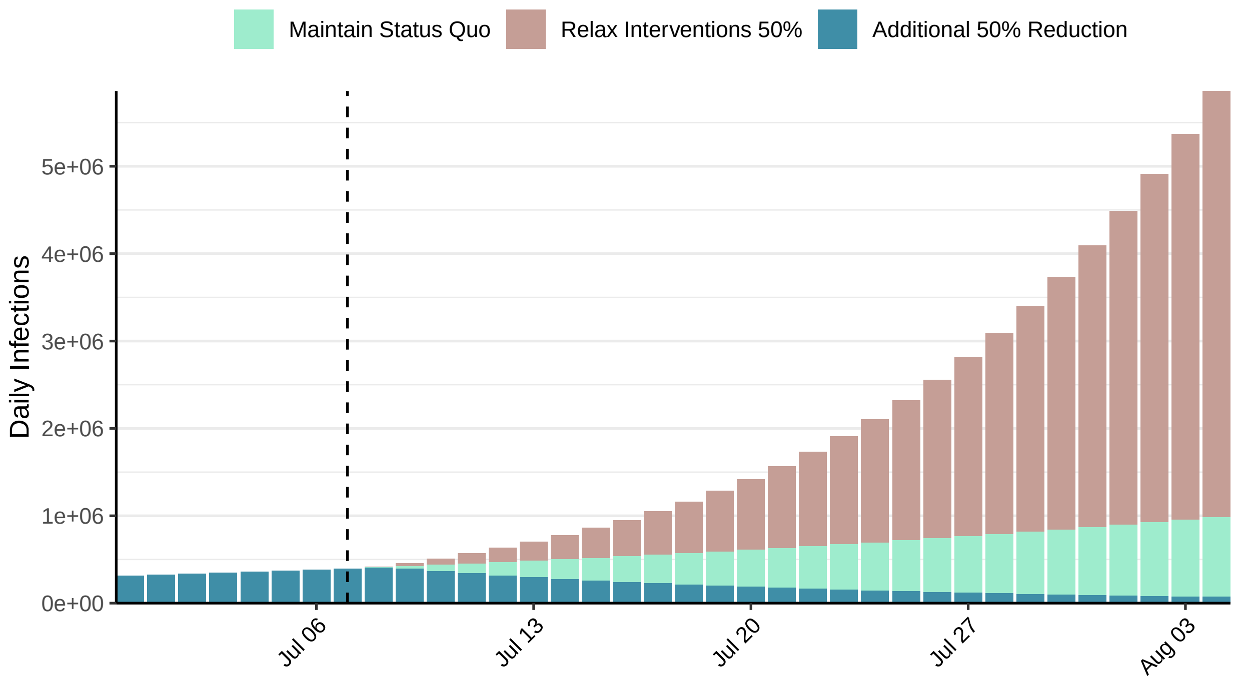

Figure 6: **Daily number of infections estimated by fitting to deaths.** Projected infections for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

To explore different scenarios, we recommend using our COVID-19 Scenario Analysis Tool - https://covidsim.org/, which can be used to simulate different intervention scenarios and explore the long term impact on healthcare demand.

Situation Report for COVID-19: Iraq, 2020-07-07

Download the report for Iraq, 2020-07-07 here. This report uses data from the European Centre for Disease Control. These data are updated daily and whilst there may be a short delay, they are generally consistent with Ministry reports. These data are then used to back-calculate an 'inferred number of COVID-19 infections' using mathematical modelling techniques (see Report 12 for further details) to estimate the number of people that have been infected and to make short-term projections for future healthcare needs.

Epidemiological Situation

Total Reported Cases	New Reported Cases	Total Reported Deaths	New Reported Deaths	Estimated R_t
62,275	1,796	2,567	94	1.3 (95% CI: 1.28-1.33)

The figure below shows the cumulative reported deaths as a function of the time since the 10th death was reported. Dashed lines show the expected trajectory for different doubling times of the epidemic. For example, with a doubling time of 3 days, if there are currently a total of 20 deaths reported, we would expect there to be 40 deaths in total reported in 3 days-time, 80 deaths in 6 days-time, 160 deaths in 9 days-time etc. For most epidemics, in the absence of interventions, we expect a doubling time of 3-4 days for this disease.

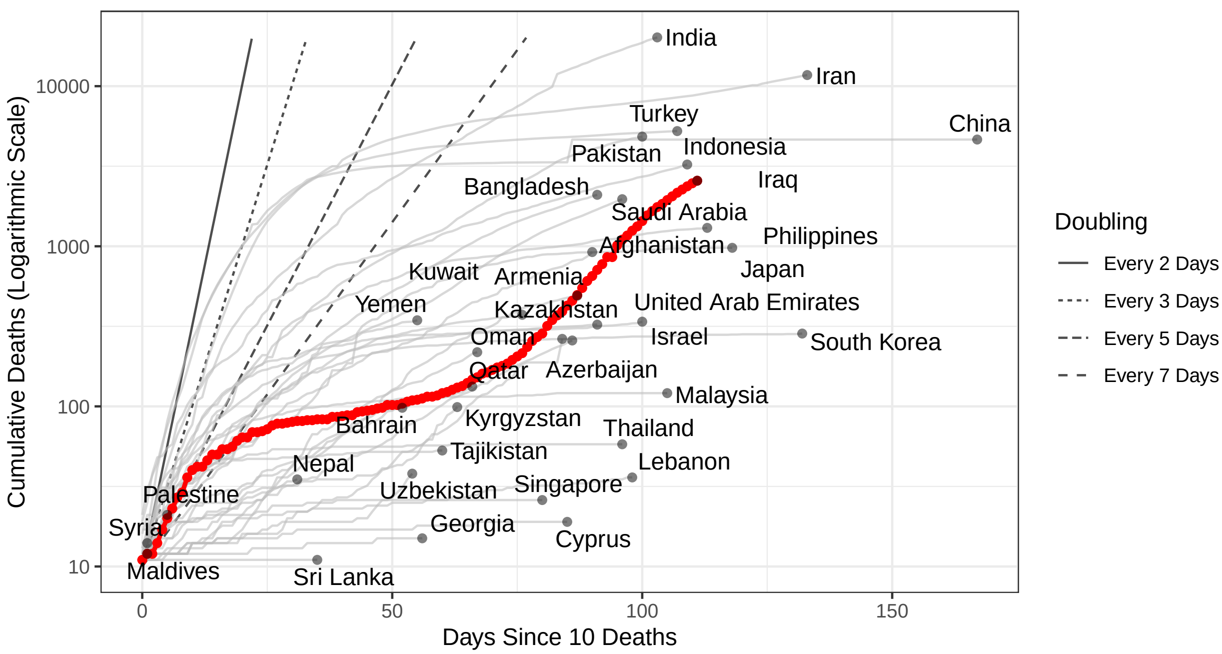

Figure 1: **Cumulative Deaths since 10 deaths.** Country not shown if fewer than 10 deaths.

COVID-19 Transmission Modelling

We assume that the deaths reported to date provide the best indication of the stage of the epidemic, as deaths are more consistently and accurately reported. Our current working estimate is that 1 death indicates that approximately 100 people will have been infected with the other 99 recovering (based on an infection fatality ratio of ~1%). These infections will have happened approximately 21 days previously – capturing a 5-day period from infection to onset of symptoms (the incubation period), 4 days from onset of symptoms to hospitalisation, and 12 days in hospital before death. With a 3-day doubling time, 100 infections that occurred 15 days ago will have generated 200 infections 12 days ago, 400 infections 9 days ago, 800 infections 6 days ago and 1,600 infections 3 days ago resulting in approximately 3,200 infections at the time the first death is observed.

To explore this, we fit our age-structured SEIR model (see Methods) to the time series of deaths in a country, in order to estimate the start date of the epidemic and the baseline R0. We assume that 100% of COVID-19 related deaths have been reported. We have also included the impact of interventions that have been put in place and their effect on human mobility and transmission based on the Google COVID-19 Community Mobility Reports. Using our mathematical model that formalises this approach, we estimate that there has been a total of 1,588,377 (95% CI: 1,460,701-1,716,054) infections over the past 4 weeks.

The figure below shows the estimated number of people infected over the past 4 weeks. The bar charts show, for comparison, the number of reported cases. The right-hand plot shows these data on a different scale as the estimated infections are likely to be much larger than the reported cases. **Importantly**, the estimated infections includes both asymptomatic and mild cases that would not necessarily be identified through surveillance. Consequently, the estimated infections are likely to be significantly higher than the reported cases (see our FAQ for further explanation of these differences and why the reported cases and estimated infections are unlikely to match).

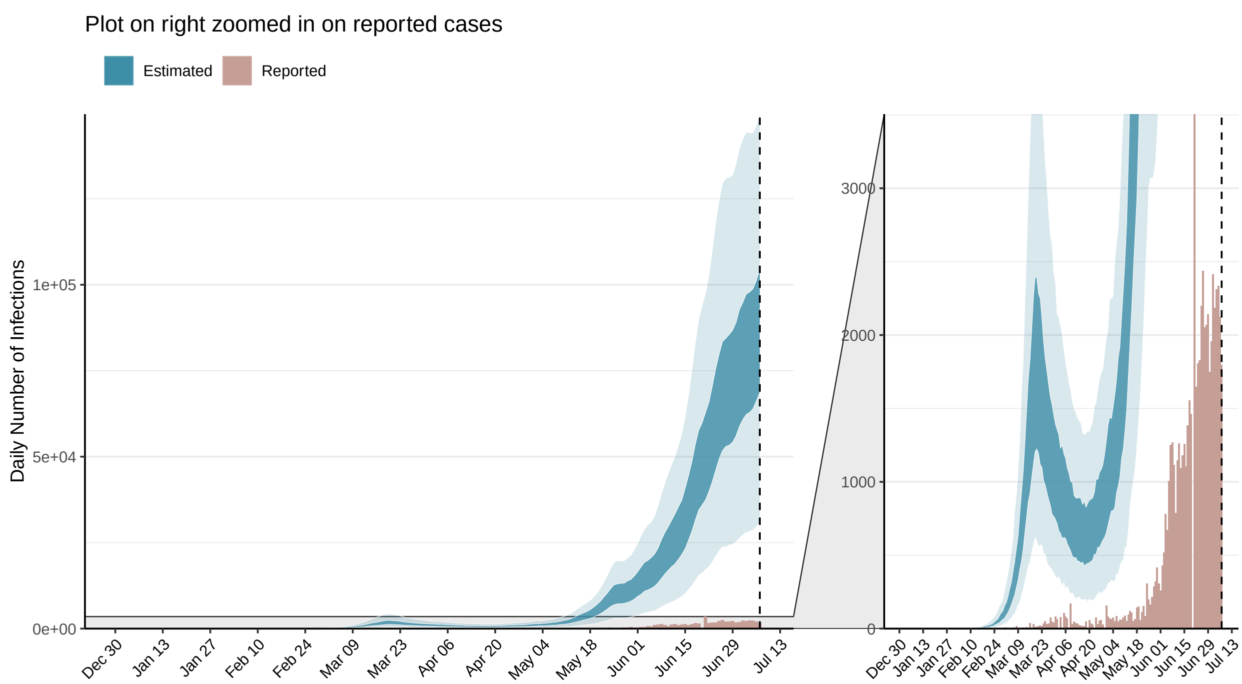

Figure 2: **Daily number of infections estimated by fitting to the current total of deaths.** Reported cases are shown in red. Model estimated infections are shown in blue (dark blue 50% interquartile range, light blue 95% quantile). The dashed line shows the current day.

By fitting to the time series of deaths, we are able to estimate a time-varying reproduction number, R_t. R_t is the the average number of secondary infections caused by a single infected person at a given time. If R_t is above 1, the rate of transmission is increasing and the number of new infections is increasing. R_t is assumed to change in relation to mobility fall in proportion. When fitting our model we assume that 100% of COVID-19 related deaths have been reported (please see our FAQ section for more information about this assumption). We also assume a fixed date at which the impact of mobility on transmission changes from pre-lockdown levels to post-lockdown levels, which may cause large changes in Rt. We are working to refine how this switch occurs and to formally calculate its shape.

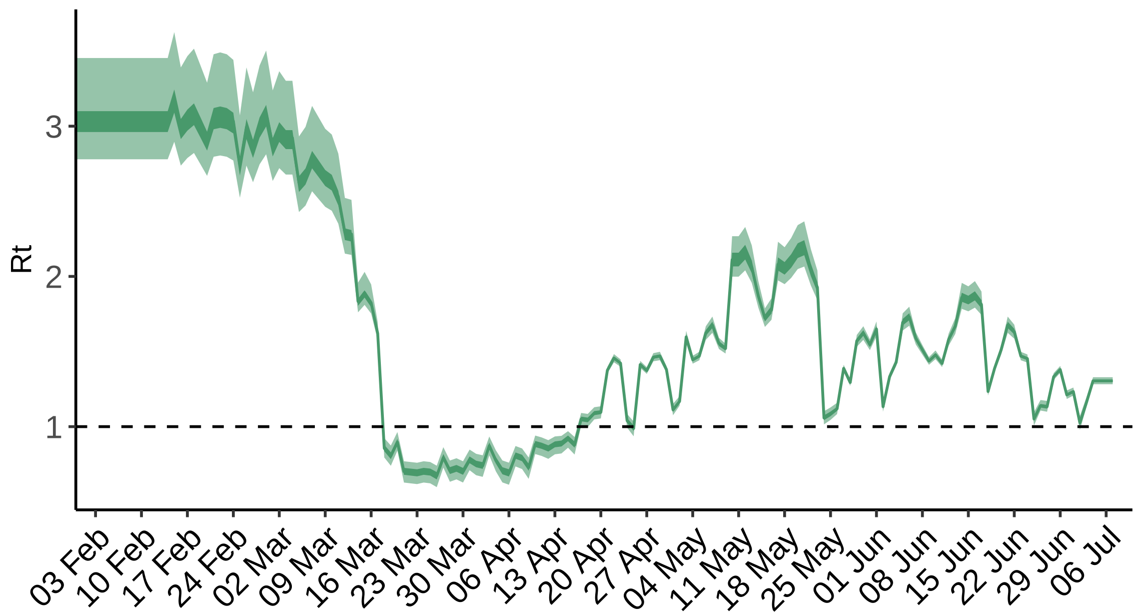

Figure 3: **Time-varying reproduction number, R_t.** R_t is the average number of secondary infections caused by a single infected person at time equal to t. $R_t < 1$ indicates a slowing epidemic in which new infections are not increasing. $R_t > 1$ indicates a growing epidemic in which new infections are increasing over time. Dark green shows the 50% CI and light green shows the 95% CI.

Using the model fit, we can forecast the expected trajectory for cumulative deaths, which is shown in the figure below. This assumes a severity pattern by age that is consistent with that observed in China, Europe and the U.S to date. This projection assumes that transmission is maintained at the current level of transmission as estimated by the final R_t value. **N.B. Iraq is forecast to be close to or surpassing our best estimates for healthcare capacity in the next 28 days.** Estimates of deaths in the next 28 days may be inaccurate due to our working assumptions for mortality in individuals who do not receive appropriate treatment. See our methods for more information.

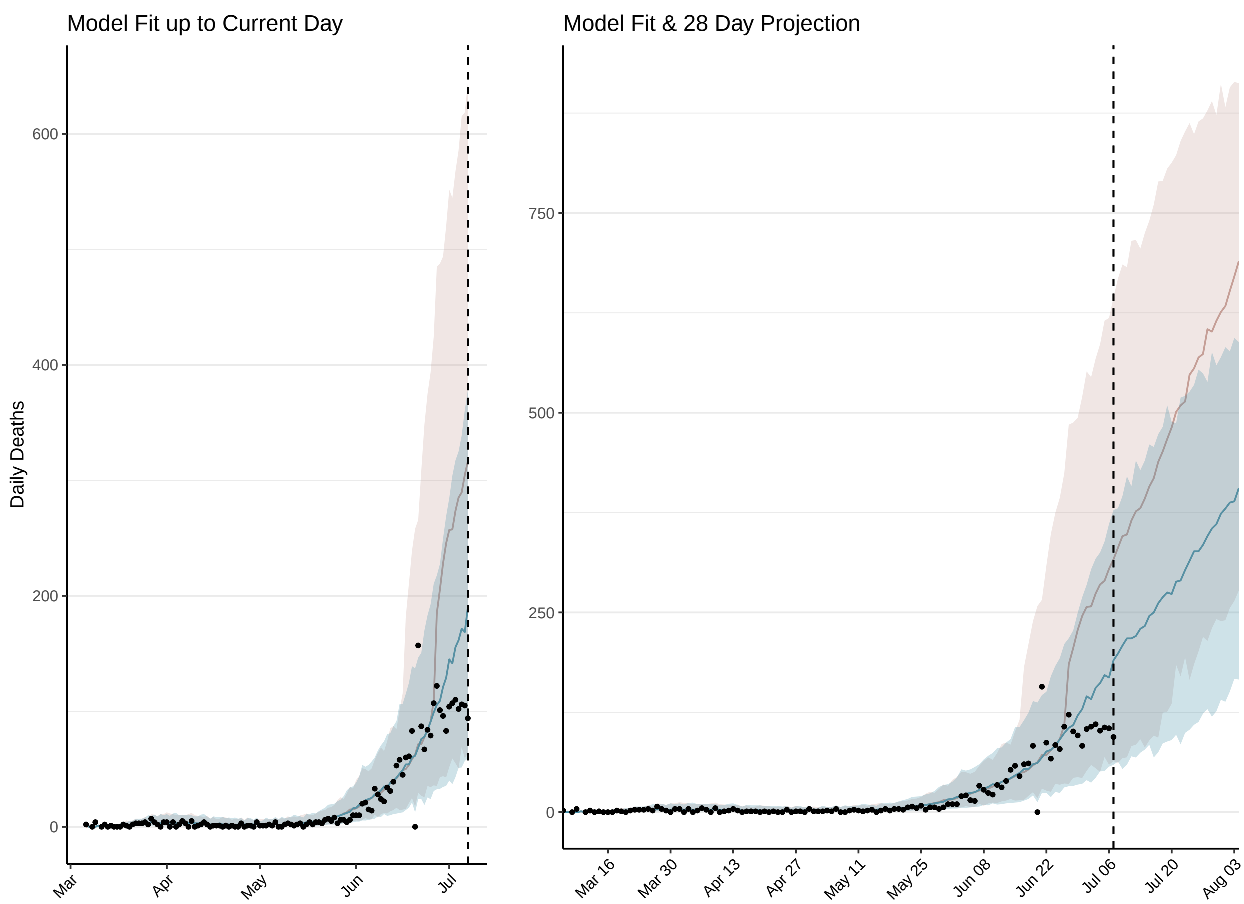

Figure 4: **Estimated daily deaths.** Projected deaths assuming the current level of interventions are maintained are shown in red (median and 95% quantile). Reported deaths are plotted in black. The plot on the left is focussed on the model fit prior to today, while the plot on the right forecasts the next 28 days. The forecasted deaths in blue assumes healthcare capacity has been surged to ensure sufficient supply of ICU and hospital beds. The red curve assumes no surging in healthcare capacity and subsequently projects increased deaths.

Short-term Epidemic Scenarios

We make the following short-term projections of healthcare demand and new infections under the following three scenarios:

- **Scenario 1.** The epidemic continues to grow at the current rate.
- **Scenario 2.** Countries will further scale up interventions (either increasing current strategies or implementing new interventions) leading to a further 50% reduction in transmission.
- **Scenario 3.** Countries will relax current interventions by 50%

N.B. These scenarios currently assume that the impact of mobility on transmission will remain the same in the future as it has in the past. We are working to extend methods to estimate the impact of increases in mobility on transmission as lockdown and interventions are reversed. Consequently, projection are likely to represent an upper estimate of the healthcare demand and case load for each scenario

We estimate that over the next 4 weeks demand for hospital beds will change from 12,143 (95% CI: 11,189-13,096) patients requiring treatment with high-pressure oxygen at the current date to 23,470 (95% CI: 22,262-24,679) hospital beds being required on 2020-08-04 if no further interventions are introduced (Scenario 1). Similarly, we estimate that over the next 4 weeks demand for critical care (ICU) beds will change from 1,724 (95% CI: 1,664-1,784) patients requiring treatment with mechanical ventilation at the current date to 2,110 (95% CI: 2,056-2,164) by 2020-08-04. These projections assume that approximately 5% of all infections will require treatment with high-pressure oxygen and that approximately 30% of hospitalised cases will require treatment with mechanical ventilation (based on analysis of ongoing epidemics in Europe). **N.B. These scenarios are unlikely to show significant differences for the first week since there is a delay of approximately 10 days between infection and hospital admission. Consequently, the effectiveness of a change in policy is likely to be better captured by hospital admission data approximately 2 weeks after the policy change is implemented.**

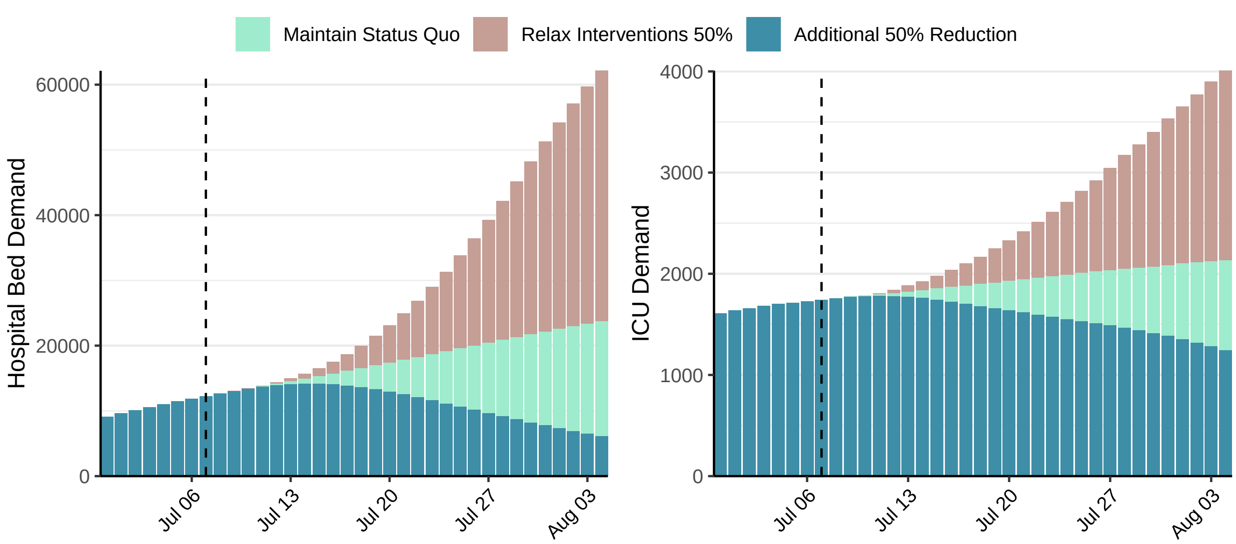

Figure 5: **Healthcare demands in the next 28 days.** Individuals needing an ICU bed are assumed to need mechanical ventilation. Projected demand for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

The impact of each scenario has a more immediate effect on the daily number of infections. The figure below shows the impact of each scenario on the estimated daily incidence of new infections. If interventions are scaled up (Scenario 2), the daily number of infections will change from 85,326 (95% CI: 79,078-91,575) at the current date to 13,214 (95% CI: 12,526-13,902) by 2020-08-04. If current interventions were relaxed by 50%, we estimate the daily number of infections will change from 85,326 (95% CI: 79,078-91,575) at the current date to 597,445 (95% CI: 580,222-614,668) by 2020-08-04.

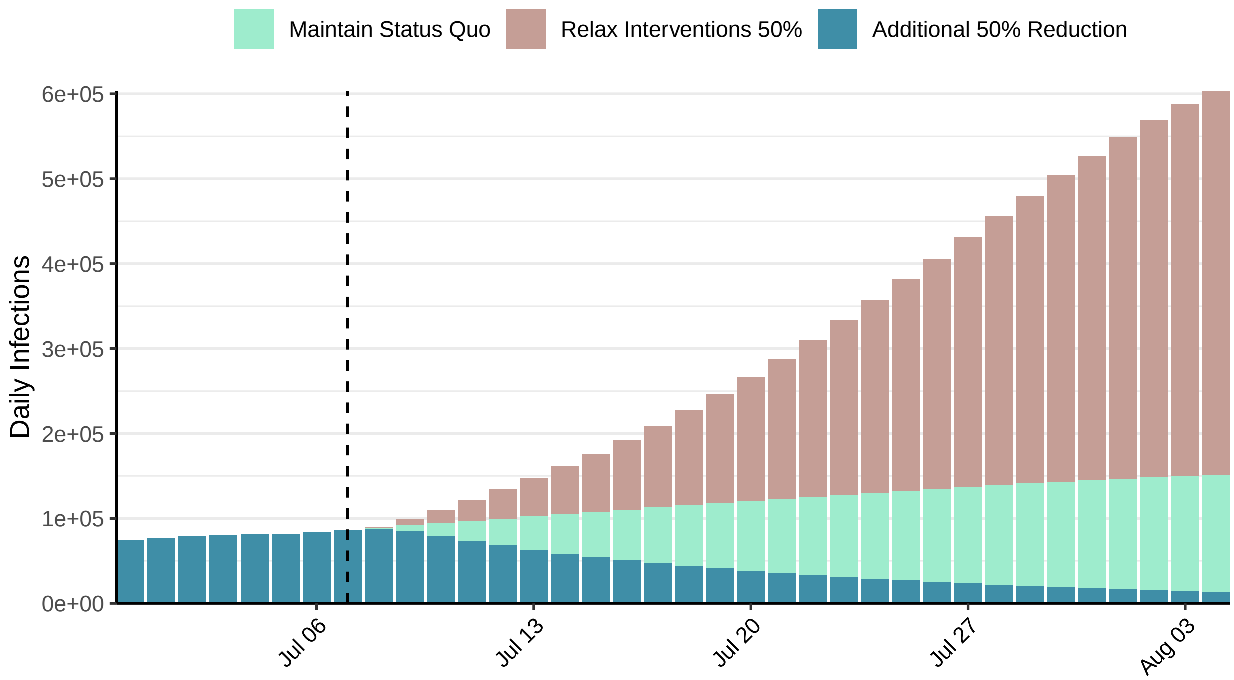

Figure 6: **Daily number of infections estimated by fitting to deaths.** Projected infections for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

To explore different scenarios, we recommend using our COVID-19 Scenario Analysis Tool - https://covidsim.org/, which can be used to simulate different intervention scenarios and explore the long term impact on healthcare demand.

Situation Report for COVID-19: Jamaica, 2020-07-07

Download the report for Jamaica, 2020-07-07 here. This report uses data from the European Centre for Disease Control. These data are updated daily and whilst there may be a short delay, they are generally consistent with Ministry reports. These data are then used to back-calculate an 'inferred number of COVID-19 infections' using mathematical modelling techniques (see Report 12 for further details) to estimate the number of people that have been infected and to make short-term projections for future healthcare needs.

Epidemiological Situation

Total Reported Cases	New Reported Cases	Total Reported Deaths	New Reported Deaths	Estimated R_t
737	5	10	0	0.73 (95% CI: 0.29-1.26)

The figure below shows the cumulative reported deaths as a function of the time since the 10th death was reported. Dashed lines show the expected trajectory for different doubling times of the epidemic. For example, with a doubling time of 3 days, if there are currently a total of 20 deaths reported, we would expect there to be 40 deaths in total reported in 3 days-time, 80 deaths in 6 days-time, 160 deaths in 9 days-time etc. For most epidemics, in the absence of interventions, we expect a doubling time of 3-4 days for this disease.

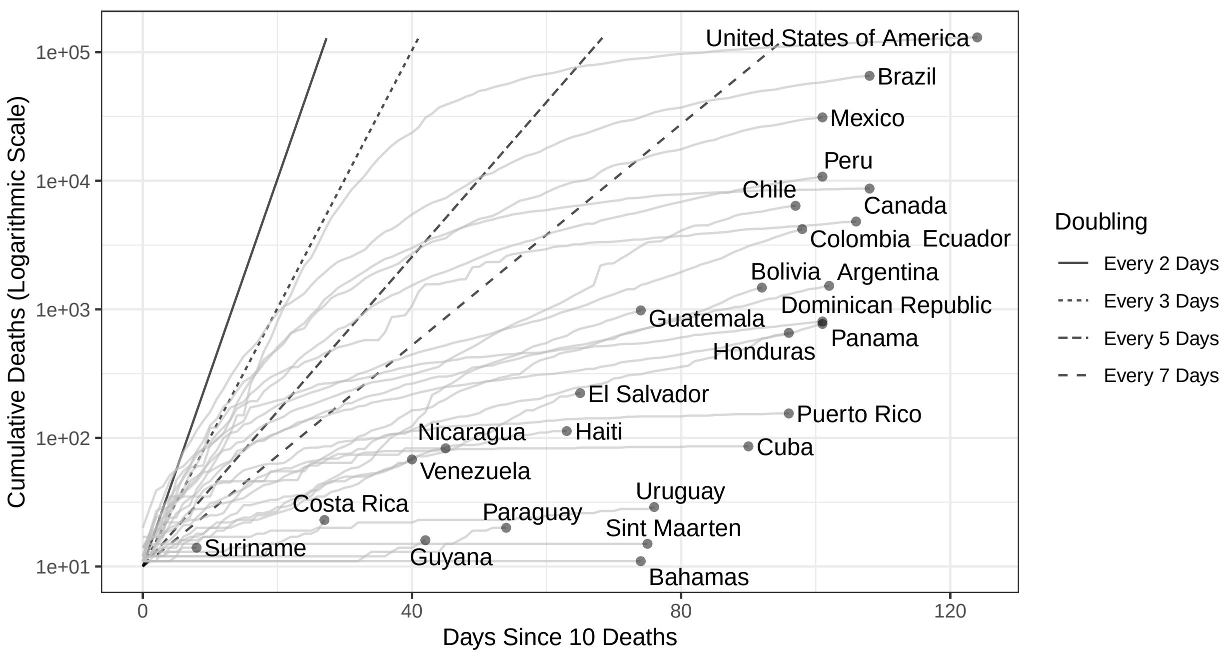

Figure 1: **Cumulative Deaths since 10 deaths.** Country not shown if fewer than 10 deaths.

COVID-19 Transmission Modelling

We assume that the deaths reported to date provide the best indication of the stage of the epidemic, as deaths are more consistently and accurately reported. Our current working estimate is that 1 death indicates that approximately 100 people will have been infected with the other 99 recovering (based on an infection fatality ratio of ~1%). These infections will have happened approximately 21 days previously – capturing a 5-day period from infection to onset of symptoms (the incubation period), 4 days from onset of symptoms to hospitalisation, and 12 days in hospital before death. With a 3-day doubling time, 100 infections that occurred 15 days ago will have generated 200 infections 12 days ago, 400 infections 9 days ago, 800 infections 6 days ago and 1,600 infections 3 days ago resulting in approximately 3,200 infections at the time the first death is observed.

To explore this, we fit our age-structured SEIR model (see Methods) to the time series of deaths in a country, in order to estimate the start date of the epidemic and the baseline R0. We assume that 100% of COVID-19 related deaths have been reported. We have also included the impact of interventions that have been put in place and their effect on human mobility and transmission based on the Google COVID-19 Community Mobility Reports. Using our mathematical model that formalises this approach, we estimate that there has been a total of 40 (95% CI: 22-57) infections over the past 4 weeks.

The figure below shows the estimated number of people infected over the past 4 weeks. The bar charts show, for comparison, the number of reported cases. The right-hand plot shows these data on a different scale as the estimated infections are likely to be much larger than the reported cases. **Importantly**, the estimated infections includes both asymptomatic and mild cases that would not necessarily be identified through surveillance. Consequently, the estimated infections are likely to be significantly higher than the reported cases (see our FAQ for further explanation of these differences and why the reported cases and estimated infections are unlikely to match).

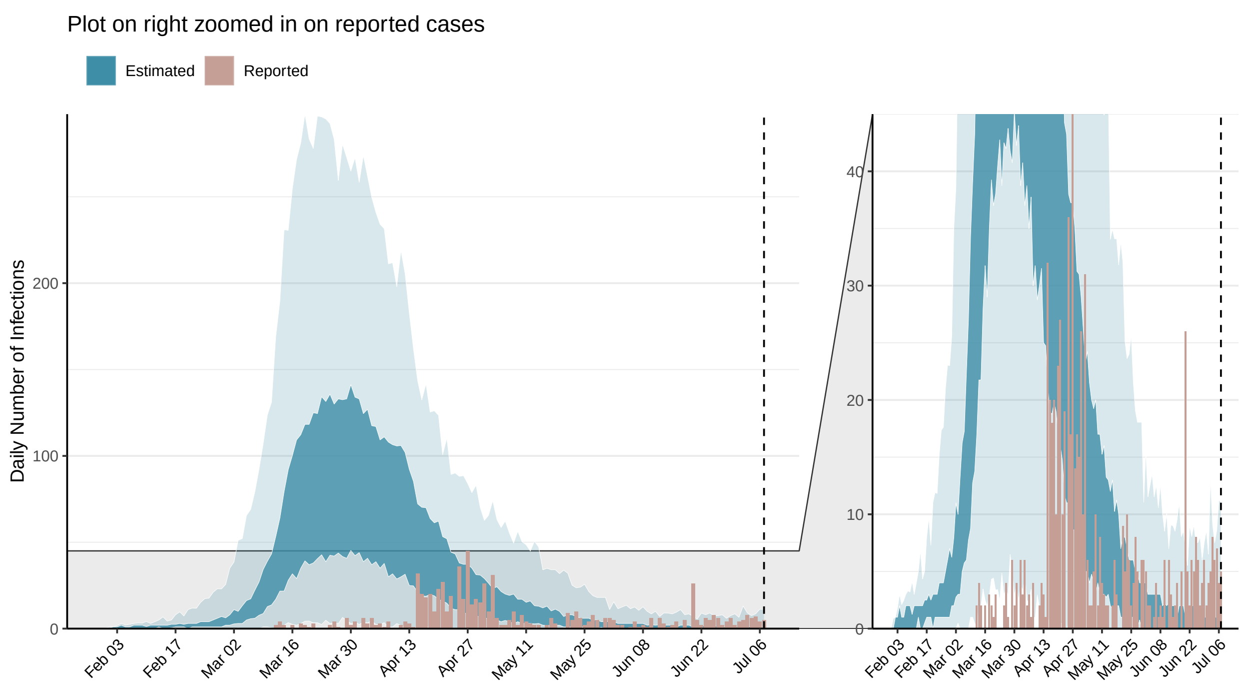

Figure 2: **Daily number of infections estimated by fitting to the current total of deaths.** Reported cases are shown in red. Model estimated infections are shown in blue (dark blue 50% interquartile range, light blue 95% quantile). The dashed line shows the current day.

By fitting to the time series of deaths, we are able to estimate a time-varying reproduction number, R_t. R_t is the the average number of secondary infections caused by a single infected person at a given time. If R_t is above 1, the rate of transmission is increasing and the number of new infections is increasing. R_t is assumed to change in relation to mobility fall in proportion. When fitting our model we assume that 100% of COVID-19 related deaths have been reported (please see our FAQ section for more information about this assumption). We also assume a fixed date at which the impact of mobility on transmission changes from pre-lockdown levels to post-lockdown levels, which may cause large changes in Rt. We are working to refine how this switch occurs and to formally calculate its shape.

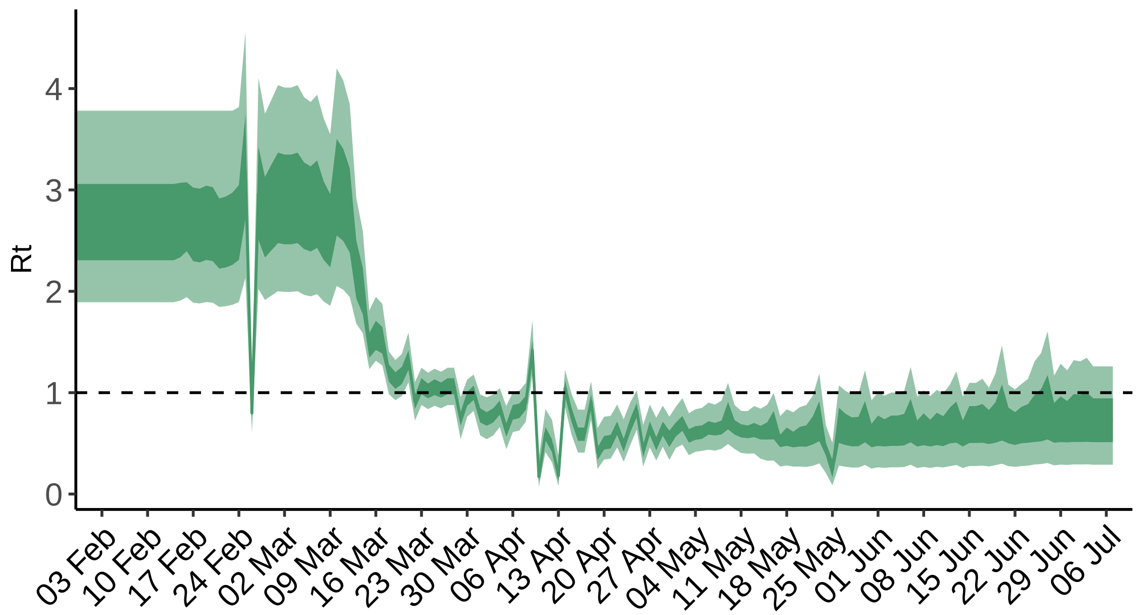

Figure 3: **Time-varying reproduction number, R_t.** R_t is the average number of secondary infections caused by a single infected person at time equal to t. $R_t < 1$ indicates a slowing epidemic in which new infections are not increasing. $R_t > 1$ indicates a growing epidemic in which new infections are increasing over time. Dark green shows the 50% CI and light green shows the 95% CI.

Using the model fit, we can forecast the expected trajectory for cumulative deaths, which is shown in the figure below. This assumes a severity pattern by age that is consistent with that observed in China, Europe and the U.S to date. This projection assumes that transmission is maintained at the current level of transmission as estimated by the final R_t value.

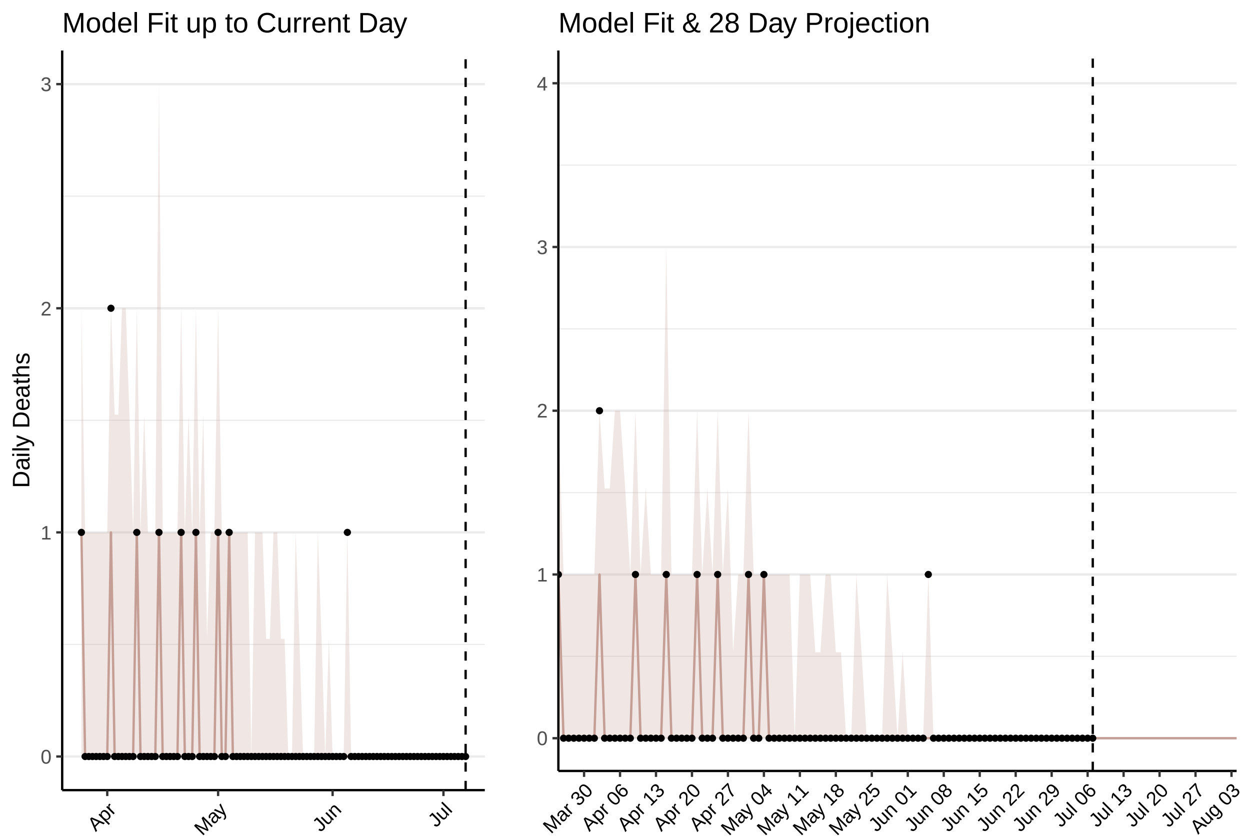

Figure 4: **Estimated daily deaths.** Projected deaths assuming the current level of interventions are maintained are shown in red (median and 95% quantile). Reported deaths are plotted in black. The plot on the left is focussed on the model fit prior to today, while the plot on the right forecasts the next 28 days.

Short-term Epidemic Scenarios

We make the following short-term projections of healthcare demand and new infections under the following three scenarios:

- **Scenario 1.** The epidemic continues to grow at the current rate.
- **Scenario 2.** Countries will further scale up interventions (either increasing current strategies or implementing new interventions) leading to a further 50% reduction in transmission.
- **Scenario 3.** Countries will relax current interventions by 50%

N.B. These scenarios currently assume that the impact of mobility on transmission will remain the same in the future as it has in the past. We are working to extend methods to estimate the impact of increases in mobility on transmission as lockdown and interventions are reversed. Consequently, projection are likely to represent an upper estimate of the healthcare demand and case load for each scenario

We estimate that over the next 4 weeks demand for hospital beds will change from 0 (95% CI: 0-0) patients requiring treatment with high-pressure oxygen at the current date to 0 (95% CI: 0-0) hospital beds being required on 2020-08-04 if no further interventions are introduced (Scenario 1). Similarly, we estimate that over the next 4 weeks demand for critical care (ICU) beds will change from 0 (95% CI: 0-0) patients requiring treatment with mechanical ventilation at the current date to 0 (95% CI: 0-0) by 2020-08-04. These projections assume that approximately 5% of all infections will require treatment with high-pressure oxygen and that approximately 30% of hospitalised cases will require treatment with mechanical ventilation (based on analysis of ongoing epidemics in Europe). **N.B. These scenarios are unlikely to show significant differences for the first week since there is a delay of approximately 10 days between infection and hospital admission. Consequently, the effectiveness of a change in policy is likely to be better captured by hospital admission data approximately 2 weeks after the policy change is implemented.**

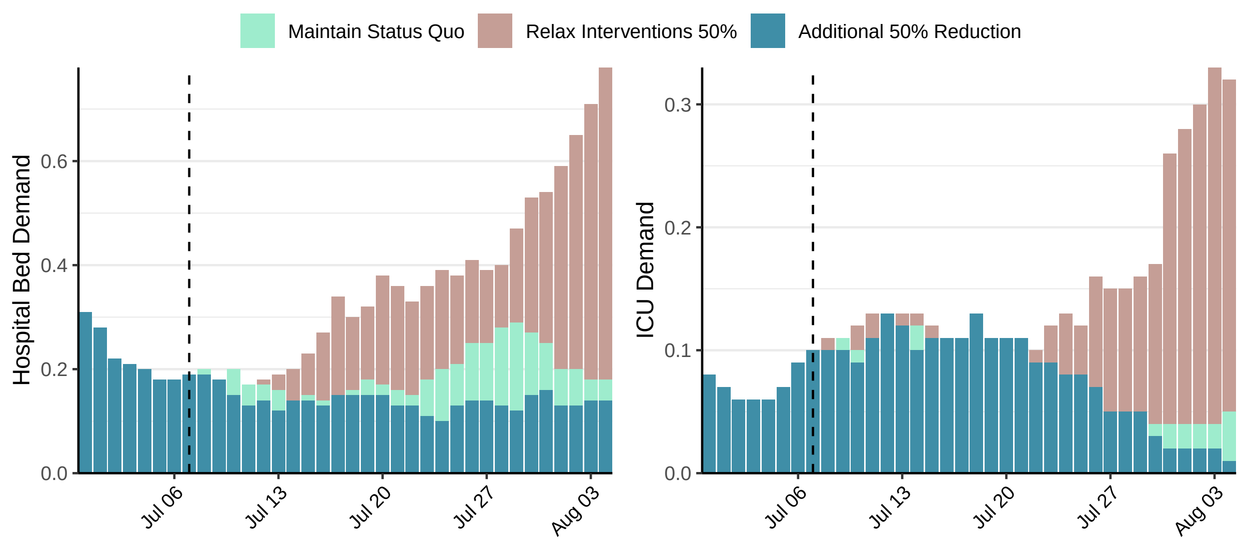

Figure 5: **Healthcare demands in the next 28 days.** Individuals needing an ICU bed are assumed to need mechanical ventilation. Projected demand for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

The impact of each scenario has a more immediate effect on the daily number of infections. The figure below shows the impact of each scenario on the estimated daily incidence of new infections. If interventions are scaled up (Scenario 2), the daily number of infections will change from 1 (95% CI: 1-2) at the current date to 0 (95% CI: 0-0) by 2020-08-04. If current interventions were relaxed by 50%, we estimate the daily number of infections will change from 1 (95% CI: 1-2) at the current date to 12 (95% CI: 3-22) by 2020-08-04.

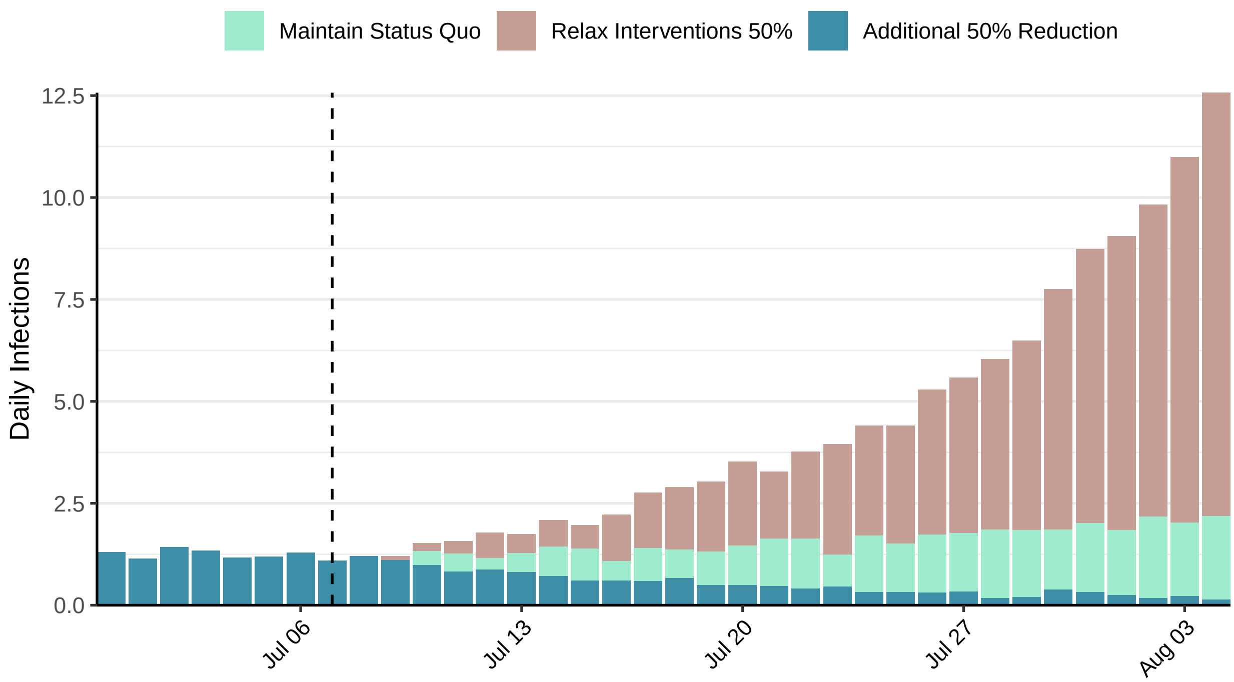

Figure 6: **Daily number of infections estimated by fitting to deaths.** Projected infections for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

To explore different scenarios, we recommend using our COVID-19 Scenario Analysis Tool - https://covidsim.org/, which can be used to simulate different intervention scenarios and explore the long term impact on healthcare demand.

Situation Report for COVID-19: Jordan, 2020-07-07

Download the report for Jordan, 2020-07-07 here. This report uses data from the European Centre for Disease Control. These data are updated daily and whilst there may be a short delay, they are generally consistent with Ministry reports. These data are then used to back-calculate an 'inferred number of COVID-19 infections' using mathematical modelling techniques (see Report 12 for further details) to estimate the number of people that have been infected and to make short-term projections for future healthcare needs.

Epidemiological Situation

Total Reported Cases	New Reported Cases	Total Reported Deaths	New Reported Deaths	Estimated R_t
1,167	3	10	0	1.57 (95% CI: 0.98-2.1)

The figure below shows the cumulative reported deaths as a function of the time since the 10th death was reported. Dashed lines show the expected trajectory for different doubling times of the epidemic. For example, with a doubling time of 3 days, if there are currently a total of 20 deaths reported, we would expect there to be 40 deaths in total reported in 3 days-time, 80 deaths in 6 days-time, 160 deaths in 9 days-time etc. For most epidemics, in the absence of interventions, we expect a doubling time of 3-4 days for this disease.

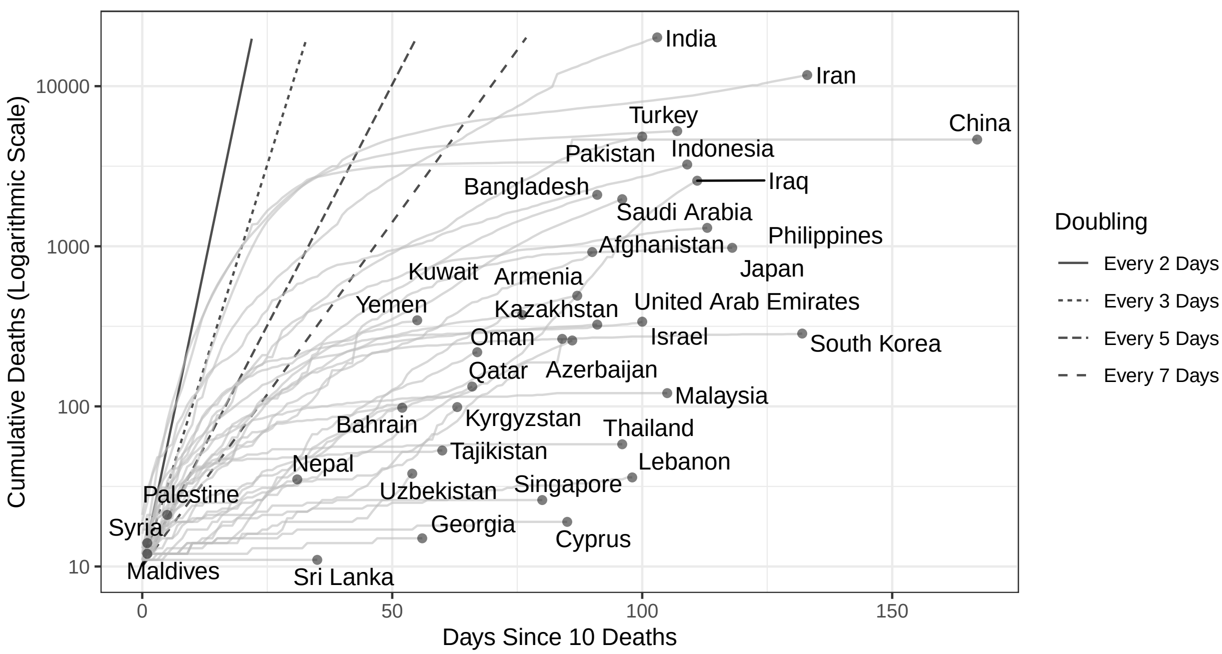

Figure 1: **Cumulative Deaths since 10 deaths.** Country not shown if fewer than 10 deaths.

COVID-19 Transmission Modelling

We assume that the deaths reported to date provide the best indication of the stage of the epidemic, as deaths are more consistently and accurately reported. Our current working estimate is that 1 death indicates that approximately 100 people will have been infected with the other 99 recovering (based on an infection fatality ratio of ~1%). These infections will have happened approximately 21 days previously – capturing a 5-day period from infection to onset of symptoms (the incubation period), 4 days from onset of symptoms to hospitalisation, and 12 days in hospital before death. With a 3-day doubling time, 100 infections that occurred 15 days ago will have generated 200 infections 12 days ago, 400 infections 9 days ago, 800 infections 6 days ago and 1,600 infections 3 days ago resulting in approximately 3,200 infections at the time the first death is observed.

To explore this, we fit our age-structured SEIR model (see Methods) to the time series of deaths in a country, in order to estimate the start date of the epidemic and the baseline R0. We assume that 100% of COVID-19 related deaths have been reported. We have also included the impact of interventions that have been put in place and their effect on human mobility and transmission based on the Google COVID-19 Community Mobility Reports. Using our mathematical model that formalises this approach, we estimate that there has been a total of 540 (95% CI: 414-667) infections over the past 4 weeks.

The figure below shows the estimated number of people infected over the past 4 weeks. The bar charts show, for comparison, the number of reported cases. The right-hand plot shows these data on a different scale as the estimated infections are likely to be much larger than the reported cases. **Importantly**, the estimated infections includes both asymptomatic and mild cases that would not necessarily be identified through surveillance. Consequently, the estimated infections are likely to be significantly higher than the reported cases (see our FAQ for further explanation of these differences and why the reported cases and estimated infections are unlikely to match).

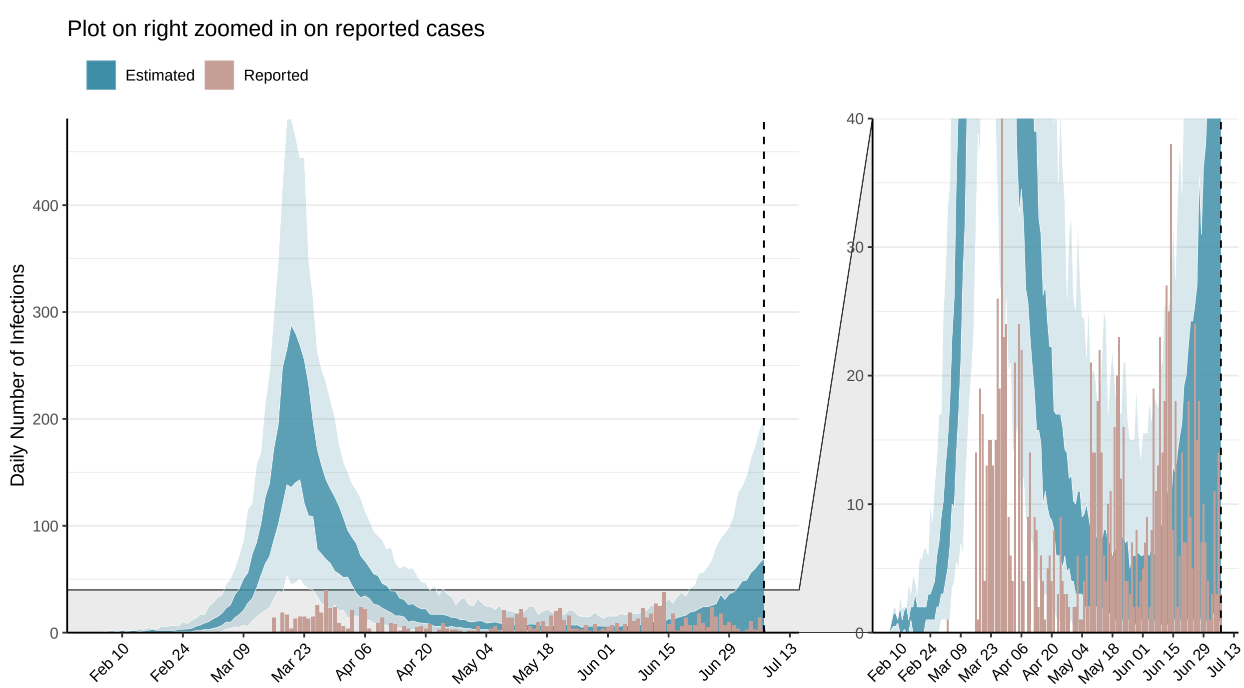

Figure 2: **Daily number of infections estimated by fitting to the current total of deaths.** Reported cases are shown in red. Model estimated infections are shown in blue (dark blue 50% interquartile range, light blue 95% quantile). The dashed line shows the current day.

By fitting to the time series of deaths, we are able to estimate a time-varying reproduction number, R_t. R_t is the the average number of secondary infections caused by a single infected person at a given time. If R_t is above 1, the rate of transmission is increasing and the number of new infections is increasing. R_t is assumed to change in relation to mobility fall in proportion. When fitting our model we assume that 100% of COVID-19 related deaths have been reported (please see our FAQ section for more information about this assumption). We also assume a fixed date at which the impact of mobility on transmission changes from pre-lockdown levels to post-lockdown levels, which may cause large changes in Rt. We are working to refine how this switch occurs and to formally calculate its shape.

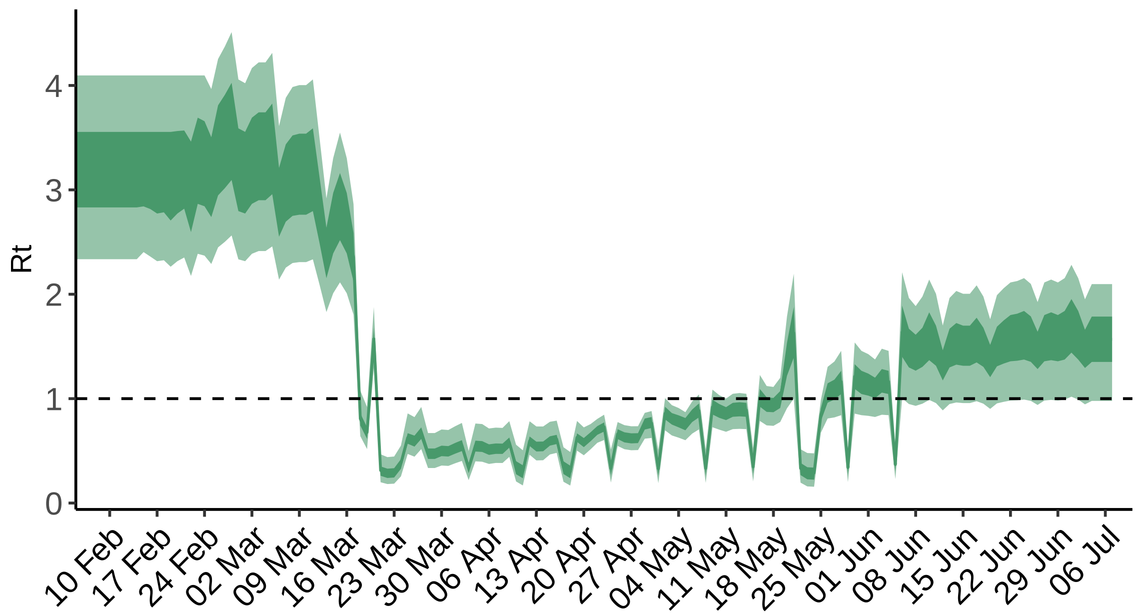

Figure 3: **Time-varying reproduction number, R_t.** R_t is the average number of secondary infections caused by a single infected person at time equal to t. $R_t < 1$ indicates a slowing epidemic in which new infections are not increasing. $R_t > 1$ indicates a growing epidemic in which new infections are increasing over time. Dark green shows the 50% CI and light green shows the 95% CI.

Using the model fit, we can forecast the expected trajectory for cumulative deaths, which is shown in the figure below. This assumes a severity pattern by age that is consistent with that observed in China, Europe and the U.S to date. This projection assumes that transmission is maintained at the current level of transmission as estimated by the final R_t value.

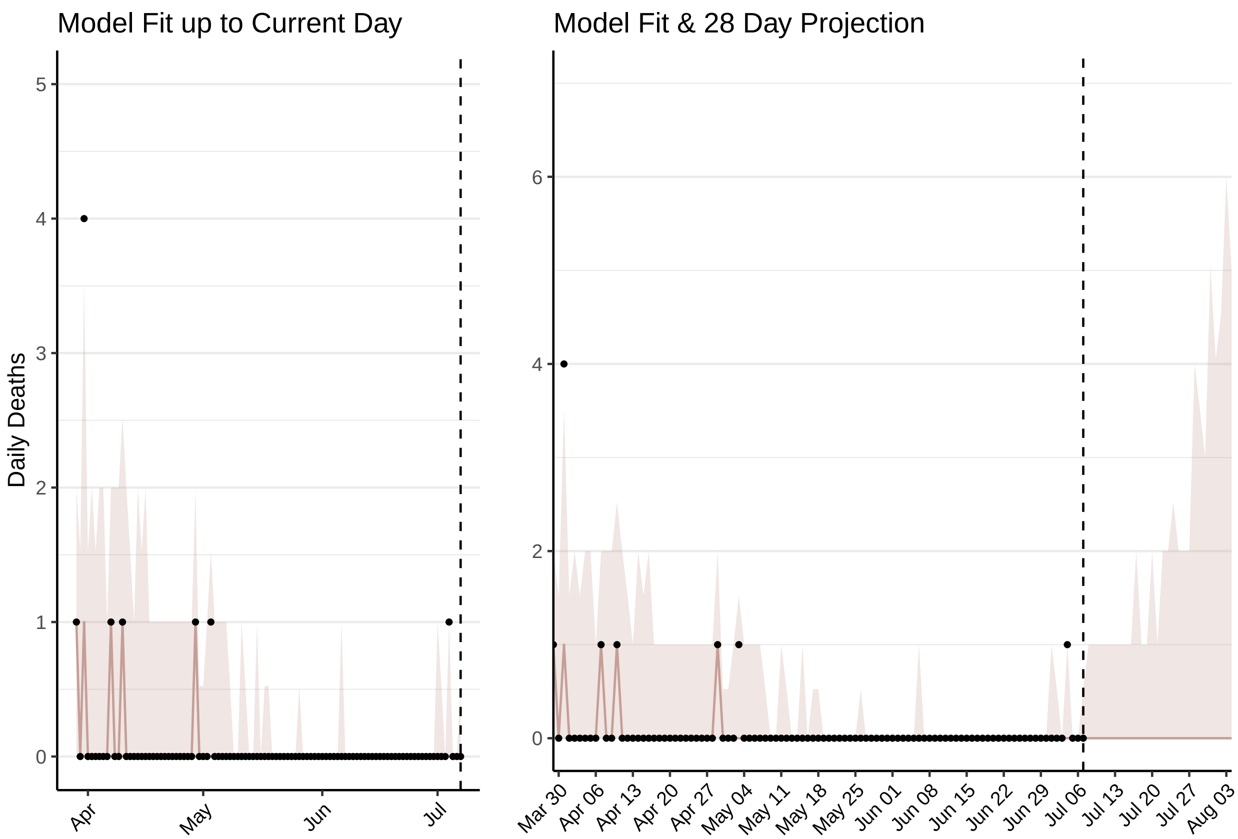

Figure 4: **Estimated daily deaths.** Projected deaths assuming the current level of interventions are maintained are shown in red (median and 95% quantile). Reported deaths are plotted in black. The plot on the left is focussed on the model fit prior to today, while the plot on the right forecasts the next 28 days.

Short-term Epidemic Scenarios

We make the following short-term projections of healthcare demand and new infections under the following three scenarios:

- **Scenario 1.** The epidemic continues to grow at the current rate.
- **Scenario 2.** Countries will further scale up interventions (either increasing current strategies or implementing new interventions) leading to a further 50% reduction in transmission.
- **Scenario 3.** Countries will relax current interventions by 50%

N.B. These scenarios currently assume that the impact of mobility on transmission will remain the same in the future as it has in the past. We are working to extend methods to estimate the impact of increases in mobility on transmission as lockdown and interventions are reversed. Consequently, projection are likely to represent an upper estimate of the healthcare demand and case load for each scenario

We estimate that over the next 4 weeks demand for hospital beds will change from 4 (95% CI: 3-5) patients requiring treatment with high-pressure oxygen at the current date to 62 (95% CI: 42-83) hospital beds being required on 2020-08-04 if no further interventions are introduced (Scenario 1). Similarly, we estimate that over the next 4 weeks demand for critical care (ICU) beds will change from 1 (95% CI: 1-2) patients requiring treatment with mechanical ventilation at the current date to 15 (95% CI: 10-20) by 2020-08-04. These projections assume that approximately 5% of all infections will require treatment with high-pressure oxygen and that approximately 30% of hospitalised cases will require treatment with mechanical ventilation (based on analysis of ongoing epidemics in Europe). **N.B. These scenarios are unlikely to show significant differences for the first week since there is a delay of approximately 10 days between infection and hospital admission. Consequently, the effectiveness of a change in policy is likely to be better captured by hospital admission data approximately 2 weeks after the policy change is implemented.**

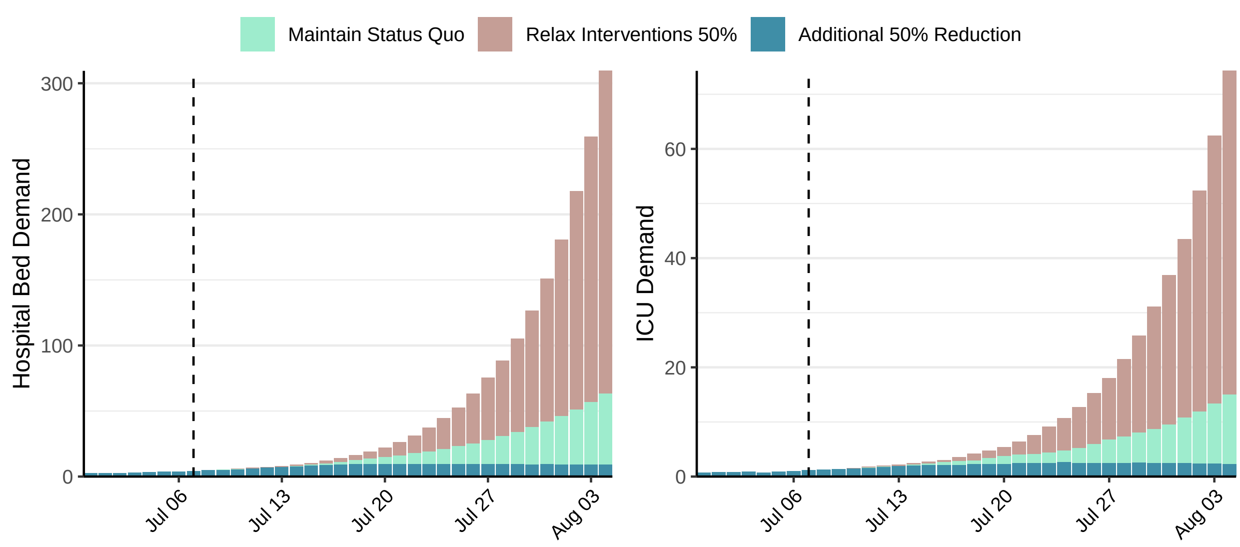

Figure 5: **Healthcare demands in the next 28 days.** Individuals needing an ICU bed are assumed to need mechanical ventilation. Projected demand for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

The impact of each scenario has a more immediate effect on the daily number of infections. The figure below shows the impact of each scenario on the estimated daily incidence of new infections. If interventions are scaled up (Scenario 2), the daily number of infections will change from 49 (95% CI: 36-62) at the current date to 37 (95% CI: 24-50) by 2020-08-04. If current interventions were relaxed by 50%, we estimate the daily number of infections will change from 49 (95% CI: 36-62) at the current date to 6,676 (95% CI: 4,158-9,195) by 2020-08-04.

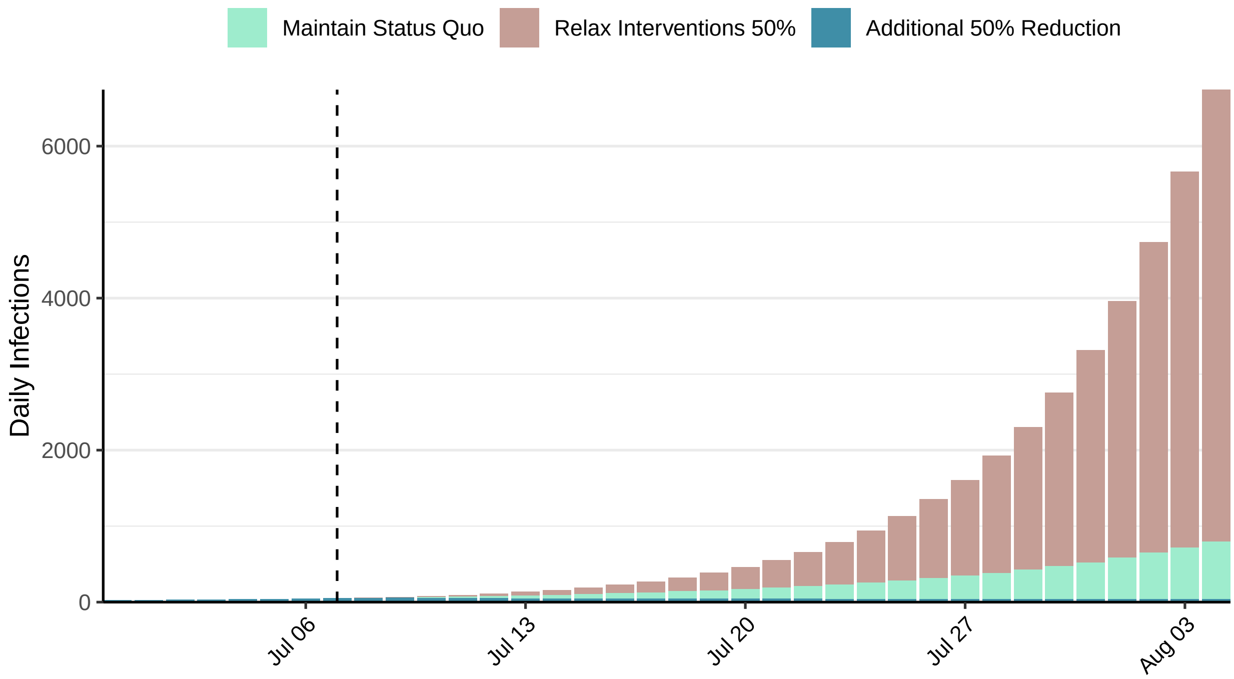

Figure 6: **Daily number of infections estimated by fitting to deaths.** Projected infections for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

To explore different scenarios, we recommend using our COVID-19 Scenario Analysis Tool - https://covidsim.org/, which can be used to simulate different intervention scenarios and explore the long term impact on healthcare demand.

Situation Report for COVID-19: Kazakhstan, 2020-07-07

Download the report for Kazakhstan, 2020-07-07 here. This report uses data from the European Centre for Disease Control. These data are updated daily and whilst there may be a short delay, they are generally consistent with Ministry reports. These data are then used to back-calculate an 'inferred number of COVID-19 infections' using mathematical modelling techniques (see Report 12 for further details) to estimate the number of people that have been infected and to make short-term projections for future healthcare needs.

Epidemiological Situation

Total Reported Cases	New Reported Cases	Total Reported Deaths	New Reported Deaths	Estimated R_t
49,683	1,109	264	76	1.5 (95% CI: 1.42-1.58)

The figure below shows the cumulative reported deaths as a function of the time since the 10th death was reported. Dashed lines show the expected trajectory for different doubling times of the epidemic. For example, with a doubling time of 3 days, if there are currently a total of 20 deaths reported, we would expect there to be 40 deaths in total reported in 3 days-time, 80 deaths in 6 days-time, 160 deaths in 9 days-time etc. For most epidemics, in the absence of interventions, we expect a doubling time of 3-4 days for this disease.

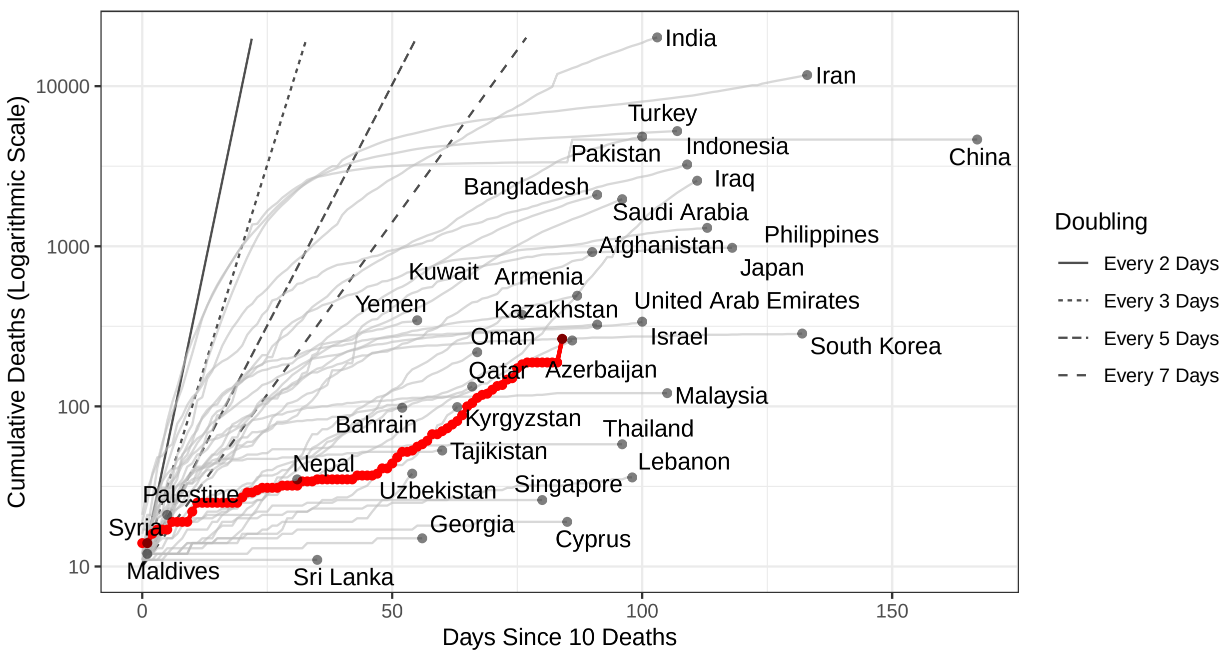

Figure 1: **Cumulative Deaths since 10 deaths.** Country not shown if fewer than 10 deaths.

COVID-19 Transmission Modelling

We assume that the deaths reported to date provide the best indication of the stage of the epidemic, as deaths are more consistently and accurately reported. Our current working estimate is that 1 death indicates that approximately 100 people will have been infected with the other 99 recovering (based on an infection fatality ratio of ~1%). These infections will have happened approximately 21 days previously – capturing a 5-day period from infection to onset of symptoms (the incubation period), 4 days from onset of symptoms to hospitalisation, and 12 days in hospital before death. With a 3-day doubling time, 100 infections that occurred 15 days ago will have generated 200 infections 12 days ago, 400 infections 9 days ago, 800 infections 6 days ago and 1,600 infections 3 days ago resulting in approximately 3,200 infections at the time the first death is observed.

To explore this, we fit our age-structured SEIR model (see Methods) to the time series of deaths in a country, in order to estimate the start date of the epidemic and the baseline R0. We assume that 100% of COVID-19 related deaths have been reported. We have also included the impact of interventions that have been put in place and their effect on human mobility and transmission based on the Google COVID-19 Community Mobility Reports. Using our mathematical model that formalises this approach, we estimate that there has been a total of 285,399 (95% CI: 257,698-313,099) infections over the past 4 weeks.

The figure below shows the estimated number of people infected over the past 4 weeks. The bar charts show, for comparison, the number of reported cases. The right-hand plot shows these data on a different scale as the estimated infections are likely to be much larger than the reported cases. **Importantly**, the estimated infections includes both asymptomatic and mild cases that would not necessarily be identified through surveillance. Consequently, the estimated infections are likely to be significantly higher than the reported cases (see our FAQ for further explanation of these differences and why the reported cases and estimated infections are unlikely to match).

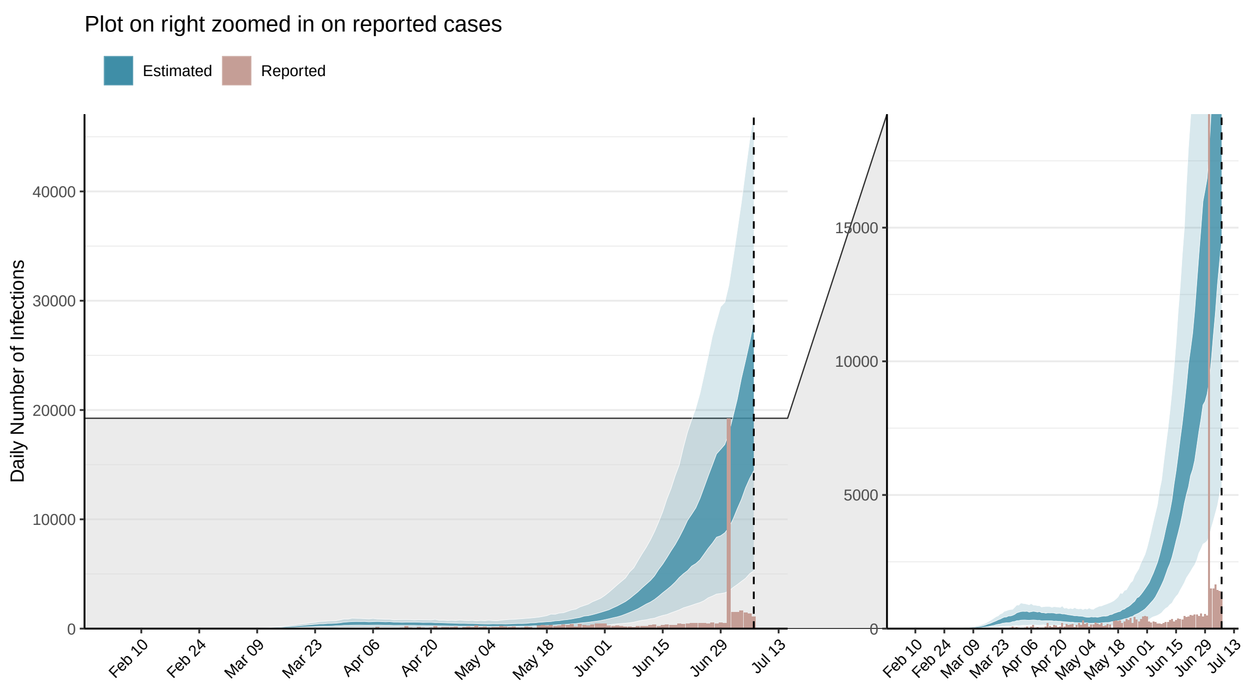

Figure 2: **Daily number of infections estimated by fitting to the current total of deaths.** Reported cases are shown in red. Model estimated infections are shown in blue (dark blue 50% interquartile range, light blue 95% quantile). The dashed line shows the current day.

By fitting to the time series of deaths, we are able to estimate a time-varying reproduction number, R_t. R_t is the the average number of secondary infections caused by a single infected person at a given time. If R_t is above 1, the rate of transmission is increasing and the number of new infections is increasing. R_t is assumed to change in relation to mobility fall in proportion. When fitting our model we assume that 100% of COVID-19 related deaths have been reported (please see our FAQ section for more information about this assumption). We also assume a fixed date at which the impact of mobility on transmission changes from pre-lockdown levels to post-lockdown levels, which may cause large changes in Rt. We are working to refine how this switch occurs and to formally calculate its shape.

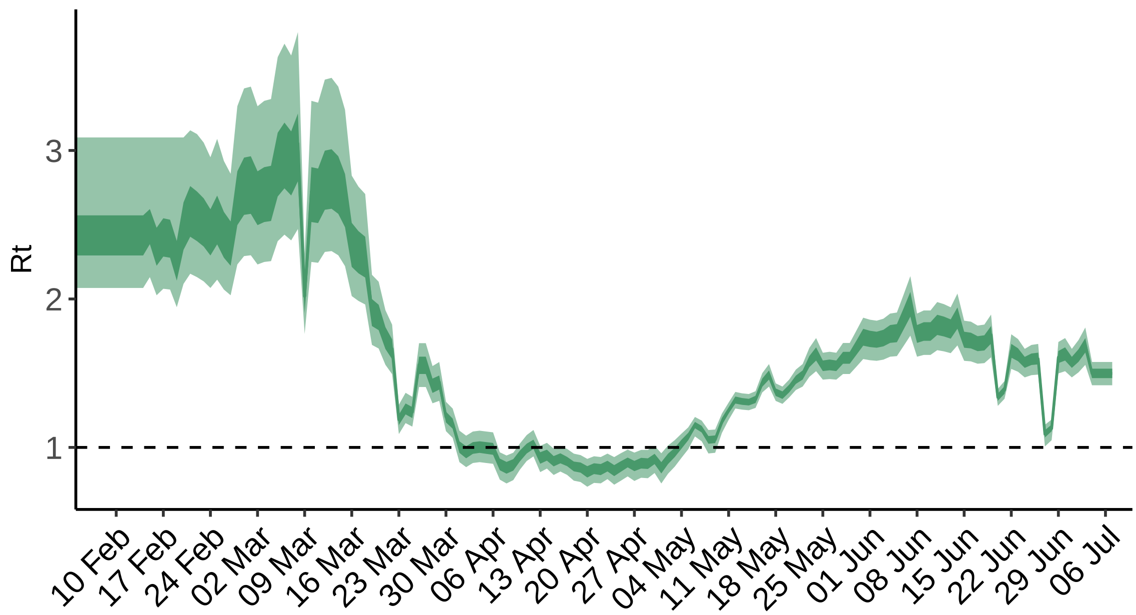

Figure 3: **Time-varying reproduction number, R_t.** R_t is the average number of secondary infections caused by a single infected person at time equal to t. $R_t < 1$ indicates a slowing epidemic in which new infections are not increasing. $R_t > 1$ indicates a growing epidemic in which new infections are increasing over time. Dark green shows the 50% CI and light green shows the 95% CI.

Using the model fit, we can forecast the expected trajectory for cumulative deaths, which is shown in the figure below. This assumes a severity pattern by age that is consistent with that observed in China, Europe and the U.S to date. This projection assumes that transmission is maintained at the current level of transmission as estimated by the final R_t value. **N.B. Kazakhstan is forecast to be close to or surpassing our best estimates for healthcare capacity in the next 28 days.** Estimates of deaths in the next 28 days may be inaccurate due to our working assumptions for mortality in individuals who do not receive appropriate treatment. See our methods for more information.

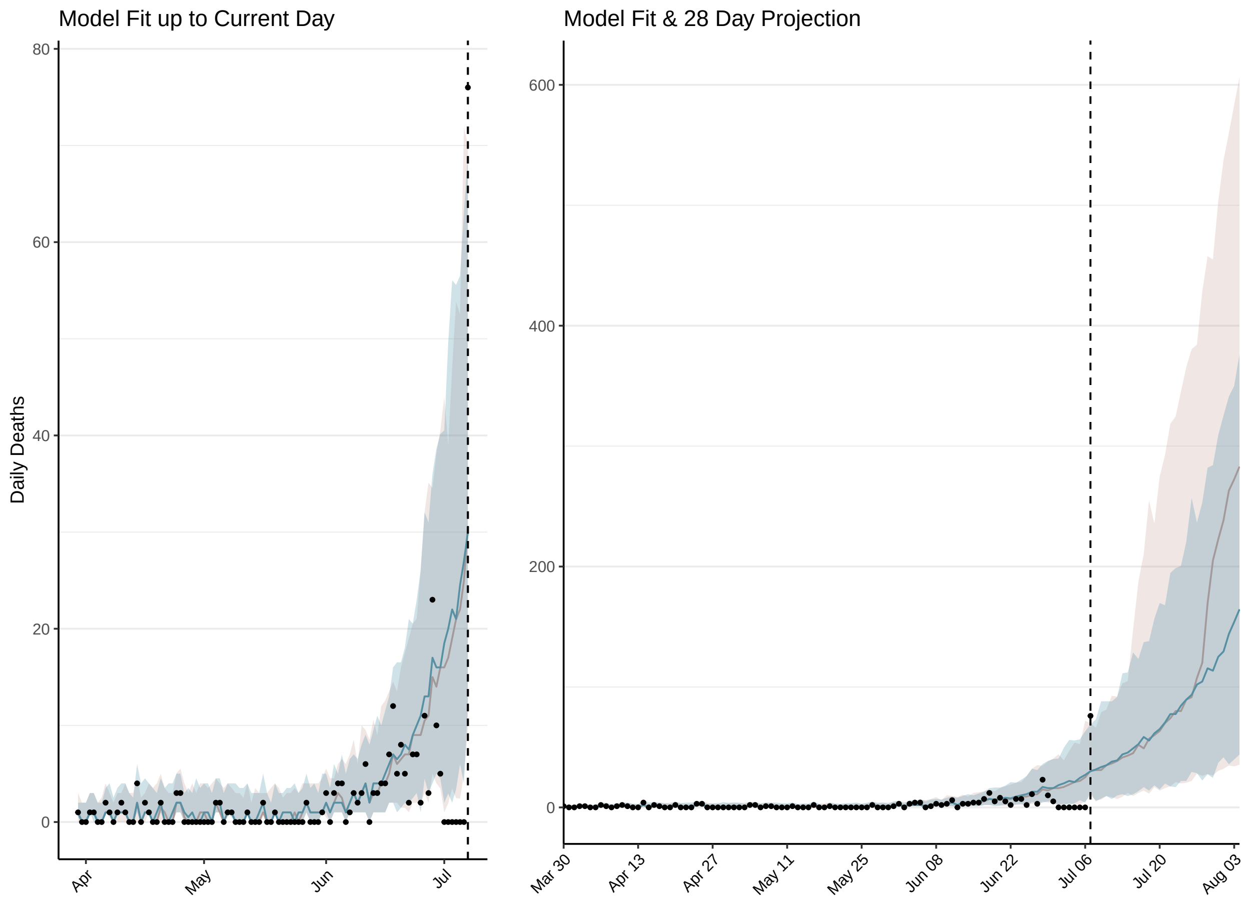

Figure 4: **Estimated daily deaths.** Projected deaths assuming the current level of interventions are maintained are shown in red (median and 95% quantile). Reported deaths are plotted in black. The plot on the left is focussed on the model fit prior to today, while the plot on the right forecasts the next 28 days. The forecasted deaths in blue assumes healthcare capacity has been surged to ensure sufficient supply of ICU and hospital beds. The red curve assumes no surging in healthcare capacity and subsequently projects increased deaths.

Short-term Epidemic Scenarios

We make the following short-term projections of healthcare demand and new infections under the following three scenarios:

- **Scenario 1.** The epidemic continues to grow at the current rate.
- **Scenario 2.** Countries will further scale up interventions (either increasing current strategies or implementing new interventions) leading to a further 50% reduction in transmission.
- **Scenario 3.** Countries will relax current interventions by 50%

N.B. These scenarios currently assume that the impact of mobility on transmission will remain the same in the future as it has in the past. We are working to extend methods to estimate the impact of increases in mobility on transmission as lockdown and interventions are reversed. Consequently, projection are likely to represent an upper estimate of the healthcare demand and case load for each scenario

We estimate that over the next 4 weeks demand for hospital beds will change from 1,972 (95% CI: 1,778-2,167) patients requiring treatment with high-pressure oxygen at the current date to 10,227 (95% CI: 9,344-11,110) hospital beds being required on 2020-08-04 if no further interventions are introduced (Scenario 1). Similarly, we estimate that over the next 4 weeks demand for critical care (ICU) beds will change from 477 (95% CI: 431-524) patients requiring treatment with mechanical ventilation at the current date to 1,723 (95% CI: 1,640-1,806) by 2020-08-04. These projections assume that approximately 5% of all infections will require treatment with high-pressure oxygen and that approximately 30% of hospitalised cases will require treatment with mechanical ventilation (based on analysis of ongoing epidemics in Europe). **N.B. These scenarios are unlikely to show significant differences for the first week since there is a delay of approximately 10 days between infection and hospital admission. Consequently, the effectiveness of a change in policy is likely to be better captured by hospital admission data approximately 2 weeks after the policy change is implemented.**

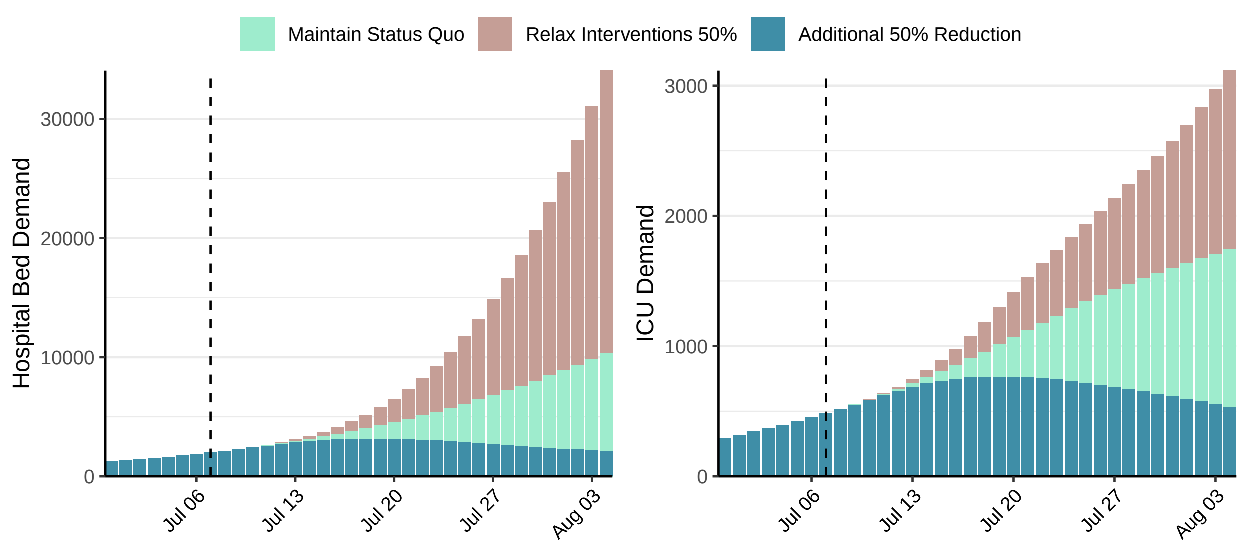

Figure 5: **Healthcare demands in the next 28 days.** Individuals needing an ICU bed are assumed to need mechanical ventilation. Projected demand for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

The impact of each scenario has a more immediate effect on the daily number of infections. The figure below shows the impact of each scenario on the estimated daily incidence of new infections. If interventions are scaled up (Scenario 2), the daily number of infections will change from 21,804 (95% CI: 19,726-23,881) at the current date to 6,725 (95% CI: 6,128-7,321) by 2020-08-04. If current interventions were relaxed by 50%, we estimate the daily number of infections will change from 21,804 (95% CI: 19,726-23,881) at the current date to 380,979 (95% CI: 361,552-400,406) by 2020-08-04.

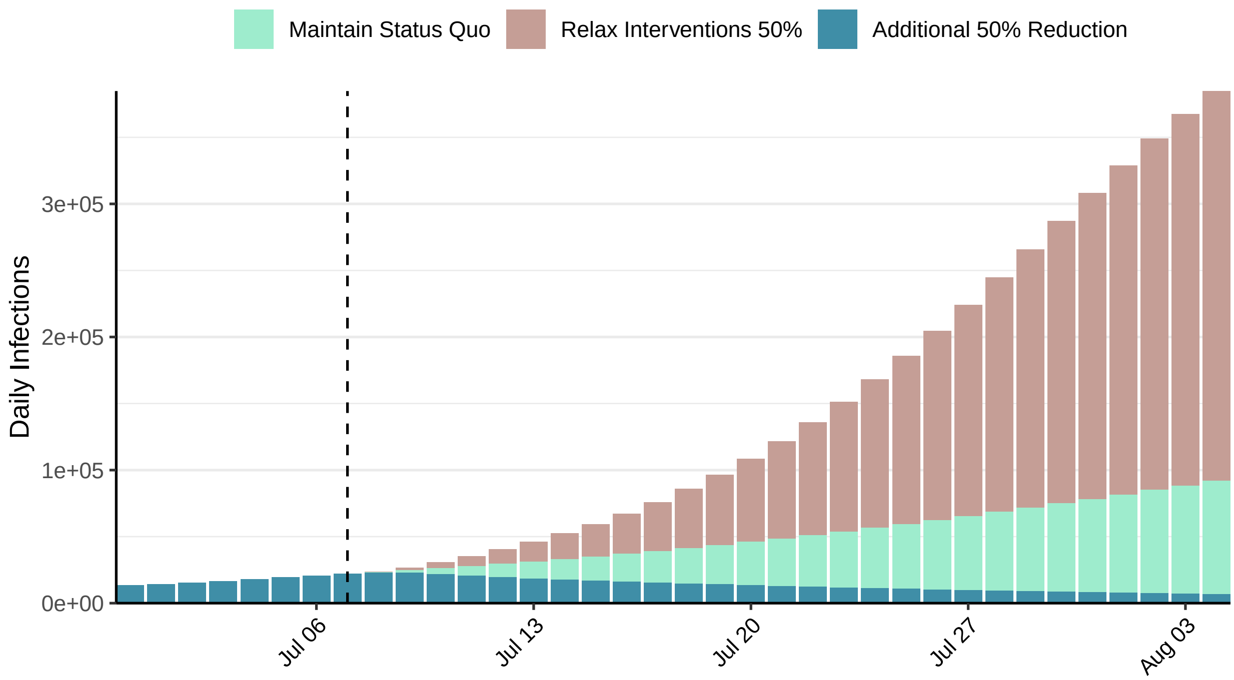

Figure 6: **Daily number of infections estimated by fitting to deaths.** Projected infections for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

To explore different scenarios, we recommend using our COVID-19 Scenario Analysis Tool - https://covidsim.org/, which can be used to simulate different intervention scenarios and explore the long term impact on healthcare demand.

Situation Report for COVID-19: Kenya, 2020-07-07

Download the report for Kenya, 2020-07-07 here. This report uses data from the European Centre for Disease Control. These data are updated daily and whilst there may be a short delay, they are generally consistent with Ministry reports. These data are then used to back-calculate an 'inferred number of COVID-19 infections' using mathematical modelling techniques (see Report 12 for further details) to estimate the number of people that have been infected and to make short-term projections for future healthcare needs.

Epidemiological Situation

Total Reported Cases	New Reported Cases	Total Reported Deaths	New Reported Deaths	Estimated R_t
8,067	181	164	4	1.17 (95% CI: 1.08-1.32)

The figure below shows the cumulative reported deaths as a function of the time since the 10th death was reported. Dashed lines show the expected trajectory for different doubling times of the epidemic. For example, with a doubling time of 3 days, if there are currently a total of 20 deaths reported, we would expect there to be 40 deaths in total reported in 3 days-time, 80 deaths in 6 days-time, 160 deaths in 9 days-time etc. For most epidemics, in the absence of interventions, we expect a doubling time of 3-4 days for this disease.

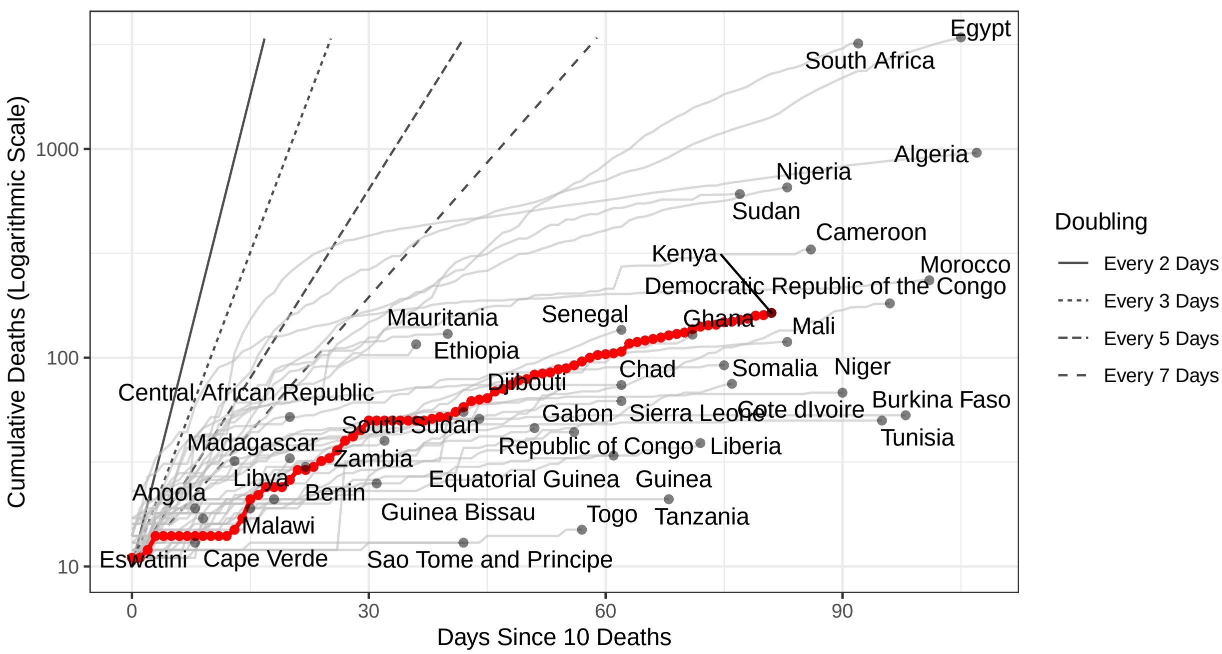

Figure 1: **Cumulative Deaths since 10 deaths.** Country not shown if fewer than 10 deaths.

COVID-19 Transmission Modelling

We assume that the deaths reported to date provide the best indication of the stage of the epidemic, as deaths are more consistently and accurately reported. Our current working estimate is that 1 death indicates that approximately 100 people will have been infected with the other 99 recovering (based on an infection fatality ratio of ~1%). These infections will have happened approximately 21 days previously – capturing a 5-day period from infection to onset of symptoms (the incubation period), 4 days from onset of symptoms to hospitalisation, and 12 days in hospital before death. With a 3-day doubling time, 100 infections that occurred 15 days ago will have generated 200 infections 12 days ago, 400 infections 9 days ago, 800 infections 6 days ago and 1,600 infections 3 days ago resulting in approximately 3,200 infections at the time the first death is observed.

To explore this, we fit our age-structured SEIR model (see Methods) to the time series of deaths in a country, in order to estimate the start date of the epidemic and the baseline R0. We assume that 100% of COVID-19 related deaths have been reported. We have also included the impact of interventions that have been put in place and their effect on human mobility and transmission based on the Google COVID-19 Community Mobility Reports. Using our mathematical model that formalises this approach, we estimate that there has been a total of 66,807 (95% CI: 59,081-74,532) infections over the past 4 weeks.

The figure below shows the estimated number of people infected over the past 4 weeks. The bar charts show, for comparison, the number of reported cases. The right-hand plot shows these data on a different scale as the estimated infections are likely to be much larger than the reported cases. **Importantly**, the estimated infections includes both asymptomatic and mild cases that would not necessarily be identified through surveillance. Consequently, the estimated infections are likely to be significantly higher than the reported cases (see our FAQ for further explanation of these differences and why the reported cases and estimated infections are unlikely to match).

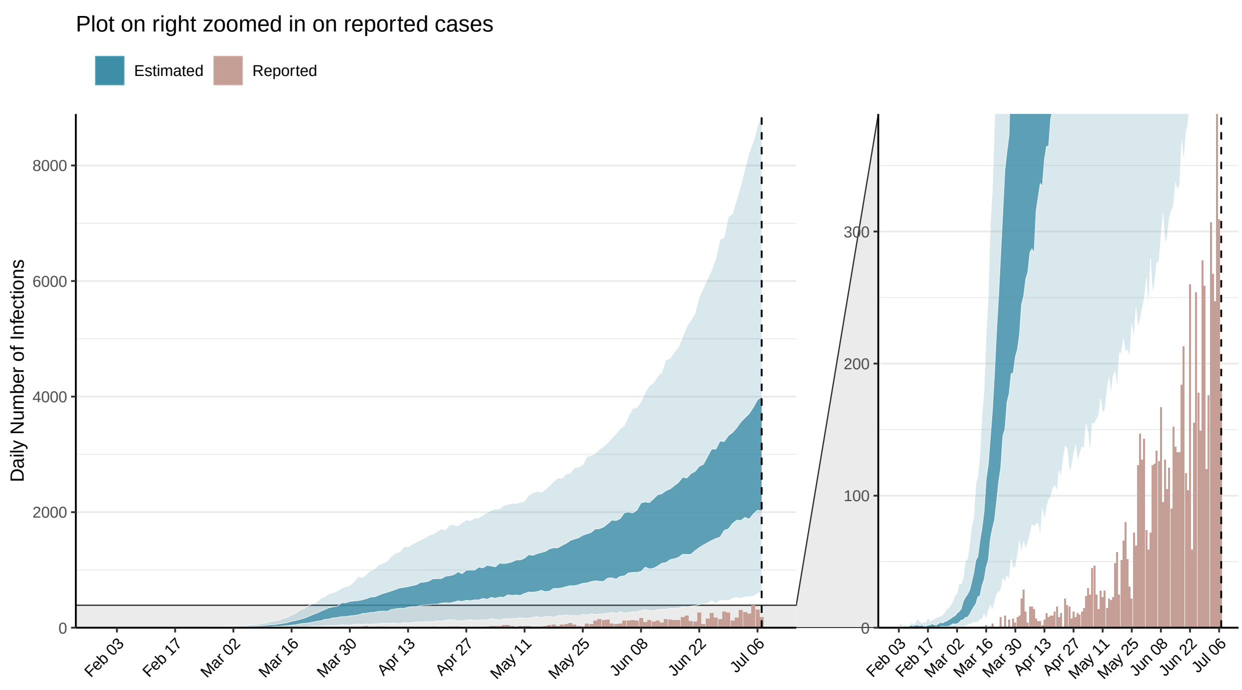

Figure 2: **Daily number of infections estimated by fitting to the current total of deaths.** Reported cases are shown in red. Model estimated infections are shown in blue (dark blue 50% interquartile range, light blue 95% quantile). The dashed line shows the current day.

By fitting to the time series of deaths, we are able to estimate a time-varying reproduction number, R_t. R_t is the the average number of secondary infections caused by a single infected person at a given time. If R_t is above 1, the rate of transmission is increasing and the number of new infections is increasing. R_t is assumed to change in relation to mobility fall in proportion. When fitting our model we assume that 100% of COVID-19 related deaths have been reported (please see our FAQ section for more information about this assumption). We also assume a fixed date at which the impact of mobility on transmission changes from pre-lockdown levels to post-lockdown levels, which may cause large changes in Rt. We are working to refine how this switch occurs and to formally calculate its shape.

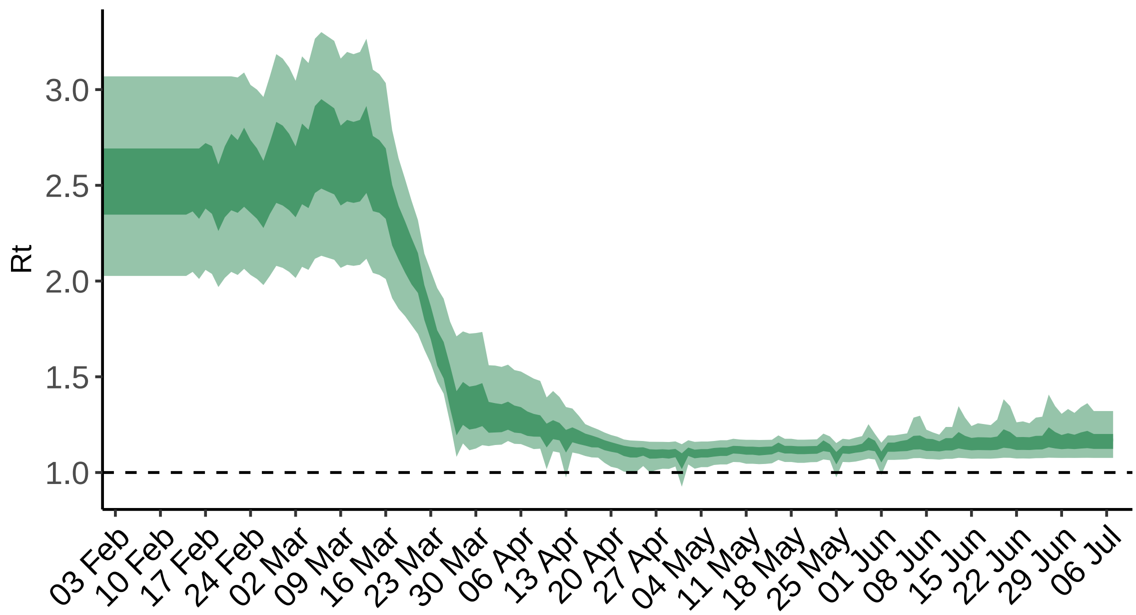

Figure 3: **Time-varying reproduction number, R_t.** R_t is the average number of secondary infections caused by a single infected person at time equal to t. $R_t < 1$ indicates a slowing epidemic in which new infections are not increasing. $R_t > 1$ indicates a growing epidemic in which new infections are increasing over time. Dark green shows the 50% CI and light green shows the 95% CI.

Using the model fit, we can forecast the expected trajectory for cumulative deaths, which is shown in the figure below. This assumes a severity pattern by age that is consistent with that observed in China, Europe and the U.S to date. This projection assumes that transmission is maintained at the current level of transmission as estimated by the final R_t value.

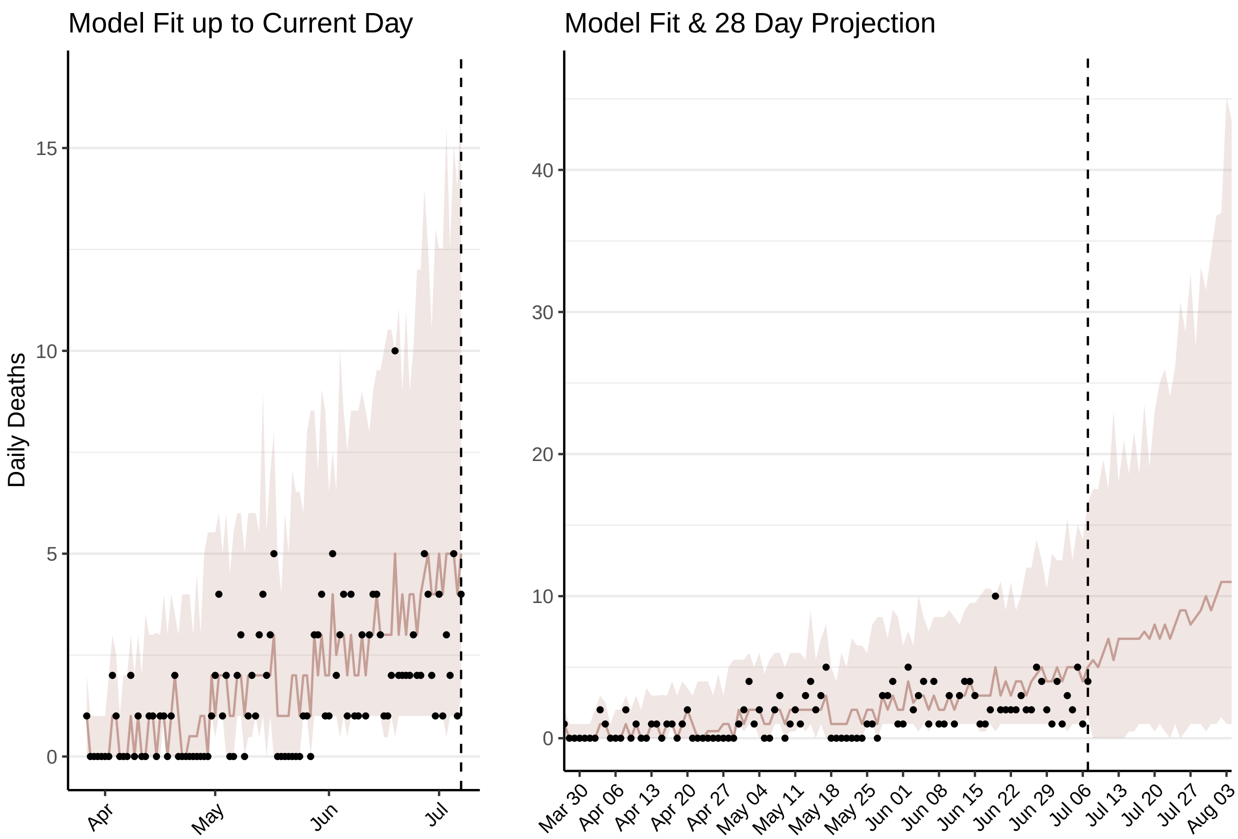

Figure 4: **Estimated daily deaths.** Projected deaths assuming the current level of interventions are maintained are shown in red (median and 95% quantile). Reported deaths are plotted in black. The plot on the left is focussed on the model fit prior to today, while the plot on the right forecasts the next 28 days.

Short-term Epidemic Scenarios

We make the following short-term projections of healthcare demand and new infections under the following three scenarios:

- **Scenario 1.** The epidemic continues to grow at the current rate.
- **Scenario 2.** Countries will further scale up interventions (either increasing current strategies or implementing new interventions) leading to a further 50% reduction in transmission.
- **Scenario 3.** Countries will relax current interventions by 50%

N.B. These scenarios currently assume that the impact of mobility on transmission will remain the same in the future as it has in the past. We are working to extend methods to estimate the impact of increases in mobility on transmission as lockdown and interventions are reversed. Consequently, projection are likely to represent an upper estimate of the healthcare demand and case load for each scenario

We estimate that over the next 4 weeks demand for hospital beds will change from 368 (95% CI: 324-411) patients requiring treatment with high-pressure oxygen at the current date to 782 (95% CI: 665-899) hospital beds being required on 2020-08-04 if no further interventions are introduced (Scenario 1). Similarly, we estimate that over the next 4 weeks demand for critical care (ICU) beds will change from 93 (95% CI: 82-104) patients requiring treatment with mechanical ventilation at the current date to 197 (95% CI: 167-226) by 2020-08-04. These projections assume that approximately 5% of all infections will require treatment with high-pressure oxygen and that approximately 30% of hospitalised cases will require treatment with mechanical ventilation (based on analysis of ongoing epidemics in Europe). **N.B. These scenarios are unlikely to show significant differences for the first week since there is a delay of approximately 10 days between infection and hospital admission. Consequently, the effectiveness of a change in policy is likely to be better captured by hospital admission data approximately 2 weeks after the policy change is implemented.**

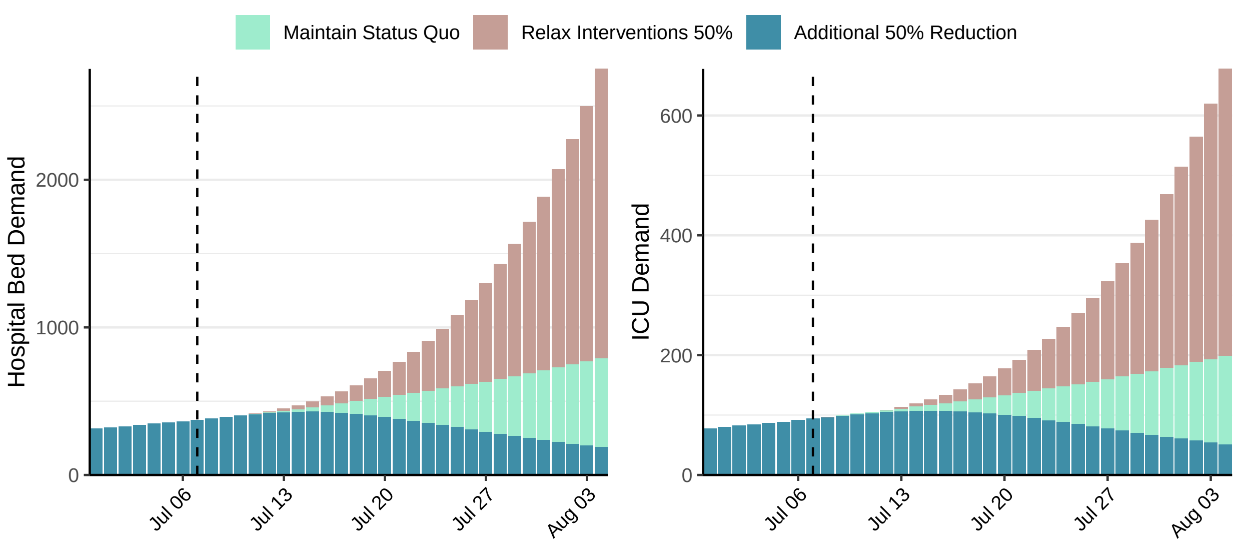

Figure 5: **Healthcare demands in the next 28 days.** Individuals needing an ICU bed are assumed to need mechanical ventilation. Projected demand for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

The impact of each scenario has a more immediate effect on the daily number of infections. The figure below shows the impact of each scenario on the estimated daily incidence of new infections. If interventions are scaled up (Scenario 2), the daily number of infections will change from 3,312 (95% CI: 2,893-3,731) at the current date to 526 (95% CI: 441-611) by 2020-08-04. If current interventions were relaxed by 50%, we estimate the daily number of infections will change from 3,312 (95% CI: 2,893-3,731) at the current date to 45,004 (95% CI: 37,138-52,870) by 2020-08-04.

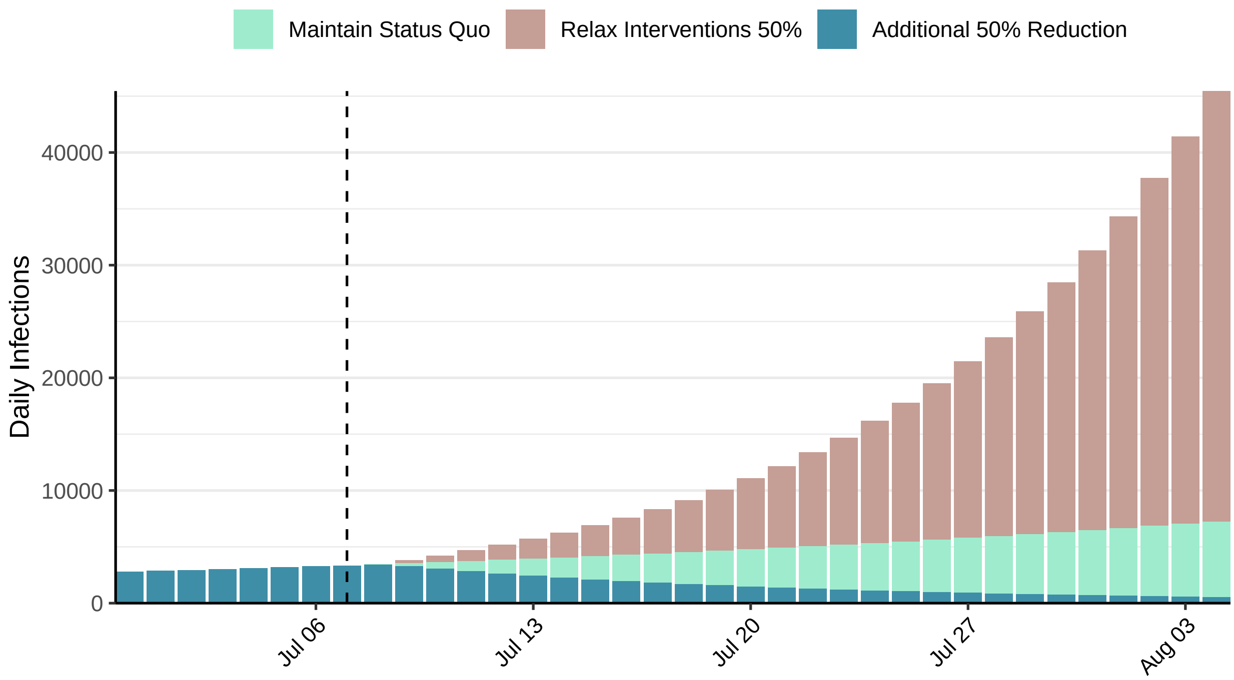

Figure 6: **Daily number of infections estimated by fitting to deaths.** Projected infections for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

To explore different scenarios, we recommend using our COVID-19 Scenario Analysis Tool - https://covidsim.org/, which can be used to simulate different intervention scenarios and explore the long term impact on healthcare demand.

Situation Report for COVID-19: Kyrgyz Republic, 2020-07-07

Download the report for Kyrgyz Republic, 2020-07-07 here. This report uses data from the European Centre for Disease Control. These data are updated daily and whilst there may be a short delay, they are generally consistent with Ministry reports. These data are then used to back-calculate an 'inferred number of COVID-19 infections' using mathematical modelling techniques (see Report 12 for further details) to estimate the number of people that have been infected and to make short-term projections for future healthcare needs.

Epidemiological Situation

Total Reported Cases	New Reported Cases	Total Reported Deaths	New Reported Deaths	Estimated R_t
8,141	450	99	7	1.64 (95% CI: 1.51-1.8)

The figure below shows the cumulative reported deaths as a function of the time since the 10th death was reported. Dashed lines show the expected trajectory for different doubling times of the epidemic. For example, with a doubling time of 3 days, if there are currently a total of 20 deaths reported, we would expect there to be 40 deaths in total reported in 3 days-time, 80 deaths in 6 days-time, 160 deaths in 9 days-time etc. For most epidemics, in the absence of interventions, we expect a doubling time of 3-4 days for this disease.

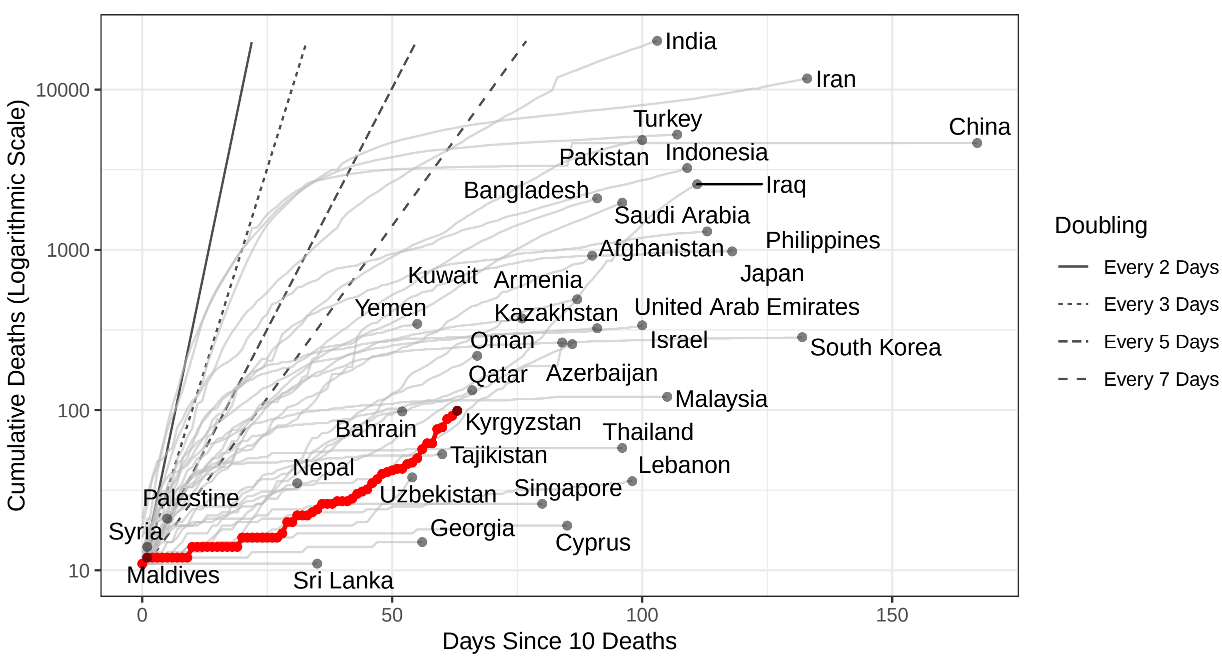

Figure 1: **Cumulative Deaths since 10 deaths.** Country not shown if fewer than 10 deaths.

COVID-19 Transmission Modelling

We assume that the deaths reported to date provide the best indication of the stage of the epidemic, as deaths are more consistently and accurately reported. Our current working estimate is that 1 death indicates that approximately 100 people will have been infected with the other 99 recovering (based on an infection fatality ratio of ~1%). These infections will have happened approximately 21 days previously – capturing a 5-day period from infection to onset of symptoms (the incubation period), 4 days from onset of symptoms to hospitalisation, and 12 days in hospital before death. With a 3-day doubling time, 100 infections that occurred 15 days ago will have generated 200 infections 12 days ago, 400 infections 9 days ago, 800 infections 6 days ago and 1,600 infections 3 days ago resulting in approximately 3,200 infections at the time the first death is observed.

To explore this, we fit our age-structured SEIR model (see Methods) to the time series of deaths in a country, in order to estimate the start date of the epidemic and the baseline R0. We assume that 100% of COVID-19 related deaths have been reported. We have also included the impact of interventions that have been put in place and their effect on human mobility and transmission based on the Google COVID-19 Community Mobility Reports. Using our mathematical model that formalises this approach, we estimate that there has been a total of 110,427 (95% CI: 97,292-123,563) infections over the past 4 weeks.

The figure below shows the estimated number of people infected over the past 4 weeks. The bar charts show, for comparison, the number of reported cases. The right-hand plot shows these data on a different scale as the estimated infections are likely to be much larger than the reported cases. **Importantly**, the estimated infections includes both asymptomatic and mild cases that would not necessarily be identified through surveillance. Consequently, the estimated infections are likely to be significantly higher than the reported cases (see our FAQ for further explanation of these differences and why the reported cases and estimated infections are unlikely to match).

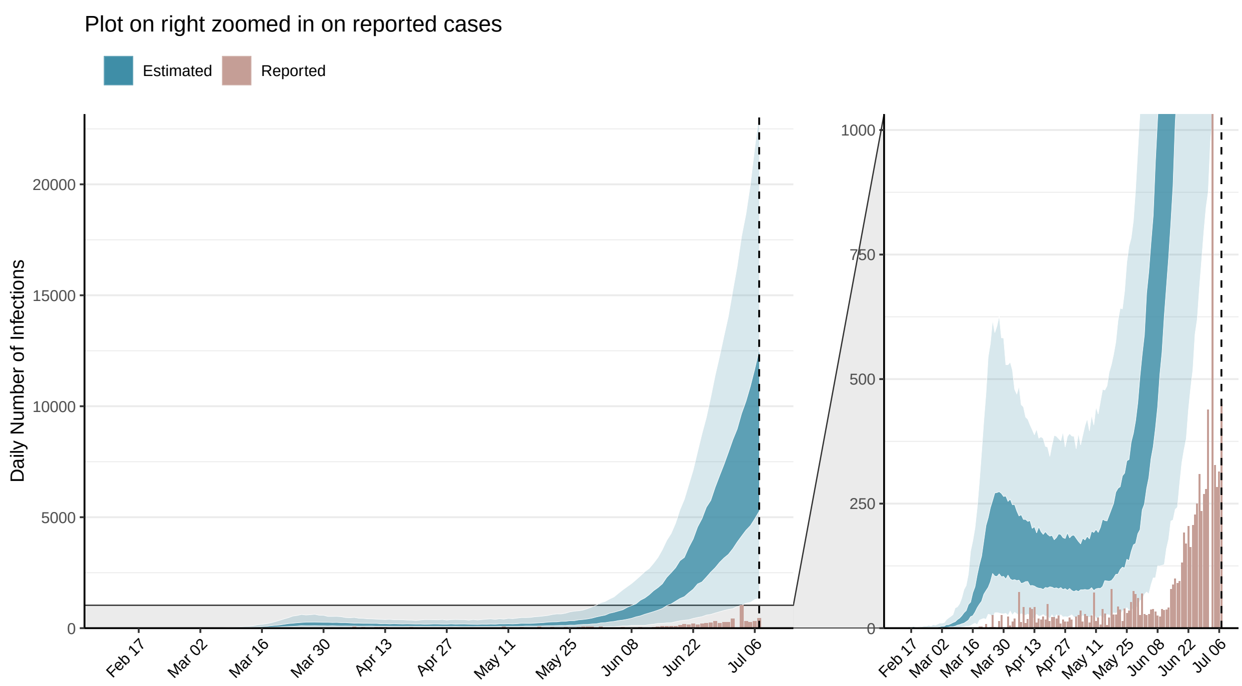

Figure 2: **Daily number of infections estimated by fitting to the current total of deaths.** Reported cases are shown in red. Model estimated infections are shown in blue (dark blue 50% interquartile range, light blue 95% quantile). The dashed line shows the current day.

By fitting to the time series of deaths, we are able to estimate a time-varying reproduction number, R_t. R_t is the the average number of secondary infections caused by a single infected person at a given time. If R_t is above 1, the rate of transmission is increasing and the number of new infections is increasing. R_t is assumed to change in relation to mobility fall in proportion. When fitting our model we assume that 100% of COVID-19 related deaths have been reported (please see our FAQ section for more information about this assumption). We also assume a fixed date at which the impact of mobility on transmission changes from pre-lockdown levels to post-lockdown levels, which may cause large changes in Rt. We are working to refine how this switch occurs and to formally calculate its shape.

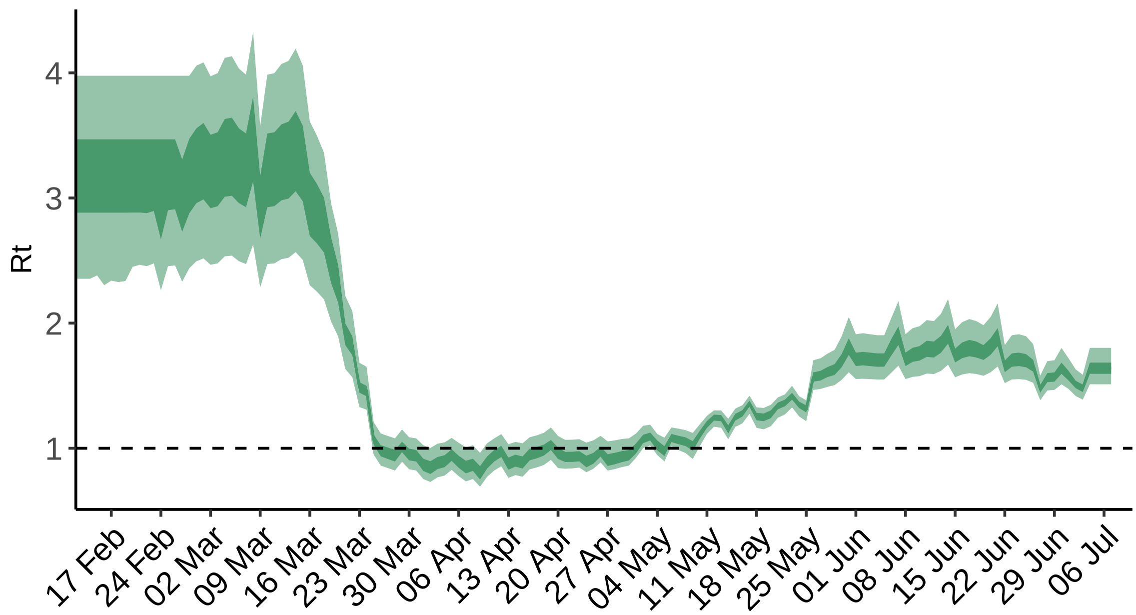

Figure 3: **Time-varying reproduction number, R_t.** R_t is the average number of secondary infections caused by a single infected person at time equal to t. $R_t < 1$ indicates a slowing epidemic in which new infections are not increasing. $R_t > 1$ indicates a growing epidemic in which new infections are increasing over time. Dark green shows the 50% CI and light green shows the 95% CI.

Using the model fit, we can forecast the expected trajectory for cumulative deaths, which is shown in the figure below. This assumes a severity pattern by age that is consistent with that observed in China, Europe and the U.S to date. This projection assumes that transmission is maintained at the current level of transmission as estimated by the final R_t value. **N.B. Kyrgyz Republic is forecast to be close to or surpassing our best estimates for healthcare capacity in the next 28 days.** Estimates of deaths in the next 28 days may be inaccurate due to our working assumptions for mortality in individuals who do not receive appropriate treatment. See our methods for more information.

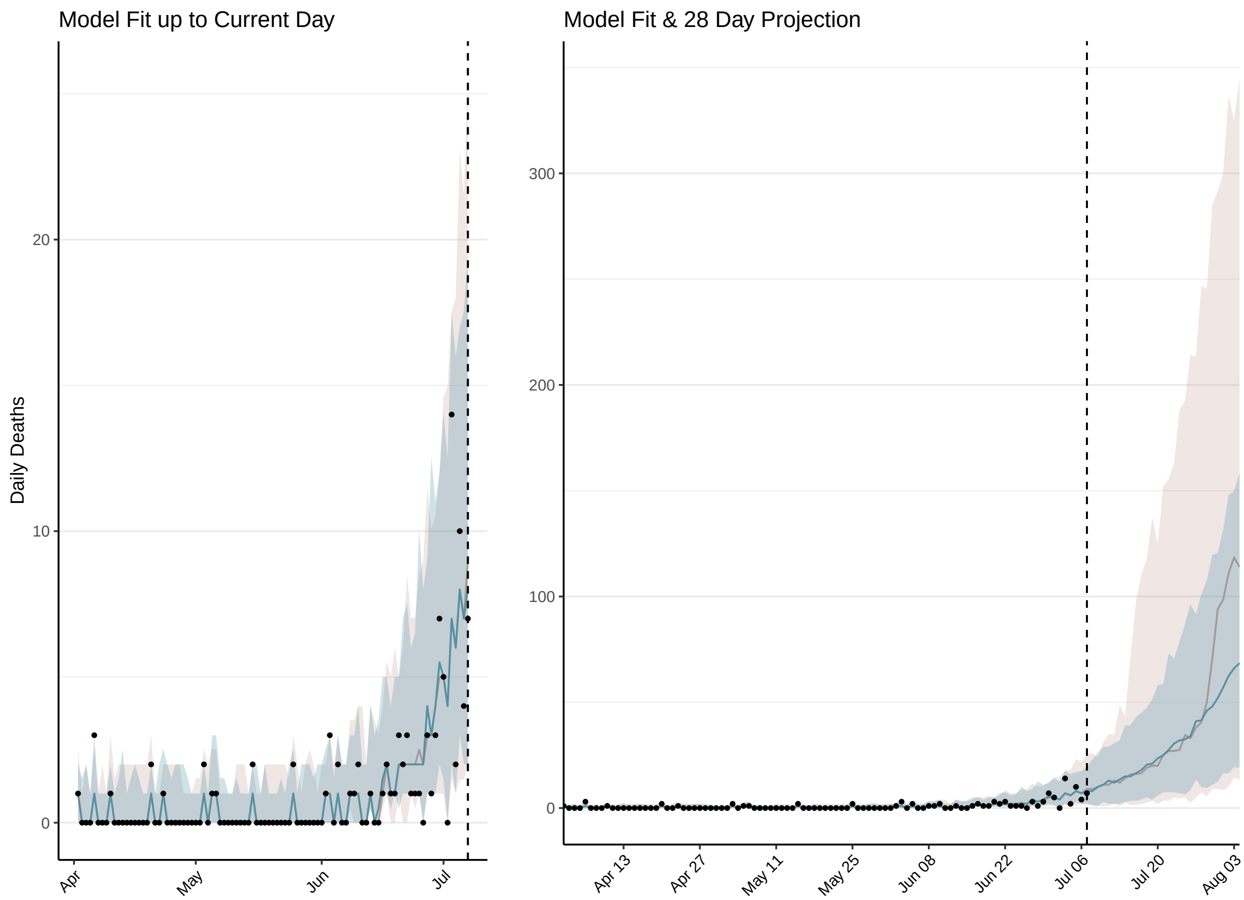

Figure 4: **Estimated daily deaths.** Projected deaths assuming the current level of interventions are maintained are shown in red (median and 95% quantile). Reported deaths are plotted in black. The plot on the left is focussed on the model fit prior to today, while the plot on the right forecasts the next 28 days. The forecasted deaths in blue assumes healthcare capacity has been surged to ensure sufficient supply of ICU and hospital beds. The red curve assumes no surging in healthcare capacity and subsequently projects increased deaths.

Short-term Epidemic Scenarios

We make the following short-term projections of healthcare demand and new infections under the following three scenarios:

- **Scenario 1.** The epidemic continues to grow at the current rate.
- **Scenario 2.** Countries will further scale up interventions (either increasing current strategies or implementing new interventions) leading to a further 50% reduction in transmission.
- **Scenario 3.** Countries will relax current interventions by 50%

N.B. These scenarios currently assume that the impact of mobility on transmission will remain the same in the future as it has in the past. We are working to extend methods to estimate the impact of increases in mobility on transmission as lockdown and interventions are reversed. Consequently, projection are likely to represent an upper estimate of the healthcare demand and case load for each scenario

We estimate that over the next 4 weeks demand for hospital beds will change from 712 (95% CI: 628-797) patients requiring treatment with high-pressure oxygen at the current date to 4,931 (95% CI: 4,385-5,476) hospital beds being required on 2020-08-04 if no further interventions are introduced (Scenario 1). Similarly, we estimate that over the next 4 weeks demand for critical care (ICU) beds will change from 158 (95% CI: 139-178) patients requiring treatment with mechanical ventilation at the current date to 701 (95% CI: 660-743) by 2020-08-04. These projections assume that approximately 5% of all infections will require treatment with high-pressure oxygen and that approximately 30% of hospitalised cases will require treatment with mechanical ventilation (based on analysis of ongoing epidemics in Europe). **N.B. These scenarios are unlikely to show significant differences for the first week since there is a delay of approximately 10 days between infection and hospital admission. Consequently, the effectiveness of a change in policy is likely to be better captured by hospital admission data approximately 2 weeks after the policy change is implemented.**

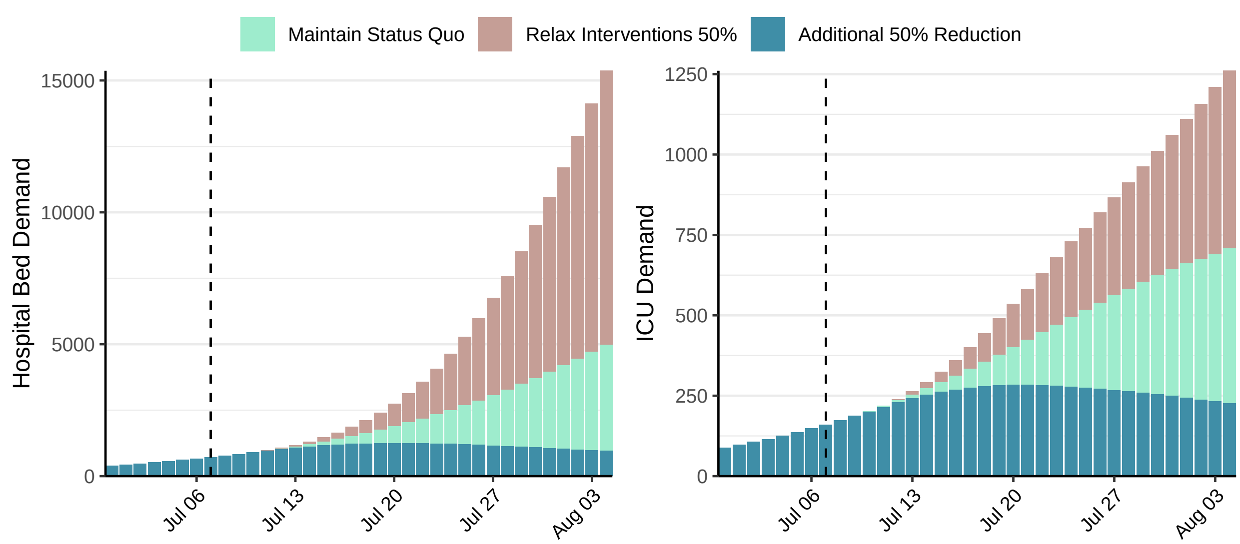

Figure 5: **Healthcare demands in the next 28 days.** Individuals needing an ICU bed are assumed to need mechanical ventilation. Projected demand for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

The impact of each scenario has a more immediate effect on the daily number of infections. The figure below shows the impact of each scenario on the estimated daily incidence of new infections. If interventions are scaled up (Scenario 2), the daily number of infections will change from 9,156 (95% CI: 8,043-10,268) at the current date to 3,902 (95% CI: 3,434-4,371) by 2020-08-04. If current interventions were relaxed by 50%, we estimate the daily number of infections will change from 9,156 (95% CI: 8,043-10,268) at the current date to 168,152 (95% CI: 160,148-176,155) by 2020-08-04.

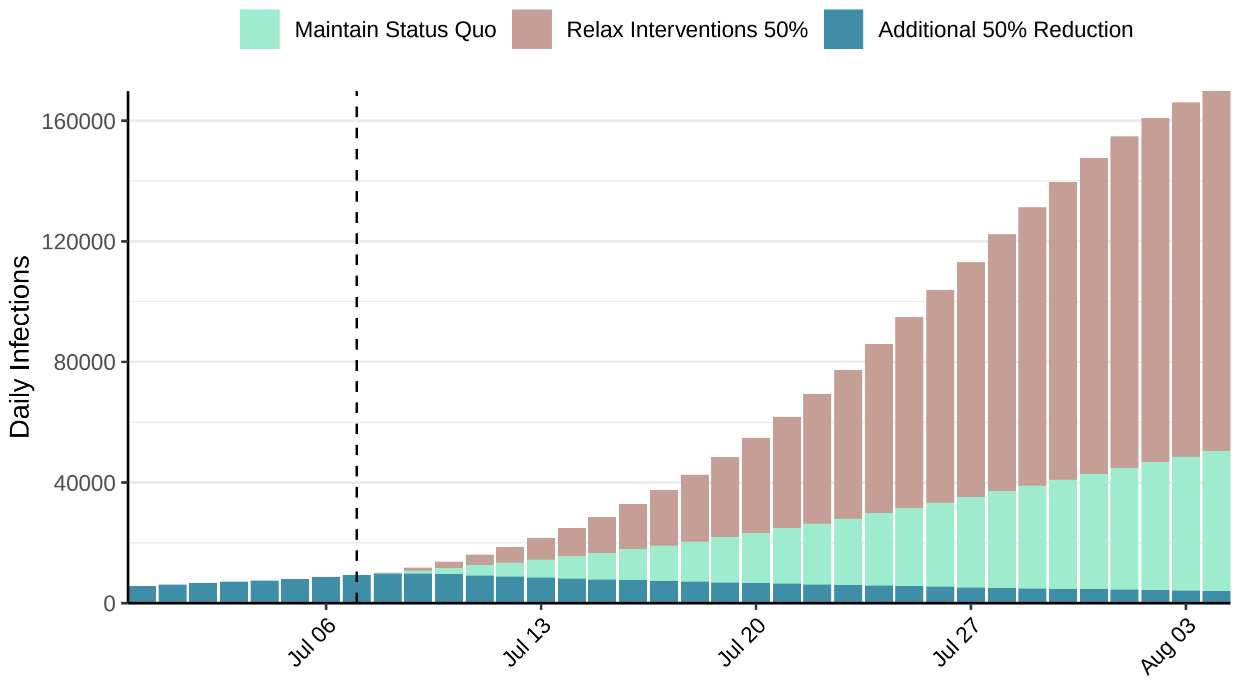

Figure 6: **Daily number of infections estimated by fitting to deaths.** Projected infections for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

To explore different scenarios, we recommend using our COVID-19 Scenario Analysis Tool - https://covidsim.org/, which can be used to simulate different intervention scenarios and explore the long term impact on healthcare demand.

Situation Report for COVID-19: Lebanon, 2020-07-07

Download the report for Lebanon, 2020-07-07 here. This report uses data from the European Centre for Disease Control. These data are updated daily and whilst there may be a short delay, they are generally consistent with Ministry reports. These data are then used to back-calculate an 'inferred number of COVID-19 infections' using mathematical modelling techniques (see Report 12 for further details) to estimate the number of people that have been infected and to make short-term projections for future healthcare needs.

Epidemiological Situation

Total Reported Cases	New Reported Cases	Total Reported Deaths	New Reported Deaths	Estimated R_t
1,885	12	36	0	1.4 (95% CI: 1.14-1.6)

The figure below shows the cumulative reported deaths as a function of the time since the 10th death was reported. Dashed lines show the expected trajectory for different doubling times of the epidemic. For example, with a doubling time of 3 days, if there are currently a total of 20 deaths reported, we would expect there to be 40 deaths in total reported in 3 days-time, 80 deaths in 6 days-time, 160 deaths in 9 days-time etc. For most epidemics, in the absence of interventions, we expect a doubling time of 3-4 days for this disease.

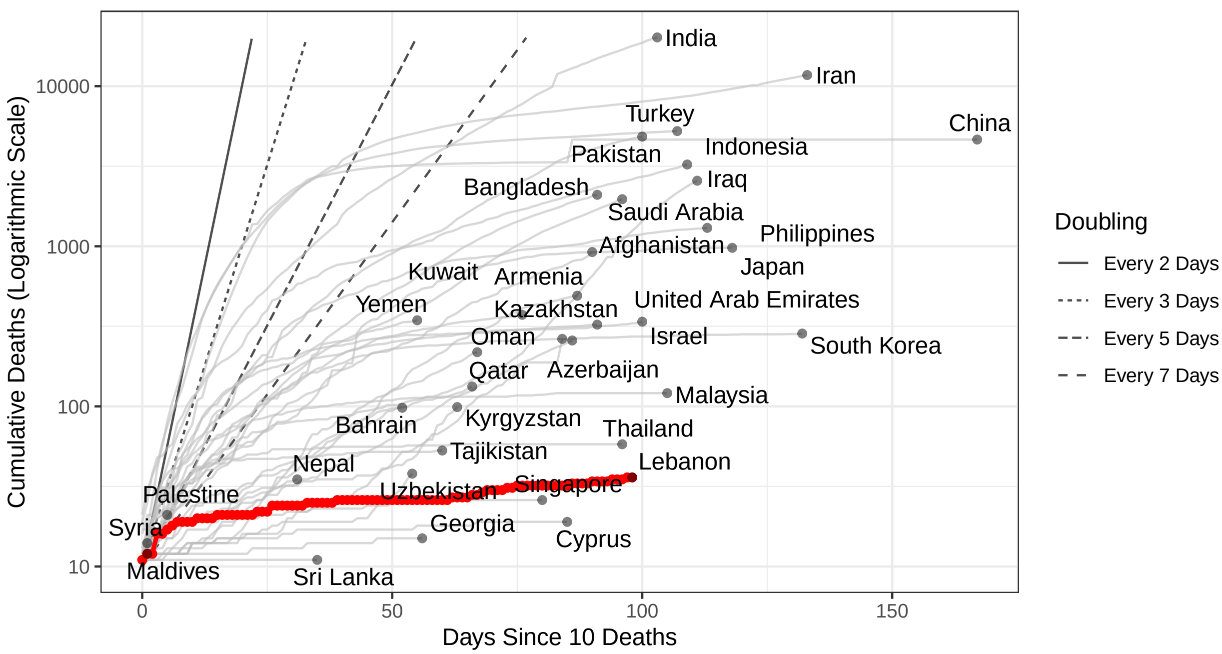

Figure 1: **Cumulative Deaths since 10 deaths.** Country not shown if fewer than 10 deaths.

COVID-19 Transmission Modelling

We assume that the deaths reported to date provide the best indication of the stage of the epidemic, as deaths are more consistently and accurately reported. Our current working estimate is that 1 death indicates that approximately 100 people will have been infected with the other 99 recovering (based on an infection fatality ratio of ~1%). These infections will have happened approximately 21 days previously – capturing a 5-day period from infection to onset of symptoms (the incubation period), 4 days from onset of symptoms to hospitalisation, and 12 days in hospital before death. With a 3-day doubling time, 100 infections that occurred 15 days ago will have generated 200 infections 12 days ago, 400 infections 9 days ago, 800 infections 6 days ago and 1,600 infections 3 days ago resulting in approximately 3,200 infections at the time the first death is observed.

To explore this, we fit our age-structured SEIR model (see Methods) to the time series of deaths in a country, in order to estimate the start date of the epidemic and the baseline R0. We assume that 100% of COVID-19 related deaths have been reported. We have also included the impact of interventions that have been put in place and their effect on human mobility and transmission based on the Google COVID-19 Community Mobility Reports. Using our mathematical model that formalises this approach, we estimate that there has been a total of 3,461 (95% CI: 2,947-3,976) infections over the past 4 weeks.

The figure below shows the estimated number of people infected over the past 4 weeks. The bar charts show, for comparison, the number of reported cases. The right-hand plot shows these data on a different scale as the estimated infections are likely to be much larger than the reported cases. **Importantly**, the estimated infections includes both asymptomatic and mild cases that would not necessarily be identified through surveillance. Consequently, the estimated infections are likely to be significantly higher than the reported cases (see our FAQ for further explanation of these differences and why the reported cases and estimated infections are unlikely to match).

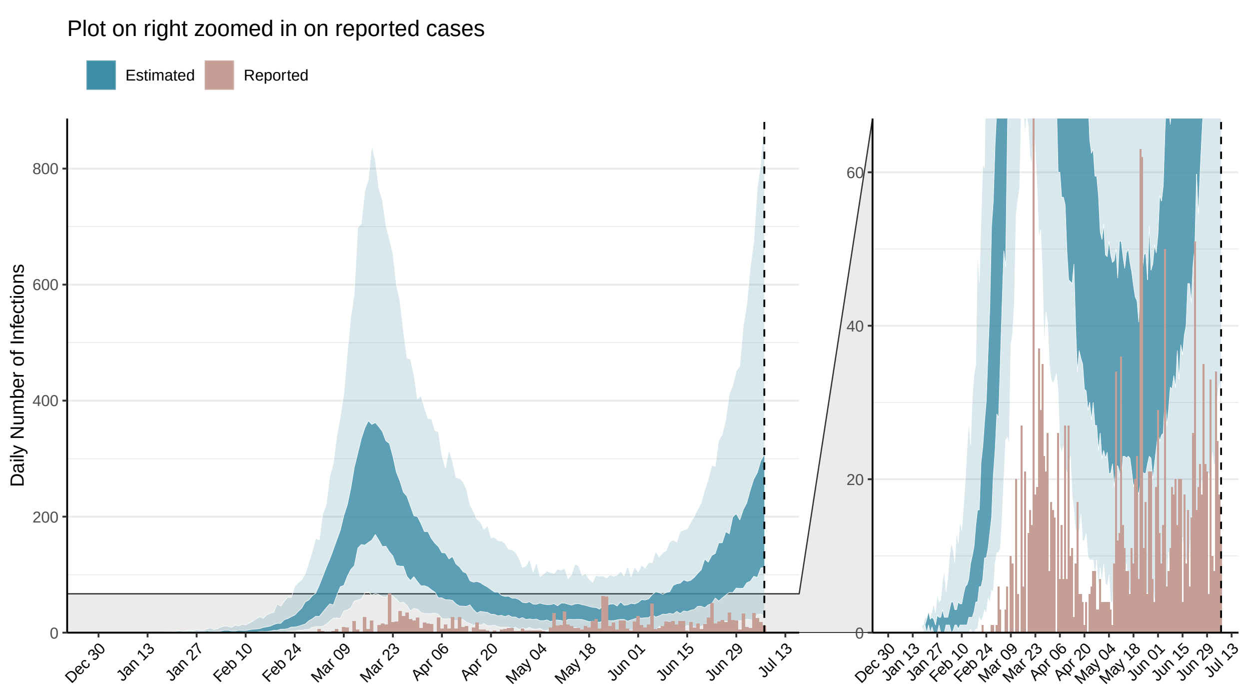

Figure 2: **Daily number of infections estimated by fitting to the current total of deaths.** Reported cases are shown in red. Model estimated infections are shown in blue (dark blue 50% interquartile range, light blue 95% quantile). The dashed line shows the current day.

By fitting to the time series of deaths, we are able to estimate a time-varying reproduction number, R_t. R_t is the the average number of secondary infections caused by a single infected person at a given time. If R_t is above 1, the rate of transmission is increasing and the number of new infections is increasing. R_t is assumed to change in relation to mobility fall in proportion. When fitting our model we assume that 100% of COVID-19 related deaths have been reported (please see our FAQ section for more information about this assumption). We also assume a fixed date at which the impact of mobility on transmission changes from pre-lockdown levels to post-lockdown levels, which may cause large changes in Rt. We are working to refine how this switch occurs and to formally calculate its shape.

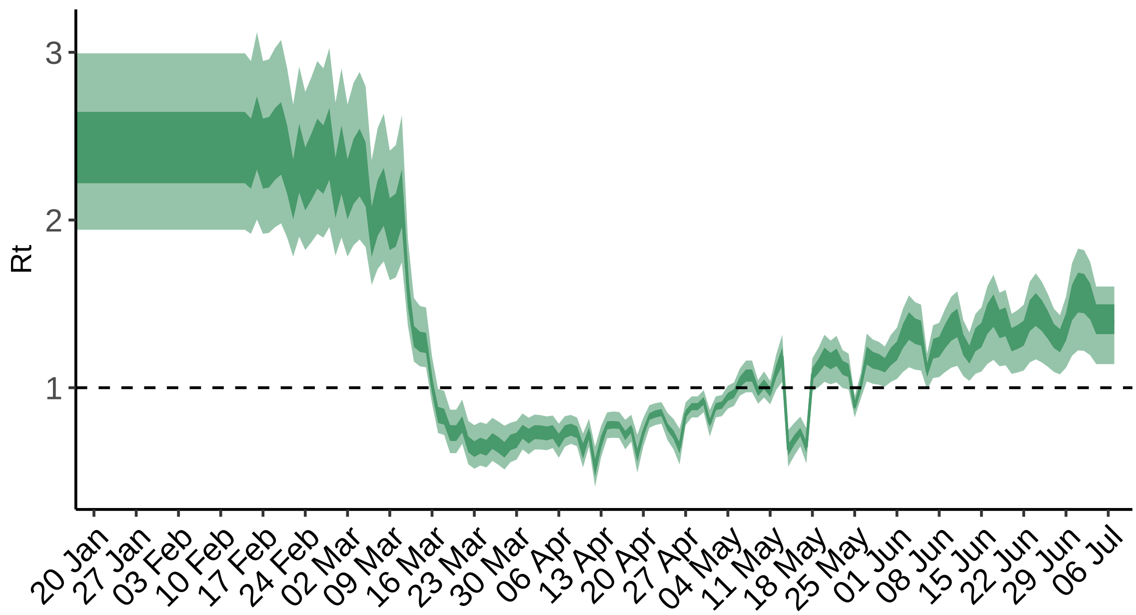

Figure 3: **Time-varying reproduction number, R_t.** R_t is the average number of secondary infections caused by a single infected person at time equal to t. $R_t < 1$ indicates a slowing epidemic in which new infections are not increasing. $R_t > 1$ indicates a growing epidemic in which new infections are increasing over time. Dark green shows the 50% CI and light green shows the 95% CI.

Using the model fit, we can forecast the expected trajectory for cumulative deaths, which is shown in the figure below. This assumes a severity pattern by age that is consistent with that observed in China, Europe and the U.S to date. This projection assumes that transmission is maintained at the current level of transmission as estimated by the final R_t value.

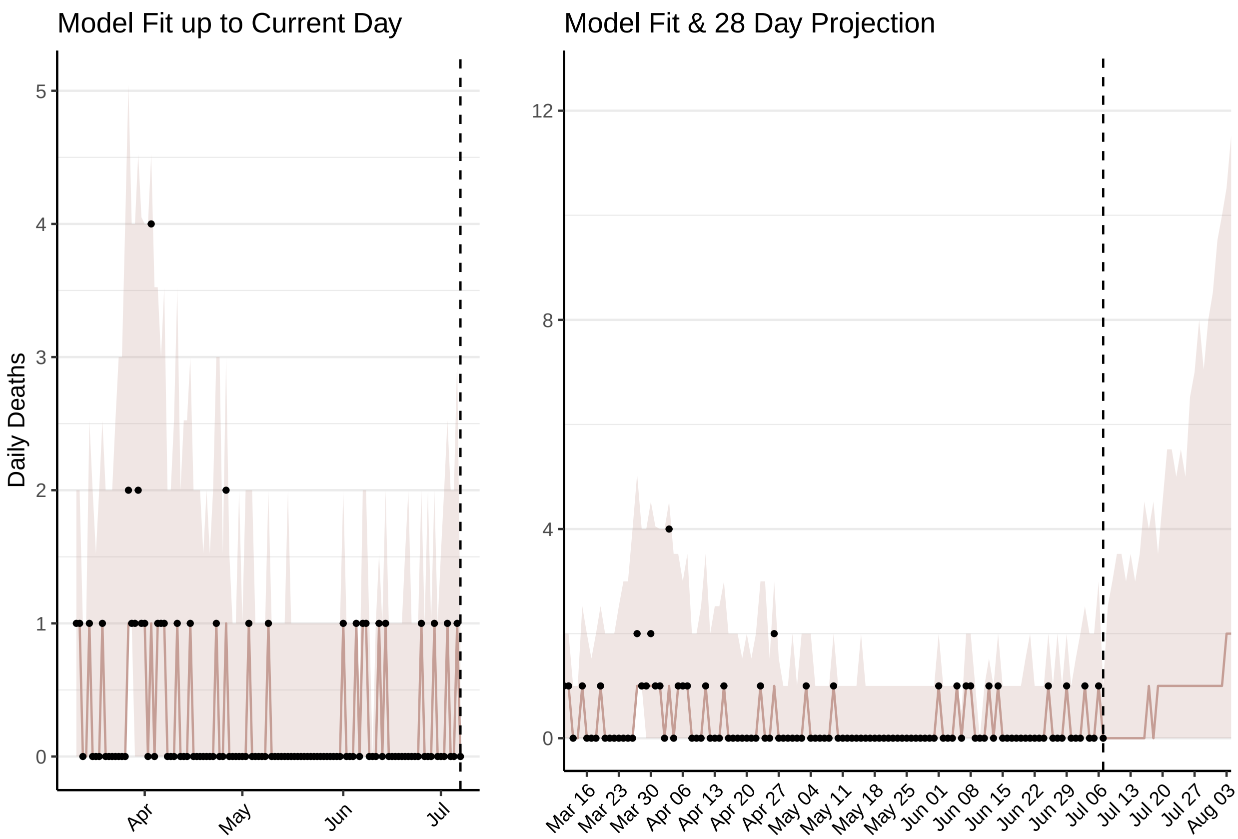

Figure 4: **Estimated daily deaths.** Projected deaths assuming the current level of interventions are maintained are shown in red (median and 95% quantile). Reported deaths are plotted in black. The plot on the left is focussed on the model fit prior to today, while the plot on the right forecasts the next 28 days.

Short-term Epidemic Scenarios

We make the following short-term projections of healthcare demand and new infections under the following three scenarios:

- **Scenario 1.** The epidemic continues to grow at the current rate.
- **Scenario 2.** Countries will further scale up interventions (either increasing current strategies or implementing new interventions) leading to a further 50% reduction in transmission.
- **Scenario 3.** Countries will relax current interventions by 50%

N.B. These scenarios currently assume that the impact of mobility on transmission will remain the same in the future as it has in the past. We are working to extend methods to estimate the impact of increases in mobility on transmission as lockdown and interventions are reversed. Consequently, projection are likely to represent an upper estimate of the healthcare demand and case load for each scenario

We estimate that over the next 4 weeks demand for hospital beds will change from 30 (95% CI: 26-34) patients requiring treatment with high-pressure oxygen at the current date to 163 (95% CI: 129-197) hospital beds being required on 2020-08-04 if no further interventions are introduced (Scenario 1). Similarly, we estimate that over the next 4 weeks demand for critical care (ICU) beds will change from 8 (95% CI: 7-10) patients requiring treatment with mechanical ventilation at the current date to 43 (95% CI: 34-52) by 2020-08-04. These projections assume that approximately 5% of all infections will require treatment with high-pressure oxygen and that approximately 30% of hospitalised cases will require treatment with mechanical ventilation (based on analysis of ongoing epidemics in Europe). **N.B. These scenarios are unlikely to show significant differences for the first week since there is a delay of approximately 10 days between infection and hospital admission. Consequently, the effectiveness of a change in policy is likely to be better captured by hospital admission data approximately 2 weeks after the policy change is implemented.**

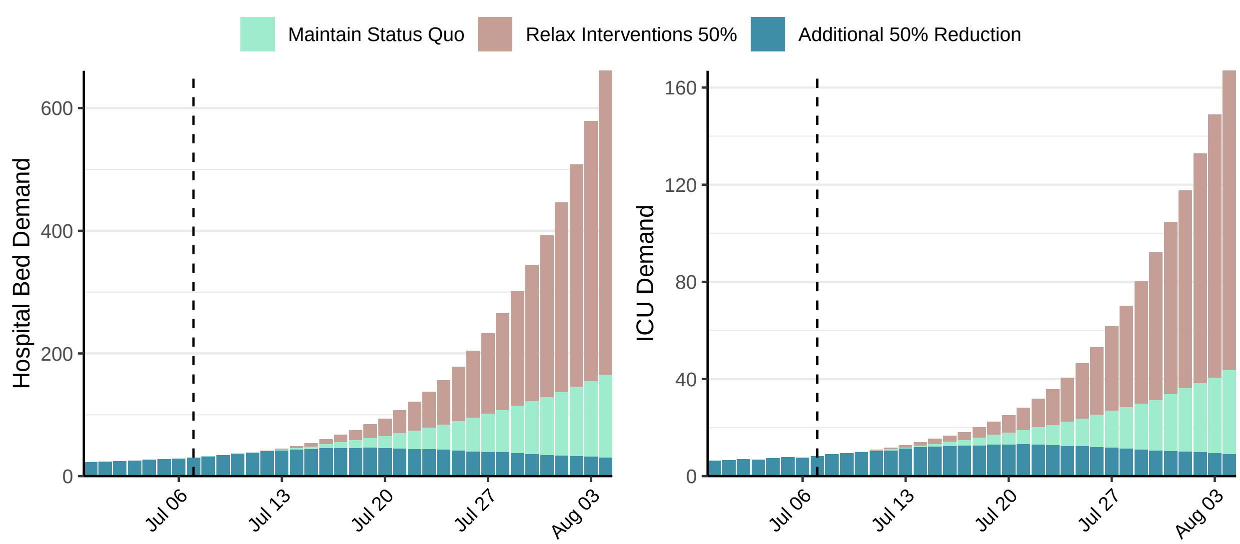

Figure 5: **Healthcare demands in the next 28 days.** Individuals needing an ICU bed are assumed to need mechanical ventilation. Projected demand for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

The impact of each scenario has a more immediate effect on the daily number of infections. The figure below shows the impact of each scenario on the estimated daily incidence of new infections. If interventions are scaled up (Scenario 2), the daily number of infections will change from 244 (95% CI: 204-284) at the current date to 78 (95% CI: 62-95) by 2020-08-04. If current interventions were relaxed by 50%, we estimate the daily number of infections will change from 244 (95% CI: 204-284) at the current date to 9,090 (95% CI: 7,020-11,160) by 2020-08-04.

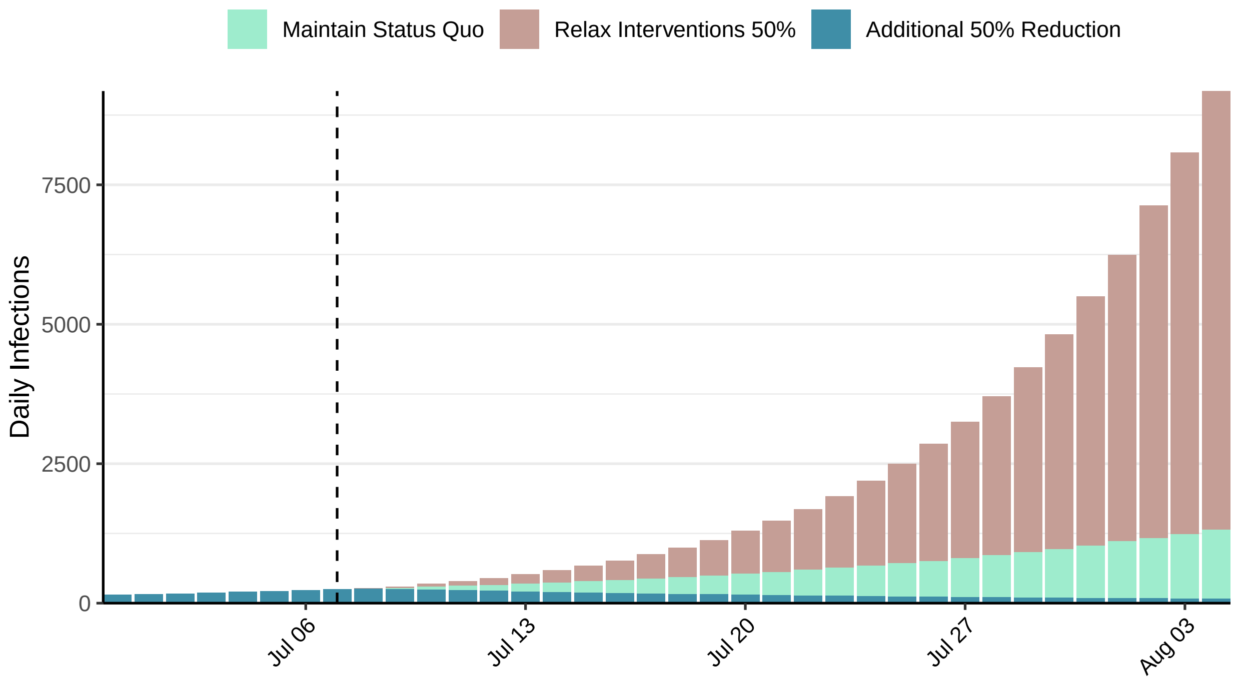

Figure 6: **Daily number of infections estimated by fitting to deaths.** Projected infections for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

To explore different scenarios, we recommend using our COVID-19 Scenario Analysis Tool - https://covidsim.org/, which can be used to simulate different intervention scenarios and explore the long term impact on healthcare demand.

Situation Report for COVID-19: Liberia, 2020-07-07

Download the report for Liberia, 2020-07-07 here. This report uses data from the European Centre for Disease Control. These data are updated daily and whilst there may be a short delay, they are generally consistent with Ministry reports. These data are then used to back-calculate an 'inferred number of COVID-19 infections' using mathematical modelling techniques (see Report 12 for further details) to estimate the number of people that have been infected and to make short-term projections for future healthcare needs.

Epidemiological Situation

Total Reported Cases	New Reported Cases	Total Reported Deaths	New Reported Deaths	Estimated R_t
891	17	39	2	1.03 (95% CI: 0.84-1.16)

The figure below shows the cumulative reported deaths as a function of the time since the 10th death was reported. Dashed lines show the expected trajectory for different doubling times of the epidemic. For example, with a doubling time of 3 days, if there are currently a total of 20 deaths reported, we would expect there to be 40 deaths in total reported in 3 days-time, 80 deaths in 6 days-time, 160 deaths in 9 days-time etc. For most epidemics, in the absence of interventions, we expect a doubling time of 3-4 days for this disease.

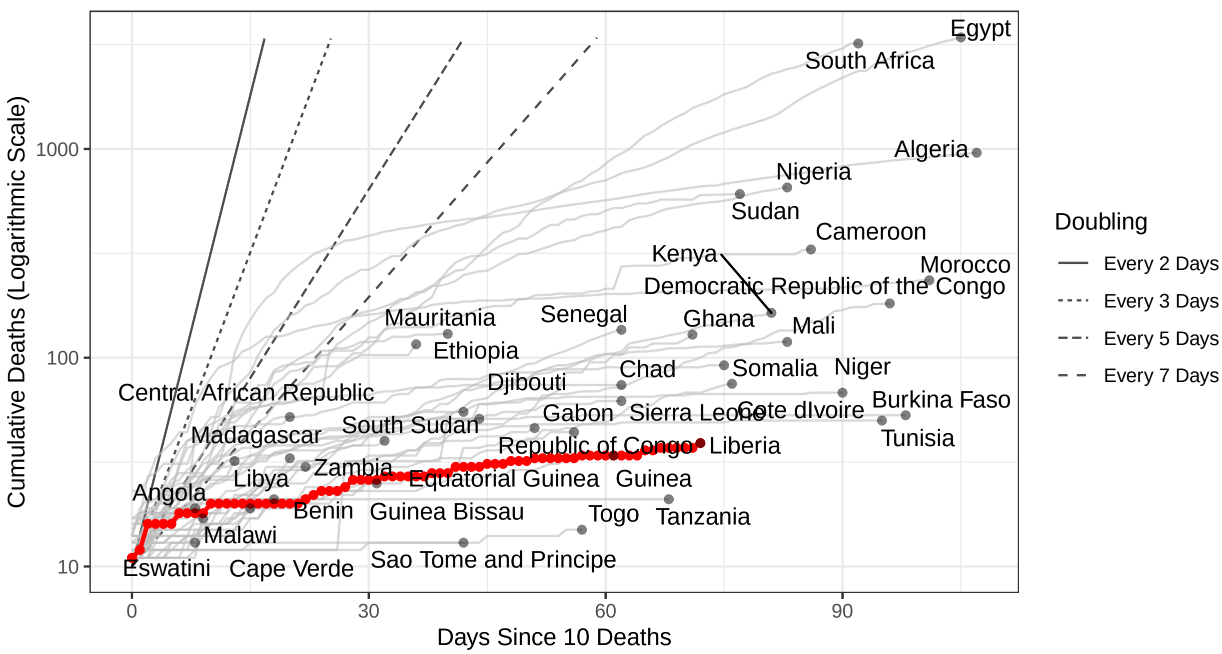

Figure 1: **Cumulative Deaths since 10 deaths.** Country not shown if fewer than 10 deaths.

COVID-19 Transmission Modelling

We assume that the deaths reported to date provide the best indication of the stage of the epidemic, as deaths are more consistently and accurately reported. Our current working estimate is that 1 death indicates that approximately 100 people will have been infected with the other 99 recovering (based on an infection fatality ratio of ~1%). These infections will have happened approximately 21 days previously – capturing a 5-day period from infection to onset of symptoms (the incubation period), 4 days from onset of symptoms to hospitalisation, and 12 days in hospital before death. With a 3-day doubling time, 100 infections that occurred 15 days ago will have generated 200 infections 12 days ago, 400 infections 9 days ago, 800 infections 6 days ago and 1,600 infections 3 days ago resulting in approximately 3,200 infections at the time the first death is observed.

To explore this, we fit our age-structured SEIR model (see Methods) to the time series of deaths in a country, in order to estimate the start date of the epidemic and the baseline R0. We assume that 100% of COVID-19 related deaths have been reported. We have also included the impact of interventions that have been put in place and their effect on human mobility and transmission based on the Google COVID-19 Community Mobility Reports. Using our mathematical model that formalises this approach, we estimate that there has been a total of 4,492 (95% CI: 3,907-5,077) infections over the past 4 weeks.

The figure below shows the estimated number of people infected over the past 4 weeks. The bar charts show, for comparison, the number of reported cases. The right-hand plot shows these data on a different scale as the estimated infections are likely to be much larger than the reported cases. **Importantly**, the estimated infections includes both asymptomatic and mild cases that would not necessarily be identified through surveillance. Consequently, the estimated infections are likely to be significantly higher than the reported cases (see our FAQ for further explanation of these differences and why the reported cases and estimated infections are unlikely to match).

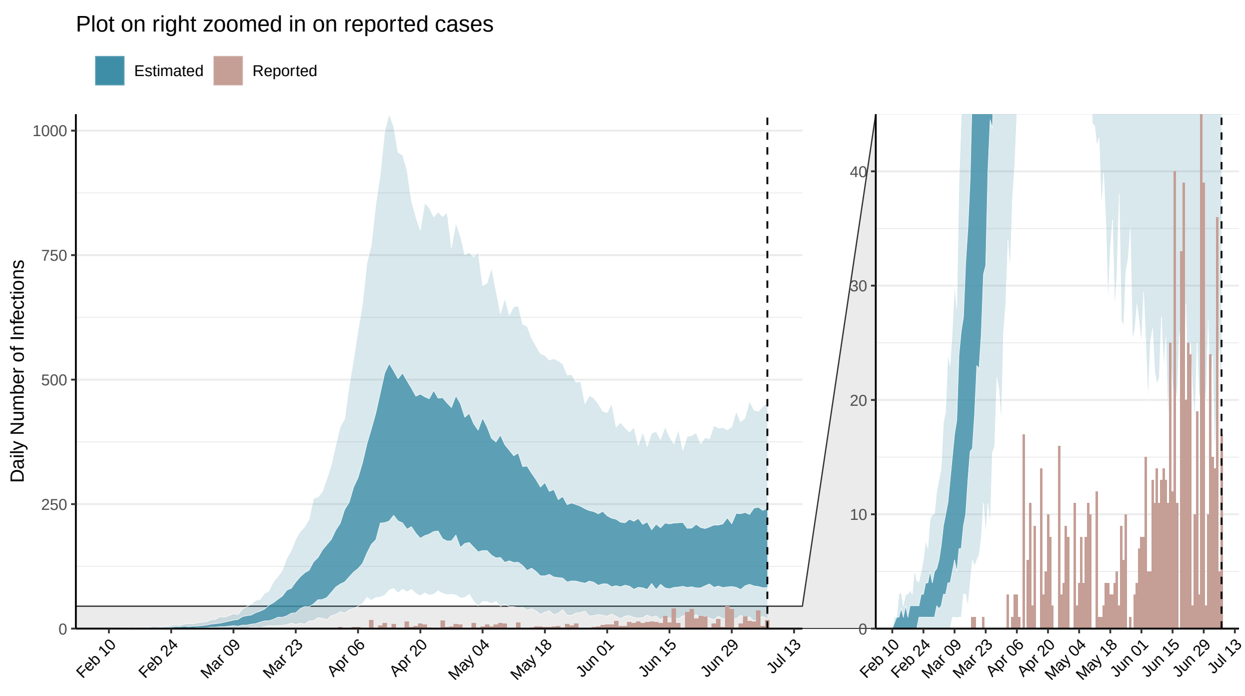

Figure 2: **Daily number of infections estimated by fitting to the current total of deaths.** Reported cases are shown in red. Model estimated infections are shown in blue (dark blue 50% interquartile range, light blue 95% quantile). The dashed line shows the current day.

By fitting to the time series of deaths, we are able to estimate a time-varying reproduction number, R_t. R_t is the the average number of secondary infections caused by a single infected person at a given time. If R_t is above 1, the rate of transmission is increasing and the number of new infections is increasing. R_t is assumed to change in relation to mobility fall in proportion. When fitting our model we assume that 100% of COVID-19 related deaths have been reported (please see our FAQ section for more information about this assumption). We also assume a fixed date at which the impact of mobility on transmission changes from pre-lockdown levels to post-lockdown levels, which may cause large changes in Rt. We are working to refine how this switch occurs and to formally calculate its shape.

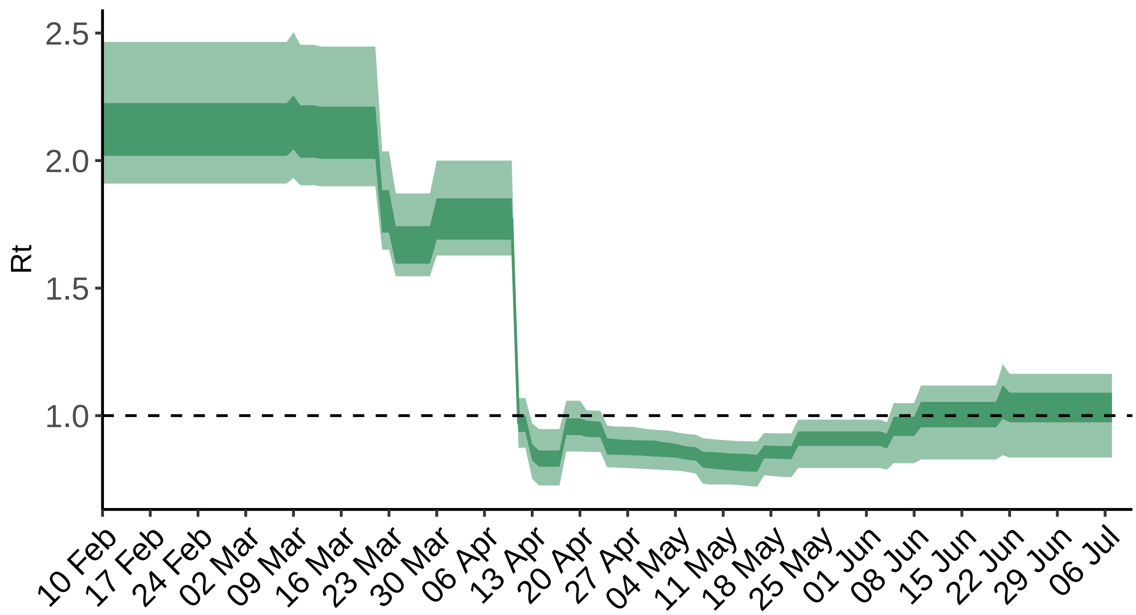

Figure 3: **Time-varying reproduction number, R_t.** R_t is the average number of secondary infections caused by a single infected person at time equal to t. $R_t < 1$ indicates a slowing epidemic in which new infections are not increasing. $R_t > 1$ indicates a growing epidemic in which new infections are increasing over time. Dark green shows the 50% CI and light green shows the 95% CI.

Using the model fit, we can forecast the expected trajectory for cumulative deaths, which is shown in the figure below. This assumes a severity pattern by age that is consistent with that observed in China, Europe and the U.S to date. This projection assumes that transmission is maintained at the current level of transmission as estimated by the final R_t value.

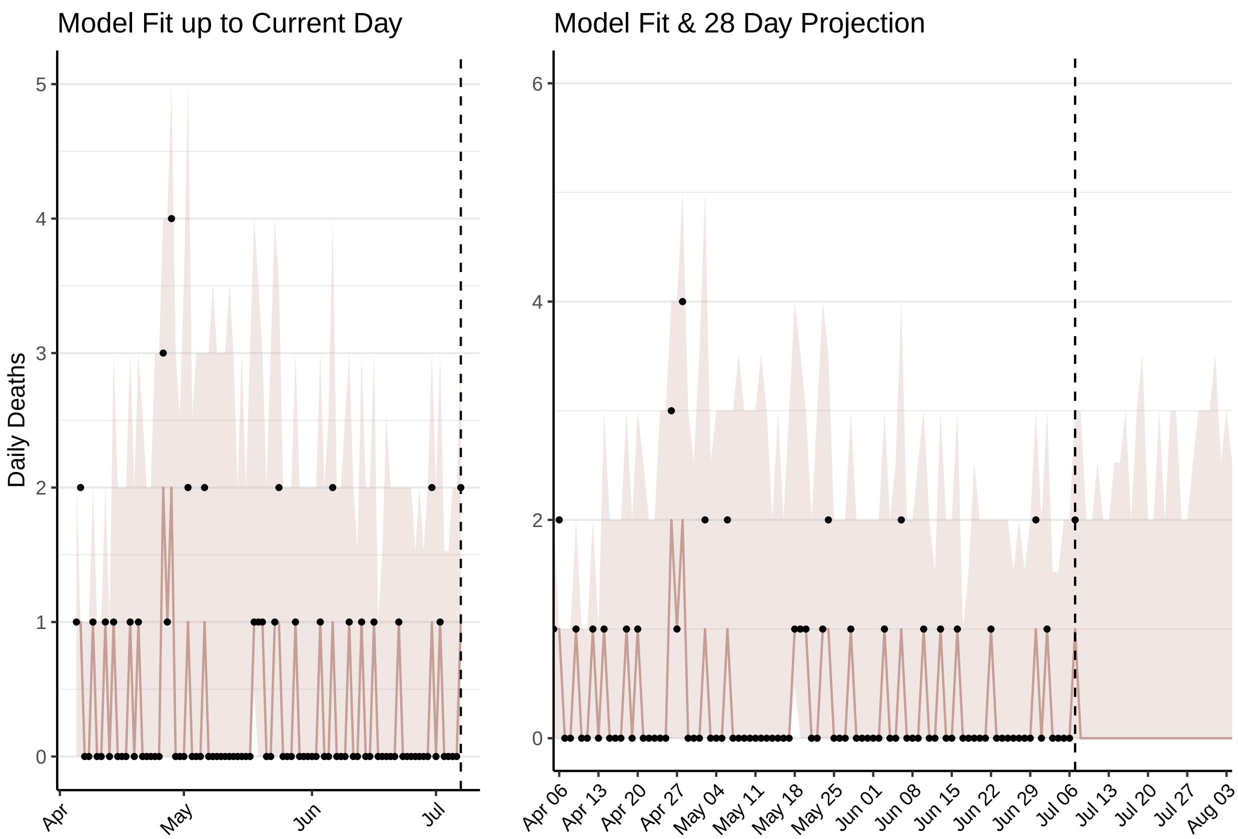

Figure 4: **Estimated daily deaths.** Projected deaths assuming the current level of interventions are maintained are shown in red (median and 95% quantile). Reported deaths are plotted in black. The plot on the left is focussed on the model fit prior to today, while the plot on the right forecasts the next 28 days.

Short-term Epidemic Scenarios

We make the following short-term projections of healthcare demand and new infections under the following three scenarios:

- **Scenario 1.** The epidemic continues to grow at the current rate.
- **Scenario 2.** Countries will further scale up interventions (either increasing current strategies or implementing new interventions) leading to a further 50% reduction in transmission.
- **Scenario 3.** Countries will relax current interventions by 50%

N.B. These scenarios currently assume that the impact of mobility on transmission will remain the same in the future as it has in the past. We are working to extend methods to estimate the impact of increases in mobility on transmission as lockdown and interventions are reversed. Consequently, projection are likely to represent an upper estimate of the healthcare demand and case load for each scenario

We estimate that over the next 4 weeks demand for hospital beds will change from 24 (95% CI: 21-28) patients requiring treatment with high-pressure oxygen at the current date to 32 (95% CI: 26-37) hospital beds being required on 2020-08-04 if no further interventions are introduced (Scenario 1). Similarly, we estimate that over the next 4 weeks demand for critical care (ICU) beds will change from 7 (95% CI: 6-9) patients requiring treatment with mechanical ventilation at the current date to 8 (95% CI: 7-10) by 2020-08-04. These projections assume that approximately 5% of all infections will require treatment with high-pressure oxygen and that approximately 30% of hospitalised cases will require treatment with mechanical ventilation (based on analysis of ongoing epidemics in Europe). **N.B. These scenarios are unlikely to show significant differences for the first week since there is a delay of approximately 10 days between infection and hospital admission. Consequently, the effectiveness of a change in policy is likely to be better captured by hospital admission data approximately 2 weeks after the policy change is implemented.**

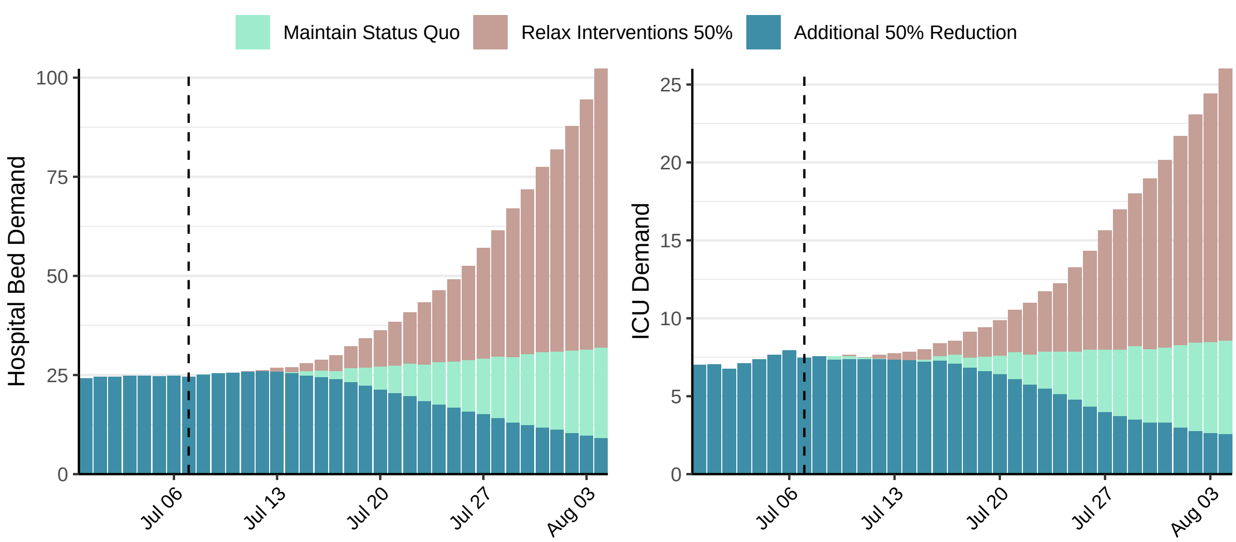

Figure 5: **Healthcare demands in the next 28 days.** Individuals needing an ICU bed are assumed to need mechanical ventilation. Projected demand for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

The impact of each scenario has a more immediate effect on the daily number of infections. The figure below shows the impact of each scenario on the estimated daily incidence of new infections. If interventions are scaled up (Scenario 2), the daily number of infections will change from 177 (95% CI: 151-203) at the current date to 18 (95% CI: 15-22) by 2020-08-04. If current interventions were relaxed by 50%, we estimate the daily number of infections will change from 177 (95% CI: 151-203) at the current date to 1,396 (95% CI: 1,144-1,648) by 2020-08-04.

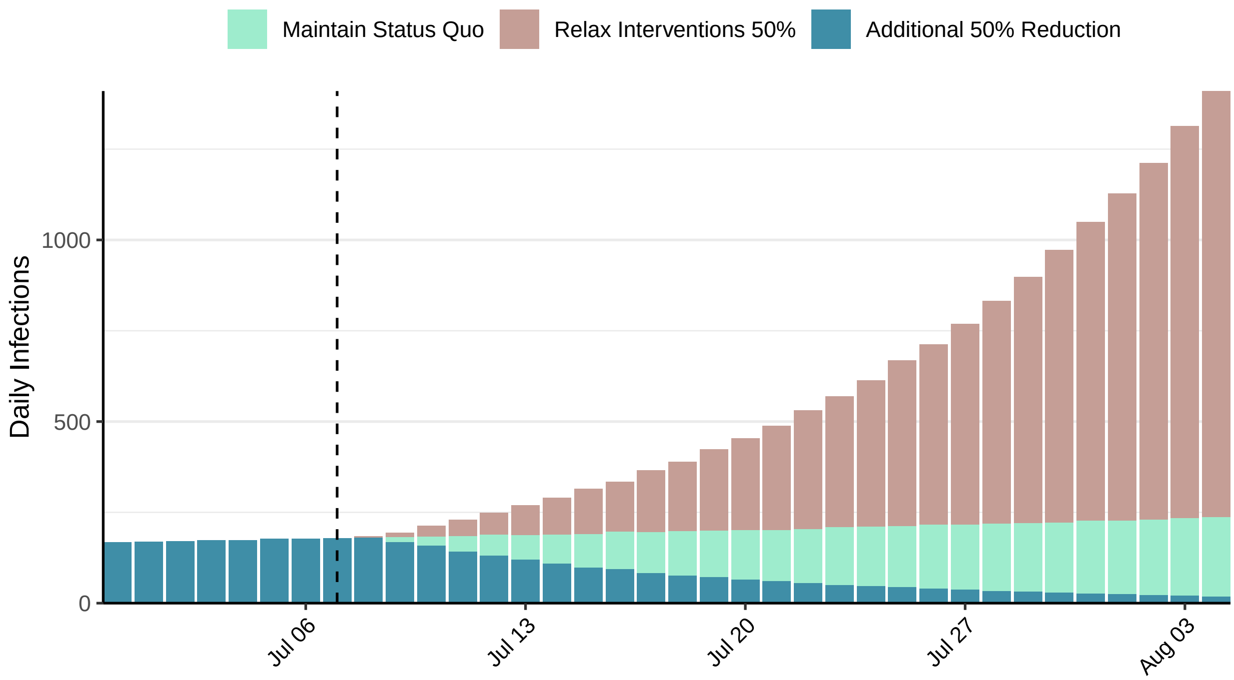

Figure 6: **Daily number of infections estimated by fitting to deaths.** Projected infections for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

To explore different scenarios, we recommend using our COVID-19 Scenario Analysis Tool - https://covidsim.org/, which can be used to simulate different intervention scenarios and explore the long term impact on healthcare demand.

Situation Report for COVID-19: Libya, 2020-07-07

Download the report for Libya, 2020-07-07 here. This report uses data from the European Centre for Disease Control. These data are updated daily and whilst there may be a short delay, they are generally consistent with Ministry reports. These data are then used to back-calculate an 'inferred number of COVID-19 infections' using mathematical modelling techniques (see Report 12 for further details) to estimate the number of people that have been infected and to make short-term projections for future healthcare needs.

Epidemiological Situation

Total Reported Cases	New Reported Cases	Total Reported Deaths	New Reported Deaths	Estimated R_t
1,046	57	32	5	1.6 (95% CI: 1.41-1.83)

The figure below shows the cumulative reported deaths as a function of the time since the 10th death was reported. Dashed lines show the expected trajectory for different doubling times of the epidemic. For example, with a doubling time of 3 days, if there are currently a total of 20 deaths reported, we would expect there to be 40 deaths in total reported in 3 days-time, 80 deaths in 6 days-time, 160 deaths in 9 days-time etc. For most epidemics, in the absence of interventions, we expect a doubling time of 3-4 days for this disease.

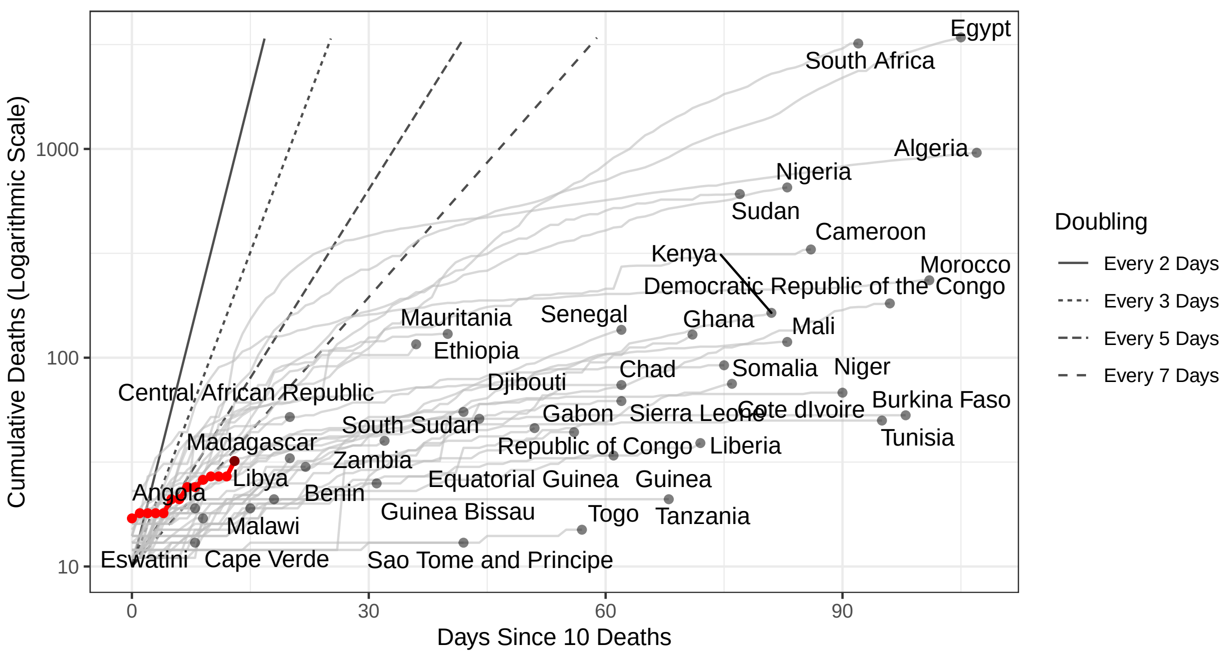

Figure 1: **Cumulative Deaths since 10 deaths.** Country not shown if fewer than 10 deaths.

COVID-19 Transmission Modelling

We assume that the deaths reported to date provide the best indication of the stage of the epidemic, as deaths are more consistently and accurately reported. Our current working estimate is that 1 death indicates that approximately 100 people will have been infected with the other 99 recovering (based on an infection fatality ratio of ~1%). These infections will have happened approximately 21 days previously – capturing a 5-day period from infection to onset of symptoms (the incubation period), 4 days from onset of symptoms to hospitalisation, and 12 days in hospital before death. With a 3-day doubling time, 100 infections that occurred 15 days ago will have generated 200 infections 12 days ago, 400 infections 9 days ago, 800 infections 6 days ago and 1,600 infections 3 days ago resulting in approximately 3,200 infections at the time the first death is observed.

To explore this, we fit our age-structured SEIR model (see Methods) to the time series of deaths in a country, in order to estimate the start date of the epidemic and the baseline R0. We assume that 100% of COVID-19 related deaths have been reported. We have also included the impact of interventions that have been put in place and their effect on human mobility and transmission based on the Google COVID-19 Community Mobility Reports. Using our mathematical model that formalises this approach, we estimate that there has been a total of 19,789 (95% CI: 16,922-22,657) infections over the past 4 weeks.

The figure below shows the estimated number of people infected over the past 4 weeks. The bar charts show, for comparison, the number of reported cases. The right-hand plot shows these data on a different scale as the estimated infections are likely to be much larger than the reported cases. **Importantly**, the estimated infections includes both asymptomatic and mild cases that would not necessarily be identified through surveillance. Consequently, the estimated infections are likely to be significantly higher than the reported cases (see our FAQ for further explanation of these differences and why the reported cases and estimated infections are unlikely to match).

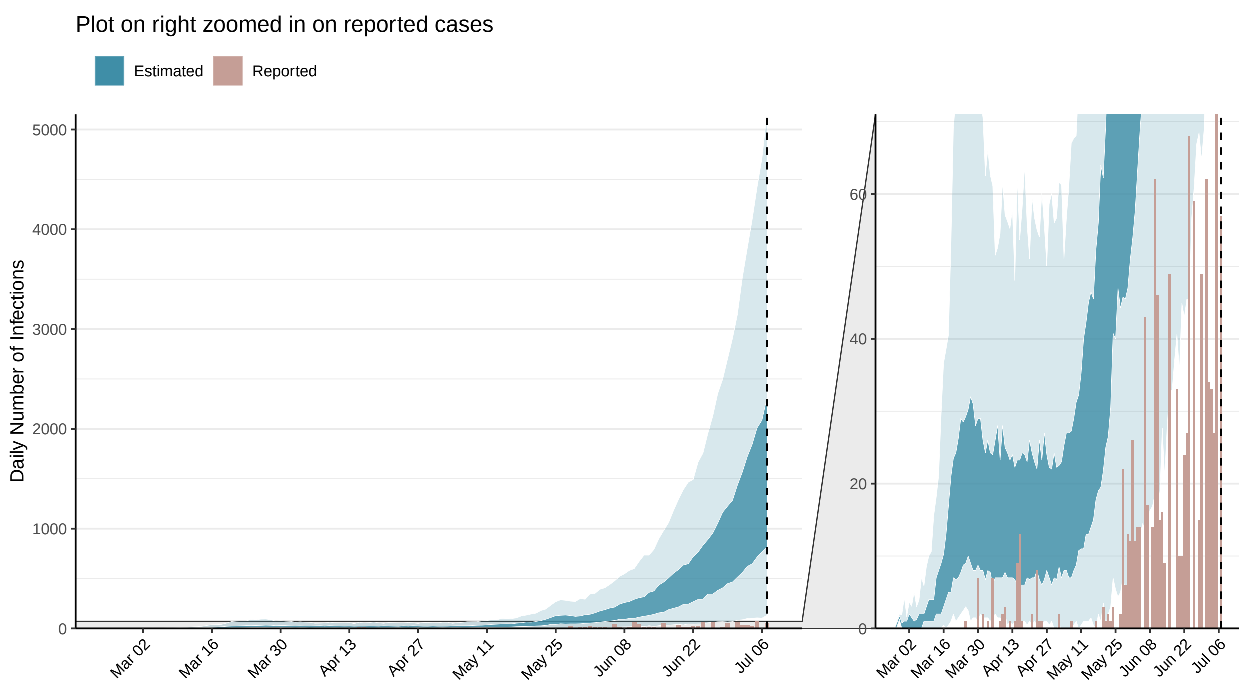

Figure 2: **Daily number of infections estimated by fitting to the current total of deaths.** Reported cases are shown in red. Model estimated infections are shown in blue (dark blue 50% interquartile range, light blue 95% quantile). The dashed line shows the current day.

By fitting to the time series of deaths, we are able to estimate a time-varying reproduction number, R_t. R_t is the the average number of secondary infections caused by a single infected person at a given time. If R_t is above 1, the rate of transmission is increasing and the number of new infections is increasing. R_t is assumed to change in relation to mobility fall in proportion. When fitting our model we assume that 100% of COVID-19 related deaths have been reported (please see our FAQ section for more information about this assumption). We also assume a fixed date at which the impact of mobility on transmission changes from pre-lockdown levels to post-lockdown levels, which may cause large changes in Rt. We are working to refine how this switch occurs and to formally calculate its shape.

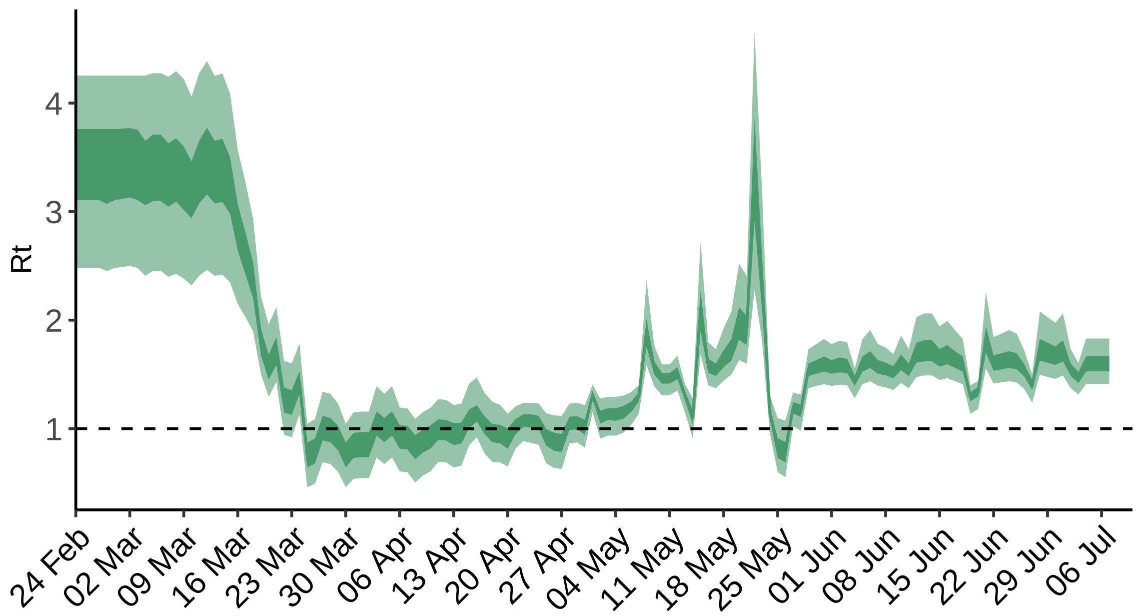

Figure 3: **Time-varying reproduction number, R_t.** R_t is the average number of secondary infections caused by a single infected person at time equal to t. $R_t < 1$ indicates a slowing epidemic in which new infections are not increasing. $R_t > 1$ indicates a growing epidemic in which new infections are increasing over time. Dark green shows the 50% CI and light green shows the 95% CI.

Using the model fit, we can forecast the expected trajectory for cumulative deaths, which is shown in the figure below. This assumes a severity pattern by age that is consistent with that observed in China, Europe and the U.S to date. This projection assumes that transmission is maintained at the current level of transmission as estimated by the final R_t value.

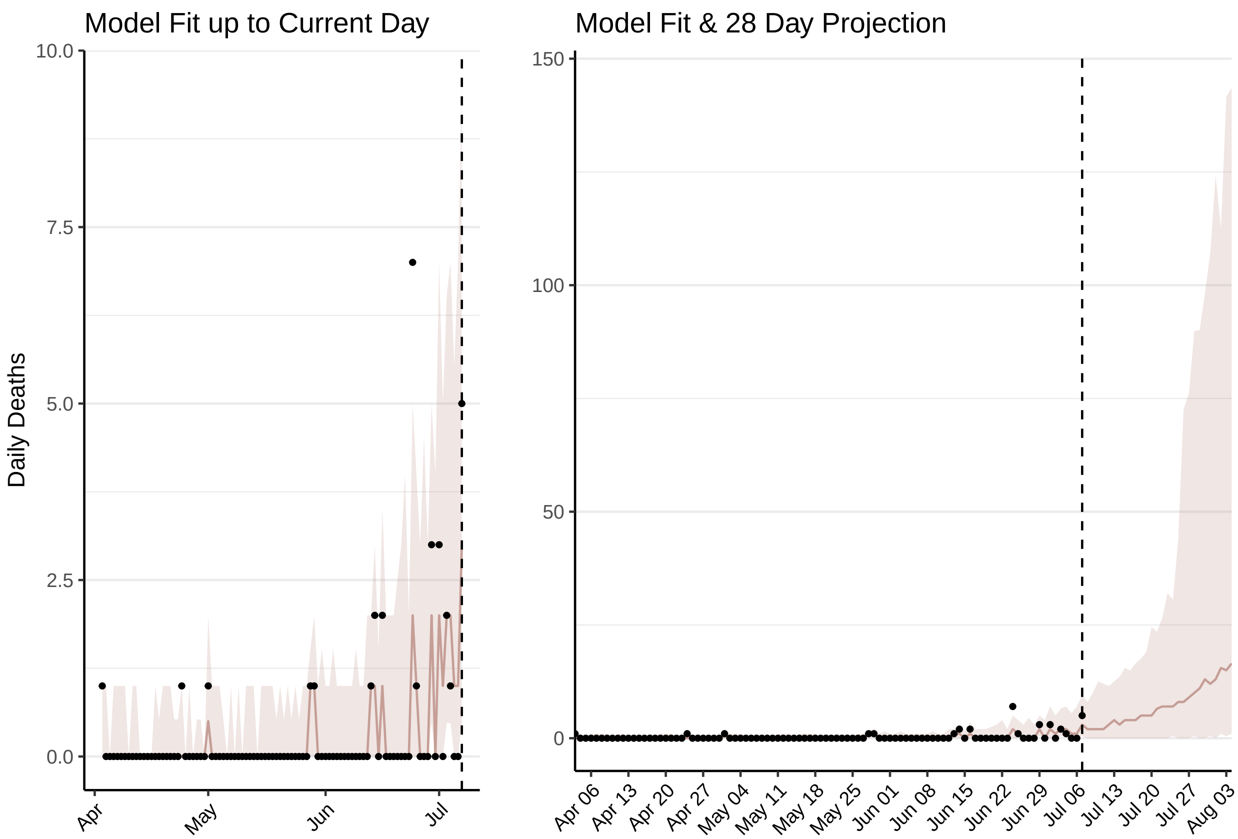

Figure 4: **Estimated daily deaths.** Projected deaths assuming the current level of interventions are maintained are shown in red (median and 95% quantile). Reported deaths are plotted in black. The plot on the left is focussed on the model fit prior to today, while the plot on the right forecasts the next 28 days.

Short-term Epidemic Scenarios

We make the following short-term projections of healthcare demand and new infections under the following three scenarios:

- **Scenario 1.** The epidemic continues to grow at the current rate.
- **Scenario 2.** Countries will further scale up interventions (either increasing current strategies or implementing new interventions) leading to a further 50% reduction in transmission.
- **Scenario 3.** Countries will relax current interventions by 50%

N.B. These scenarios currently assume that the impact of mobility on transmission will remain the same in the future as it has in the past. We are working to extend methods to estimate the impact of increases in mobility on transmission as lockdown and interventions are reversed. Consequently, projection are likely to represent an upper estimate of the healthcare demand and case load for each scenario

We estimate that over the next 4 weeks demand for hospital beds will change from 175 (95% CI: 150-200) patients requiring treatment with high-pressure oxygen at the current date to 1,475 (95% CI: 1,242-1,708) hospital beds being required on 2020-08-04 if no further interventions are introduced (Scenario 1). Similarly, we estimate that over the next 4 weeks demand for critical care (ICU) beds will change from 43 (95% CI: 37-50) patients requiring treatment with mechanical ventilation at the current date to 317 (95% CI: 278-356) by 2020-08-04. These projections assume that approximately 5% of all infections will require treatment with high-pressure oxygen and that approximately 30% of hospitalised cases will require treatment with mechanical ventilation (based on analysis of ongoing epidemics in Europe). **N.B. These scenarios are unlikely to show significant differences for the first week since there is a delay of approximately 10 days between infection and hospital admission. Consequently, the effectiveness of a change in policy is likely to be better captured by hospital admission data approximately 2 weeks after the policy change is implemented.**

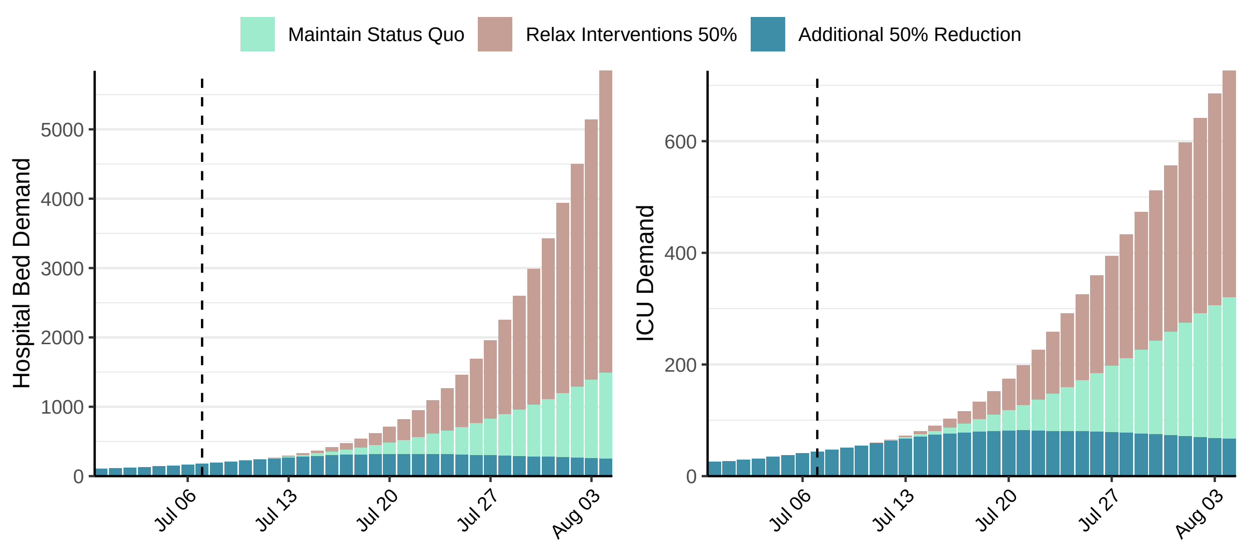

Figure 5: **Healthcare demands in the next 28 days.** Individuals needing an ICU bed are assumed to need mechanical ventilation. Projected demand for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

The impact of each scenario has a more immediate effect on the daily number of infections. The figure below shows the impact of each scenario on the estimated daily incidence of new infections. If interventions are scaled up (Scenario 2), the daily number of infections will change from 1,659 (95% CI: 1,410-1,908) at the current date to 797 (95% CI: 664-931) by 2020-08-04. If current interventions were relaxed by 50%, we estimate the daily number of infections will change from 1,659 (95% CI: 1,410-1,908) at the current date to 79,490 (95% CI: 68,862-90,119) by 2020-08-04.

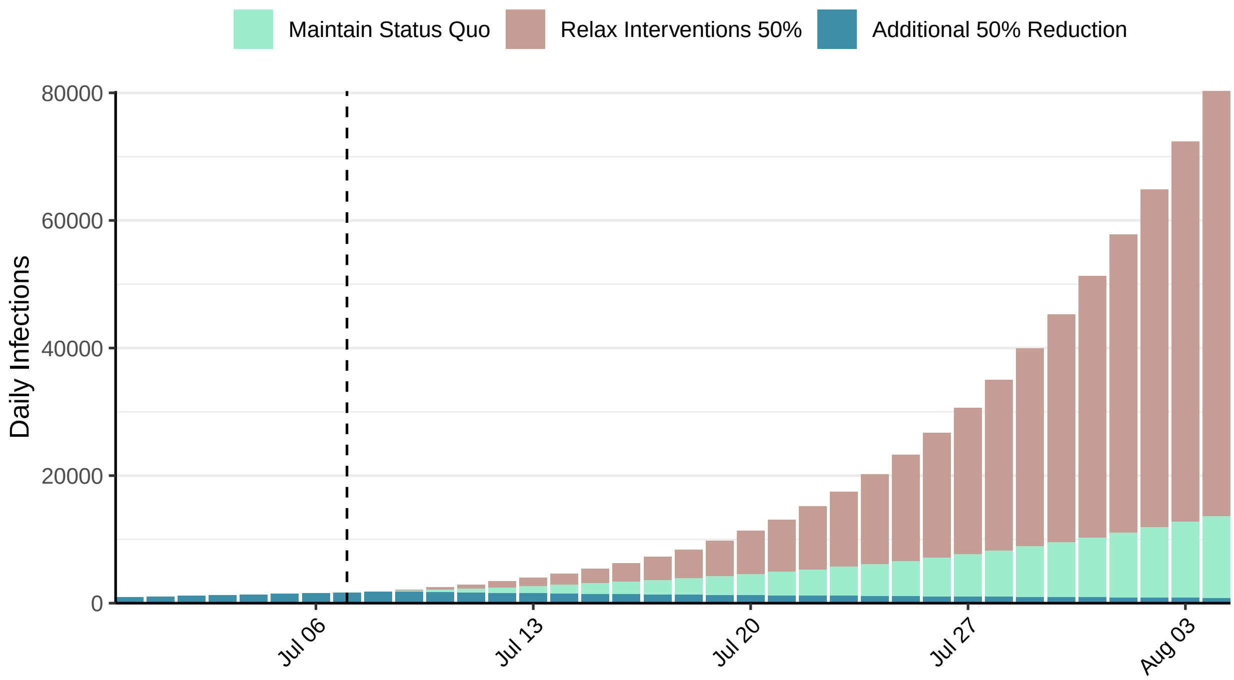

Figure 6: **Daily number of infections estimated by fitting to deaths.** Projected infections for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

To explore different scenarios, we recommend using our COVID-19 Scenario Analysis Tool - https://covidsim.org/, which can be used to simulate different intervention scenarios and explore the long term impact on healthcare demand.

Situation Report for COVID-19: Sri Lanka, 2020-07-07

Download the report for Sri Lanka, 2020-07-07 here. This report uses data from the European Centre for Disease Control. These data are updated daily and whilst there may be a short delay, they are generally consistent with Ministry reports. These data are then used to back-calculate an 'inferred number of COVID-19 infections' using mathematical modelling techniques (see Report 12 for further details) to estimate the number of people that have been infected and to make short-term projections for future healthcare needs.

Epidemiological Situation

Total Reported Cases	New Reported Cases	Total Reported Deaths	New Reported Deaths	Estimated R_t
2,078	2	11	0	0.78 (95% CI: 0.37-1.51)

The figure below shows the cumulative reported deaths as a function of the time since the 10th death was reported. Dashed lines show the expected trajectory for different doubling times of the epidemic. For example, with a doubling time of 3 days, if there are currently a total of 20 deaths reported, we would expect there to be 40 deaths in total reported in 3 days-time, 80 deaths in 6 days-time, 160 deaths in 9 days-time etc. For most epidemics, in the absence of interventions, we expect a doubling time of 3-4 days for this disease.

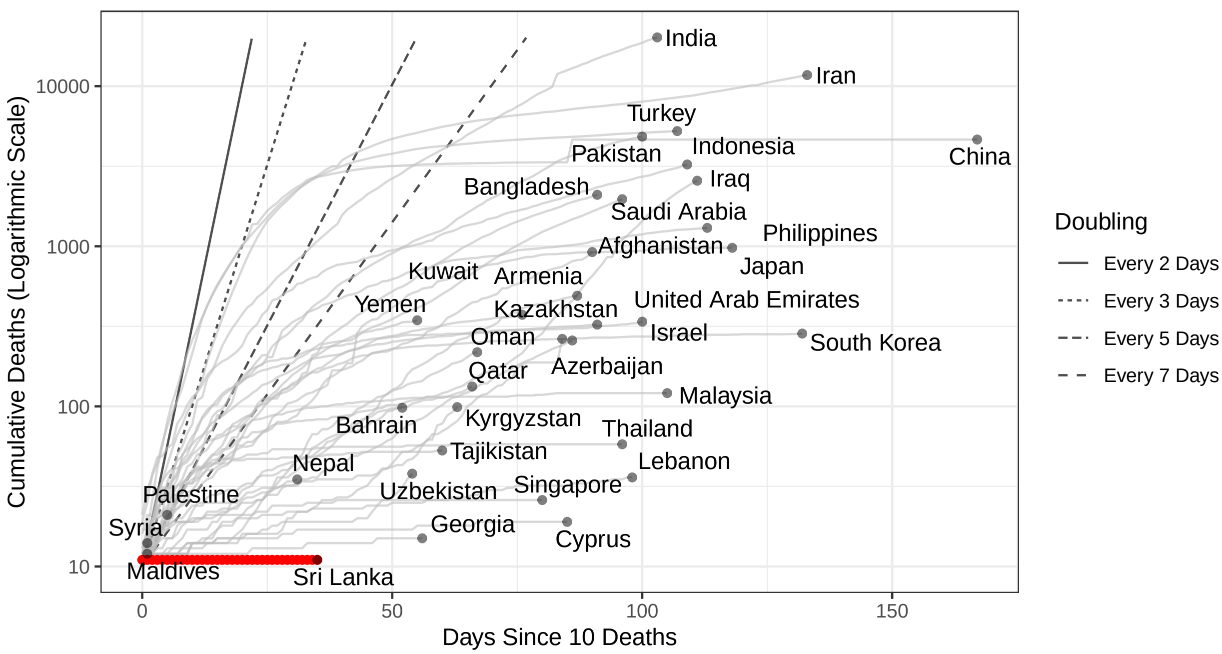

Figure 1: **Cumulative Deaths since 10 deaths.** Country not shown if fewer than 10 deaths.

COVID-19 Transmission Modelling

We assume that the deaths reported to date provide the best indication of the stage of the epidemic, as deaths are more consistently and accurately reported. Our current working estimate is that 1 death indicates that approximately 100 people will have been infected with the other 99 recovering (based on an infection fatality ratio of ~1%). These infections will have happened approximately 21 days previously – capturing a 5-day period from infection to onset of symptoms (the incubation period), 4 days from onset of symptoms to hospitalisation, and 12 days in hospital before death. With a 3-day doubling time, 100 infections that occurred 15 days ago will have generated 200 infections 12 days ago, 400 infections 9 days ago, 800 infections 6 days ago and 1,600 infections 3 days ago resulting in approximately 3,200 infections at the time the first death is observed.

To explore this, we fit our age-structured SEIR model (see Methods) to the time series of deaths in a country, in order to estimate the start date of the epidemic and the baseline R0. We assume that 100% of COVID-19 related deaths have been reported. We have also included the impact of interventions that have been put in place and their effect on human mobility and transmission based on the Google COVID-19 Community Mobility Reports. Using our mathematical model that formalises this approach, we estimate that there has been a total of 82 (95% CI: 49-115) infections over the past 4 weeks.

The figure below shows the estimated number of people infected over the past 4 weeks. The bar charts show, for comparison, the number of reported cases. The right-hand plot shows these data on a different scale as the estimated infections are likely to be much larger than the reported cases. **Importantly**, the estimated infections includes both asymptomatic and mild cases that would not necessarily be identified through surveillance. Consequently, the estimated infections are likely to be significantly higher than the reported cases (see our FAQ for further explanation of these differences and why the reported cases and estimated infections are unlikely to match).

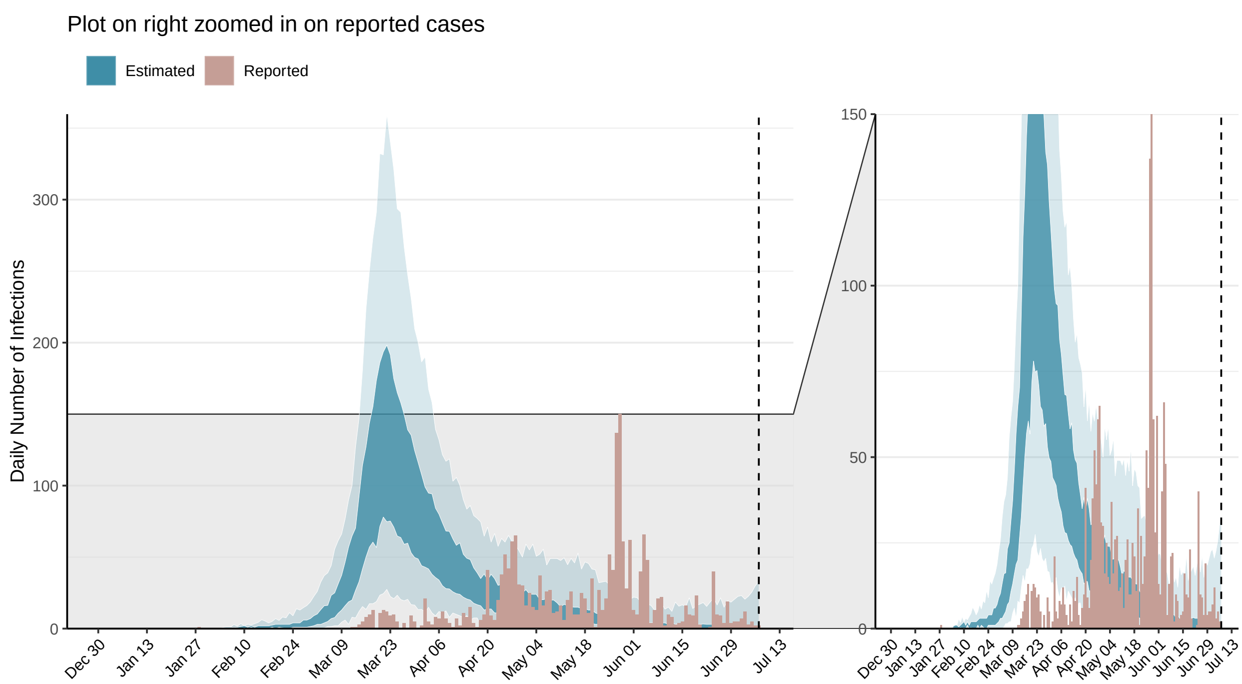

Figure 2: **Daily number of infections estimated by fitting to the current total of deaths.** Reported cases are shown in red. Model estimated infections are shown in blue (dark blue 50% interquartile range, light blue 95% quantile). The dashed line shows the current day.

By fitting to the time series of deaths, we are able to estimate a time-varying reproduction number, R_t. R_t is the the average number of secondary infections caused by a single infected person at a given time. If R_t is above 1, the rate of transmission is increasing and the number of new infections is increasing. R_t is assumed to change in relation to mobility fall in proportion. When fitting our model we assume that 100% of COVID-19 related deaths have been reported (please see our FAQ section for more information about this assumption). We also assume a fixed date at which the impact of mobility on transmission changes from pre-lockdown levels to post-lockdown levels, which may cause large changes in Rt. We are working to refine how this switch occurs and to formally calculate its shape.

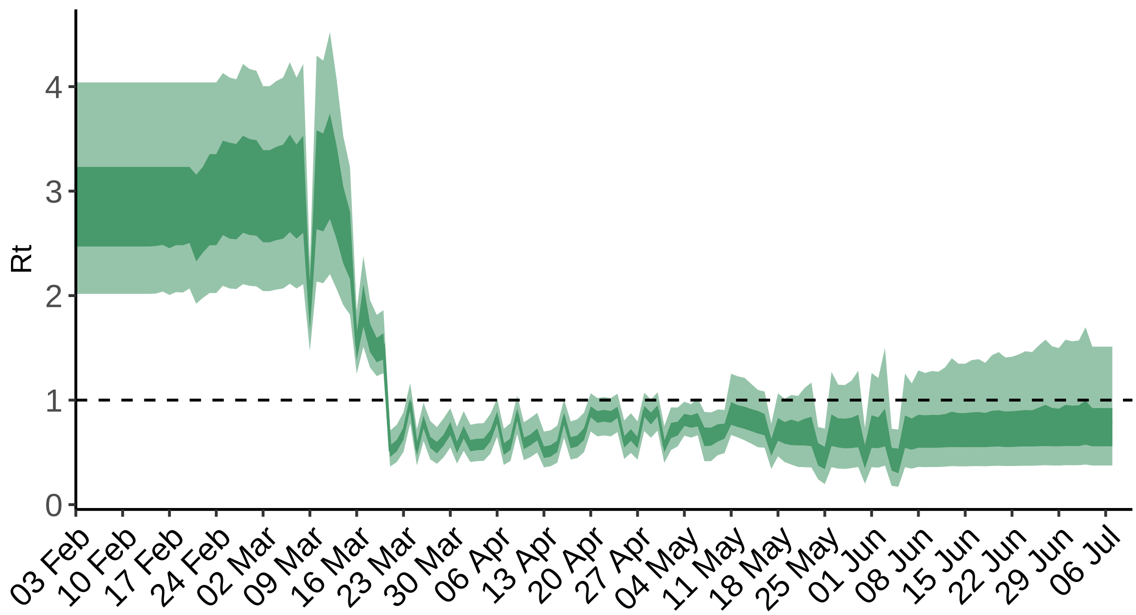

Figure 3: **Time-varying reproduction number, R_t.** R_t is the average number of secondary infections caused by a single infected person at time equal to t. $R_t < 1$ indicates a slowing epidemic in which new infections are not increasing. $R_t > 1$ indicates a growing epidemic in which new infections are increasing over time. Dark green shows the 50% CI and light green shows the 95% CI.

Using the model fit, we can forecast the expected trajectory for cumulative deaths, which is shown in the figure below. This assumes a severity pattern by age that is consistent with that observed in China, Europe and the U.S to date. This projection assumes that transmission is maintained at the current level of transmission as estimated by the final R_t value.

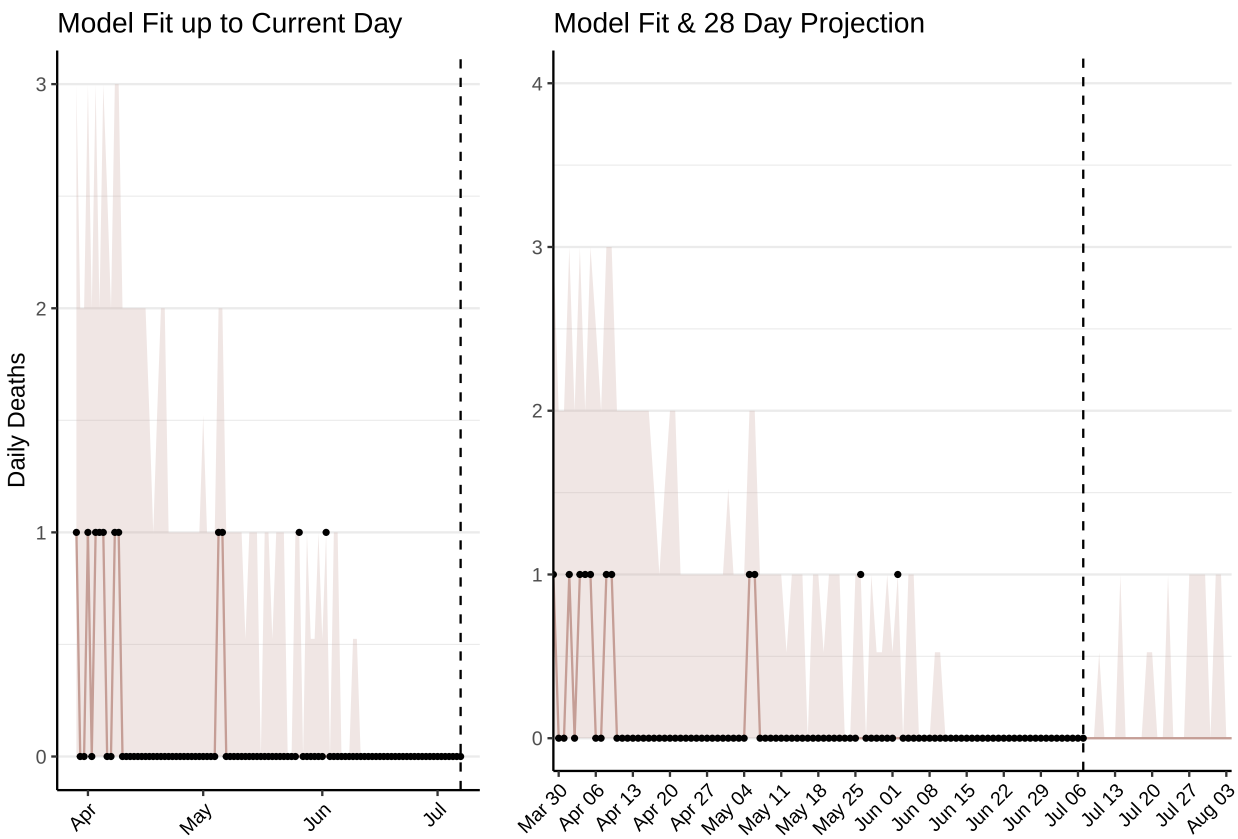

Figure 4: **Estimated daily deaths.** Projected deaths assuming the current level of interventions are maintained are shown in red (median and 95% quantile). Reported deaths are plotted in black. The plot on the left is focussed on the model fit prior to today, while the plot on the right forecasts the next 28 days.

Short-term Epidemic Scenarios

We make the following short-term projections of healthcare demand and new infections under the following three scenarios:

- **Scenario 1.** The epidemic continues to grow at the current rate.
- **Scenario 2.** Countries will further scale up interventions (either increasing current strategies or implementing new interventions) leading to a further 50% reduction in transmission.
- **Scenario 3.** Countries will relax current interventions by 50%

N.B. These scenarios currently assume that the impact of mobility on transmission will remain the same in the future as it has in the past. We are working to extend methods to estimate the impact of increases in mobility on transmission as lockdown and interventions are reversed. Consequently, projection are likely to represent an upper estimate of the healthcare demand and case load for each scenario

We estimate that over the next 4 weeks demand for hospital beds will change from 1 (95% CI: 0-1) patients requiring treatment with high-pressure oxygen at the current date to 2 (95% CI: 1-4) hospital beds being required on 2020-08-04 if no further interventions are introduced (Scenario 1). Similarly, we estimate that over the next 4 weeks demand for critical care (ICU) beds will change from 0 (95% CI: 0-0) patients requiring treatment with mechanical ventilation at the current date to 1 (95% CI: 0-1) by 2020-08-04. These projections assume that approximately 5% of all infections will require treatment with high-pressure oxygen and that approximately 30% of hospitalised cases will require treatment with mechanical ventilation (based on analysis of ongoing epidemics in Europe). **N.B. These scenarios are unlikely to show significant differences for the first week since there is a delay of approximately 10 days between infection and hospital admission. Consequently, the effectiveness of a change in policy is likely to be better captured by hospital admission data approximately 2 weeks after the policy change is implemented.**

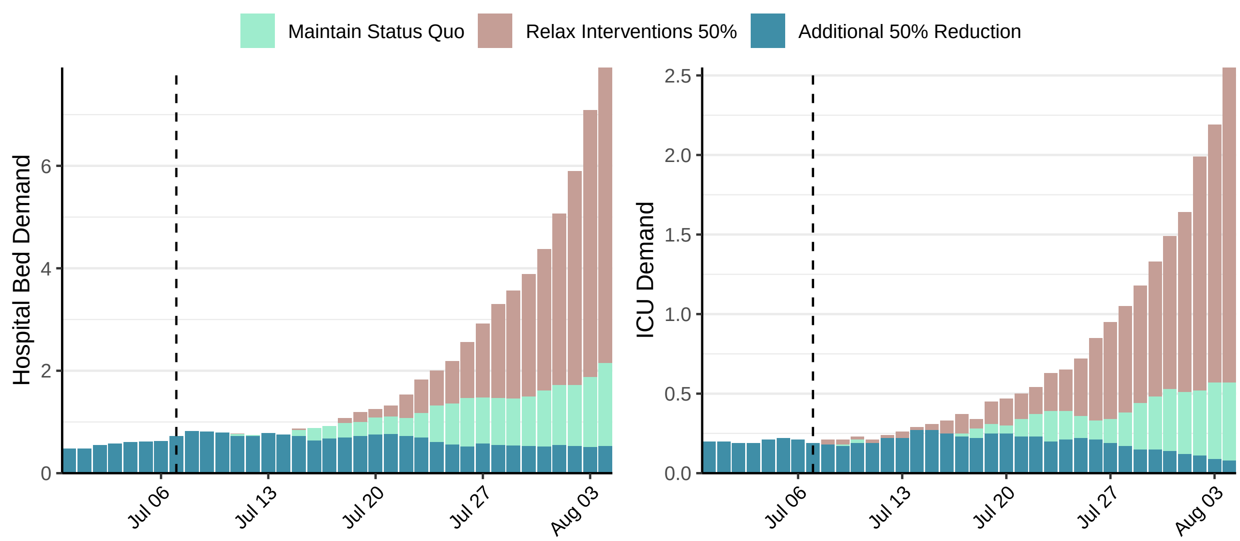

Figure 5: **Healthcare demands in the next 28 days.** Individuals needing an ICU bed are assumed to need mechanical ventilation. Projected demand for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

The impact of each scenario has a more immediate effect on the daily number of infections. The figure below shows the impact of each scenario on the estimated daily incidence of new infections. If interventions are scaled up (Scenario 2), the daily number of infections will change from 4 (95% CI: 2-5) at the current date to 1 (95% CI: 0-2) by 2020-08-04. If current interventions were relaxed by 50%, we estimate the daily number of infections will change from 4 (95% CI: 2-5) at the current date to 117 (95% CI: 14-221) by 2020-08-04.

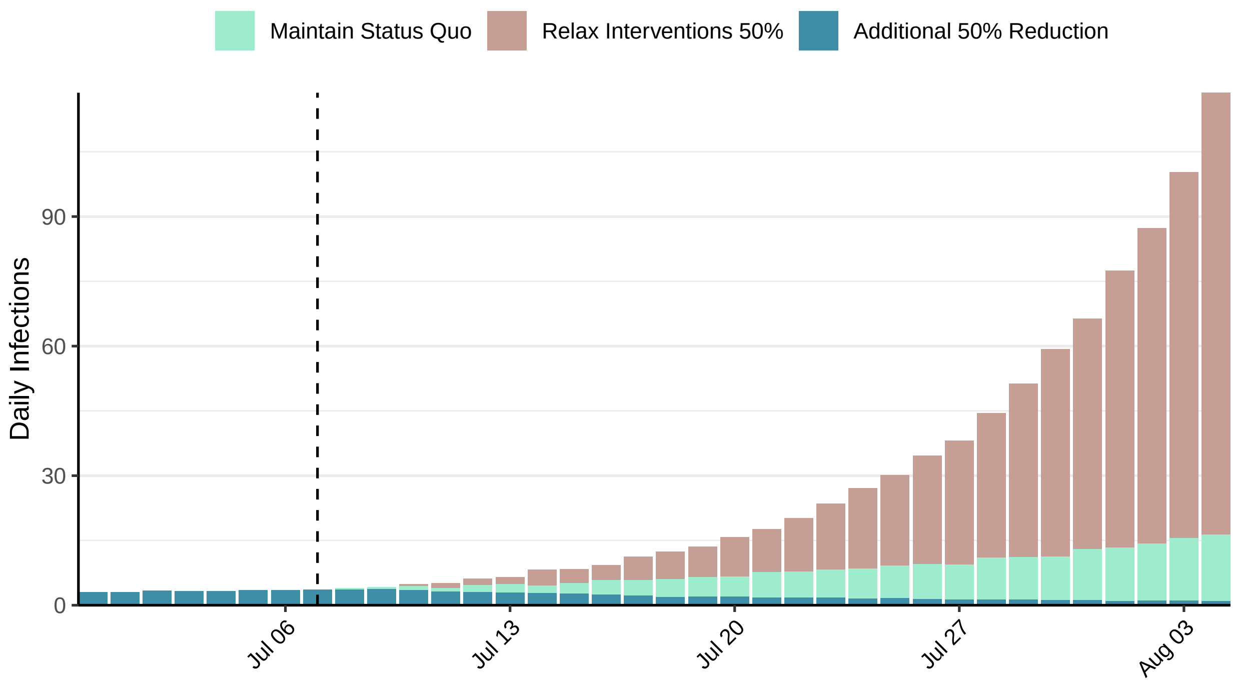

Figure 6: **Daily number of infections estimated by fitting to deaths.** Projected infections for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

To explore different scenarios, we recommend using our COVID-19 Scenario Analysis Tool - https://covidsim.org/, which can be used to simulate different intervention scenarios and explore the long term impact on healthcare demand.

Situation Report for COVID-19: Morocco, 2020-07-07

Download the report for Morocco, 2020-07-07 here. This report uses data from the European Centre for Disease Control. These data are updated daily and whilst there may be a short delay, they are generally consistent with Ministry reports. These data are then used to back-calculate an 'inferred number of COVID-19 infections' using mathematical modelling techniques (see Report 12 for further details) to estimate the number of people that have been infected and to make short-term projections for future healthcare needs.

Epidemiological Situation

Total Reported Cases	New Reported Cases	Total Reported Deaths	New Reported Deaths	Estimated R_t
14,329	114	235	0	2.01 (95% CI: 1.7-2.3)

The figure below shows the cumulative reported deaths as a function of the time since the 10th death was reported. Dashed lines show the expected trajectory for different doubling times of the epidemic. For example, with a doubling time of 3 days, if there are currently a total of 20 deaths reported, we would expect there to be 40 deaths in total reported in 3 days-time, 80 deaths in 6 days-time, 160 deaths in 9 days-time etc. For most epidemics, in the absence of interventions, we expect a doubling time of 3-4 days for this disease.

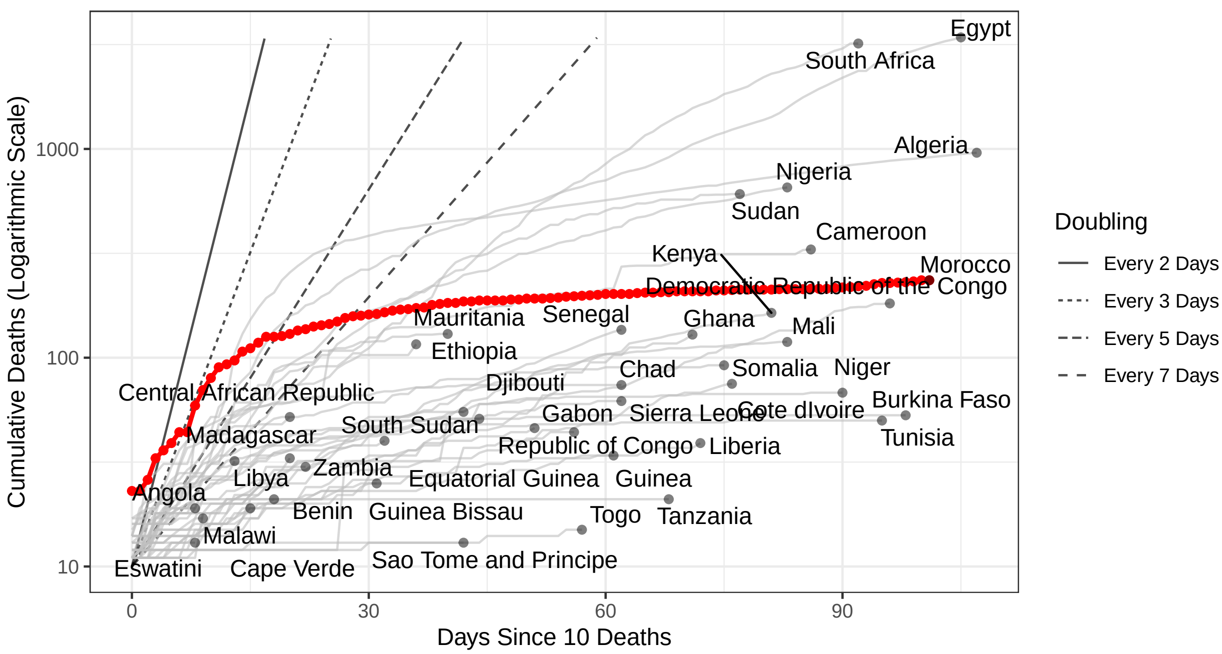

Figure 1: **Cumulative Deaths since 10 deaths.** Country not shown if fewer than 10 deaths.

COVID-19 Transmission Modelling

We assume that the deaths reported to date provide the best indication of the stage of the epidemic, as deaths are more consistently and accurately reported. Our current working estimate is that 1 death indicates that approximately 100 people will have been infected with the other 99 recovering (based on an infection fatality ratio of ~1%). These infections will have happened approximately 21 days previously – capturing a 5-day period from infection to onset of symptoms (the incubation period), 4 days from onset of symptoms to hospitalisation, and 12 days in hospital before death. With a 3-day doubling time, 100 infections that occurred 15 days ago will have generated 200 infections 12 days ago, 400 infections 9 days ago, 800 infections 6 days ago and 1,600 infections 3 days ago resulting in approximately 3,200 infections at the time the first death is observed.

To explore this, we fit our age-structured SEIR model (see Methods) to the time series of deaths in a country, in order to estimate the start date of the epidemic and the baseline R0. We assume that 100% of COVID-19 related deaths have been reported. We have also included the impact of interventions that have been put in place and their effect on human mobility and transmission based on the Google COVID-19 Community Mobility Reports. Using our mathematical model that formalises this approach, we estimate that there has been a total of 20,449 (95% CI: 18,141-22,758) infections over the past 4 weeks.

The figure below shows the estimated number of people infected over the past 4 weeks. The bar charts show, for comparison, the number of reported cases. The right-hand plot shows these data on a different scale as the estimated infections are likely to be much larger than the reported cases. **Importantly**, the estimated infections includes both asymptomatic and mild cases that would not necessarily be identified through surveillance. Consequently, the estimated infections are likely to be significantly higher than the reported cases (see our FAQ for further explanation of these differences and why the reported cases and estimated infections are unlikely to match).

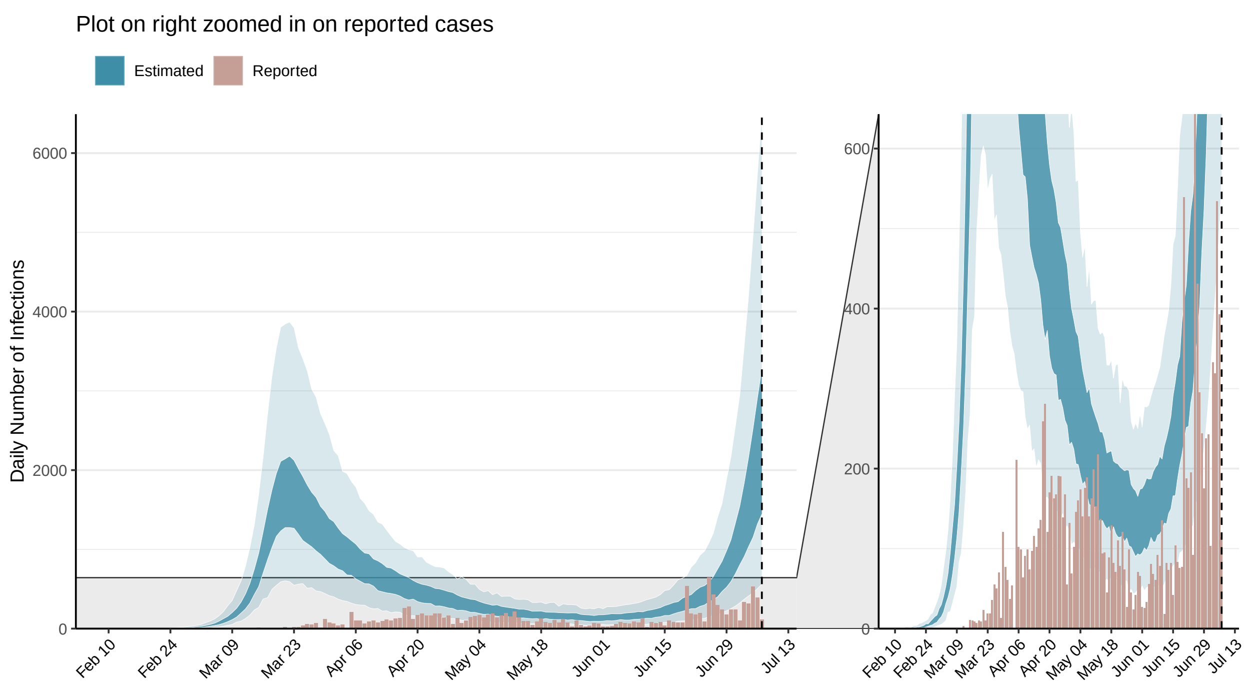

Figure 2: **Daily number of infections estimated by fitting to the current total of deaths.** Reported cases are shown in red. Model estimated infections are shown in blue (dark blue 50% interquartile range, light blue 95% quantile). The dashed line shows the current day.

By fitting to the time series of deaths, we are able to estimate a time-varying reproduction number, R_t. R_t is the the average number of secondary infections caused by a single infected person at a given time. If R_t is above 1, the rate of transmission is increasing and the number of new infections is increasing. R_t is assumed to change in relation to mobility fall in proportion. When fitting our model we assume that 100% of COVID-19 related deaths have been reported (please see our FAQ section for more information about this assumption). We also assume a fixed date at which the impact of mobility on transmission changes from pre-lockdown levels to post-lockdown levels, which may cause large changes in Rt. We are working to refine how this switch occurs and to formally calculate its shape.

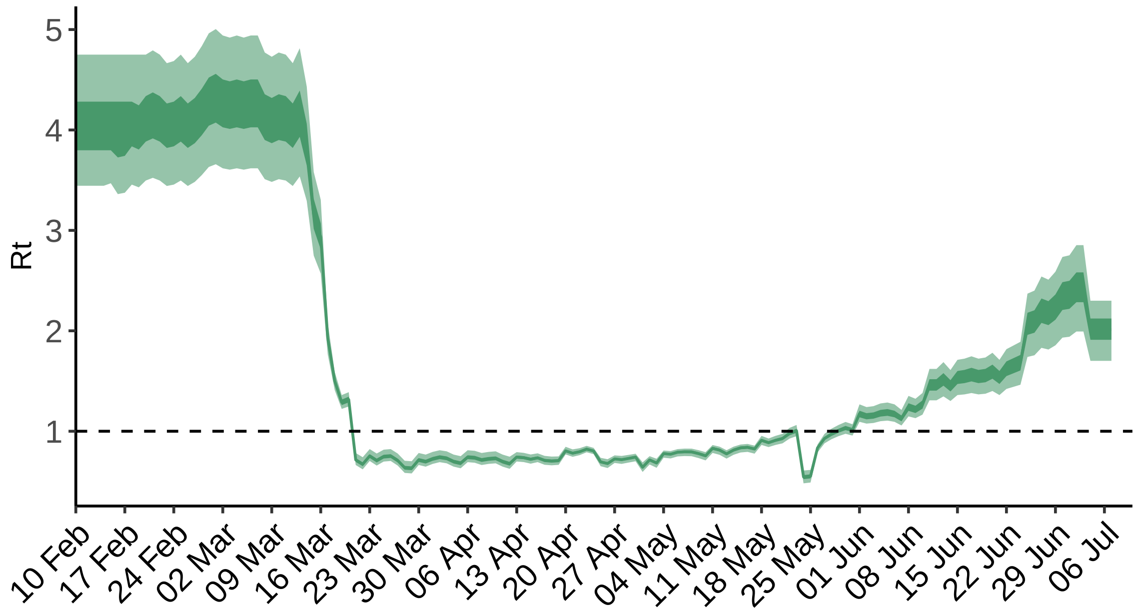

Figure 3: **Time-varying reproduction number, R_t.** R_t is the average number of secondary infections caused by a single infected person at time equal to t. $R_t < 1$ indicates a slowing epidemic in which new infections are not increasing. $R_t > 1$ indicates a growing epidemic in which new infections are increasing over time. Dark green shows the 50% CI and light green shows the 95% CI.

Using the model fit, we can forecast the expected trajectory for cumulative deaths, which is shown in the figure below. This assumes a severity pattern by age that is consistent with that observed in China, Europe and the U.S to date. This projection assumes that transmission is maintained at the current level of transmission as estimated by the final R_t value. **N.B. Morocco is forecast to be close to or surpassing our best estimates for healthcare capacity in the next 28 days.** Estimates of deaths in the next 28 days may be inaccurate due to our working assumptions for mortality in individuals who do not receive appropriate treatment. See our methods for more information.

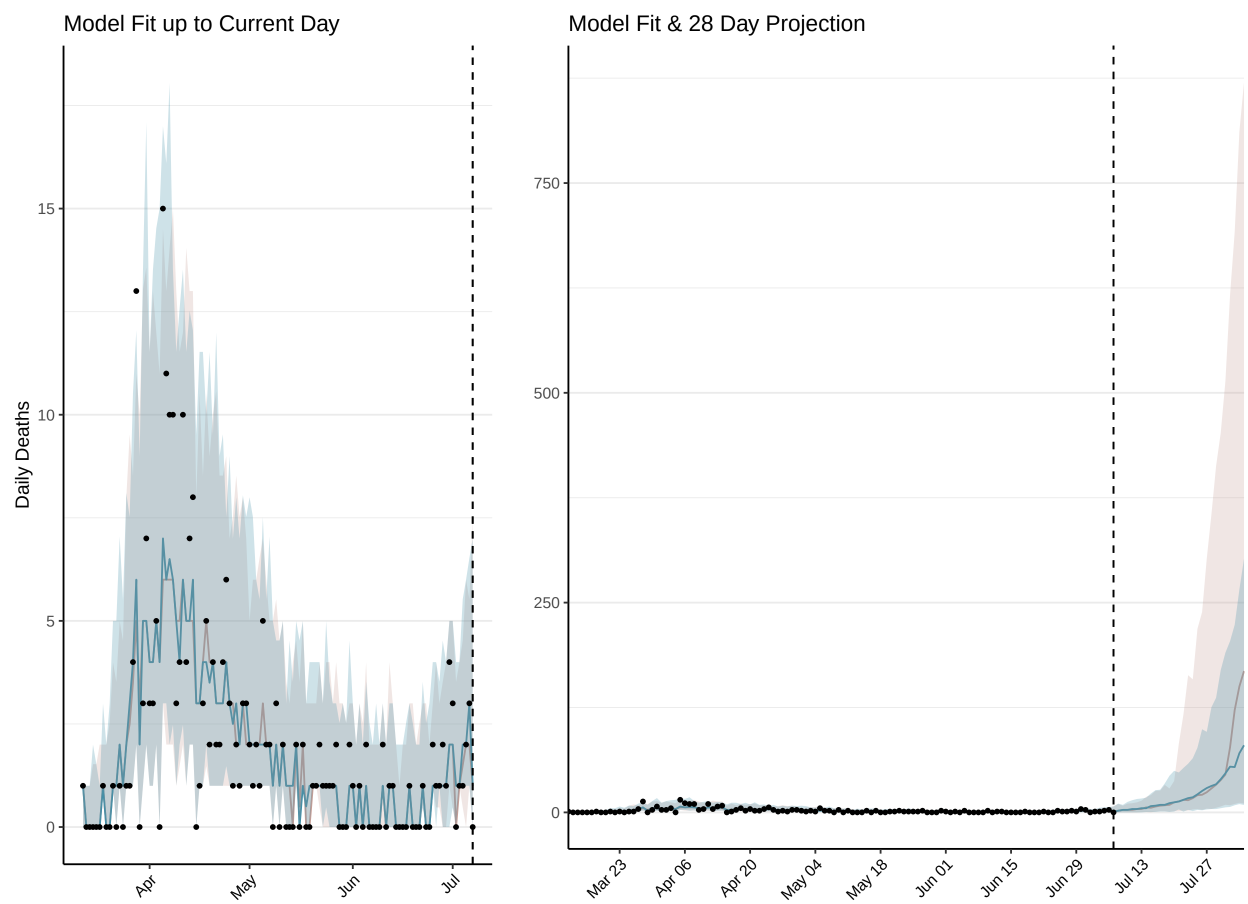

Figure 4: **Estimated daily deaths.** Projected deaths assuming the current level of interventions are maintained are shown in red (median and 95% quantile). Reported deaths are plotted in black. The plot on the left is focussed on the model fit prior to today, while the plot on the right forecasts the next 28 days. The forecasted deaths in blue assumes healthcare capacity has been surged to ensure sufficient supply of ICU and hospital beds. The red curve assumes no surging in healthcare capacity and subsequently projects increased deaths.

Short-term Epidemic Scenarios

We make the following short-term projections of healthcare demand and new infections under the following three scenarios:

- **Scenario 1.** The epidemic continues to grow at the current rate.
- **Scenario 2.** Countries will further scale up interventions (either increasing current strategies or implementing new interventions) leading to a further 50% reduction in transmission.
- **Scenario 3.** Countries will relax current interventions by 50%

N.B. These scenarios currently assume that the impact of mobility on transmission will remain the same in the future as it has in the past. We are working to extend methods to estimate the impact of increases in mobility on transmission as lockdown and interventions are reversed. Consequently, projection are likely to represent an upper estimate of the healthcare demand and case load for each scenario

We estimate that over the next 4 weeks demand for hospital beds will change from 174 (95% CI: 154-194) patients requiring treatment with high-pressure oxygen at the current date to 5,969 (95% CI: 4,702-7,236) hospital beds being required on 2020-08-04 if no further interventions are introduced (Scenario 1). Similarly, we estimate that over the next 4 weeks demand for critical care (ICU) beds will change from 45 (95% CI: 40-50) patients requiring treatment with mechanical ventilation at the current date to 843 (95% CI: 752-933) by 2020-08-04. These projections assume that approximately 5% of all infections will require treatment with high-pressure oxygen and that approximately 30% of hospitalised cases will require treatment with mechanical ventilation (based on analysis of ongoing epidemics in Europe). **N.B. These scenarios are unlikely to show significant differences for the first week since there is a delay of approximately 10 days between infection and hospital admission. Consequently, the effectiveness of a change in policy is likely to be better captured by hospital admission data approximately 2 weeks after the policy change is implemented.**

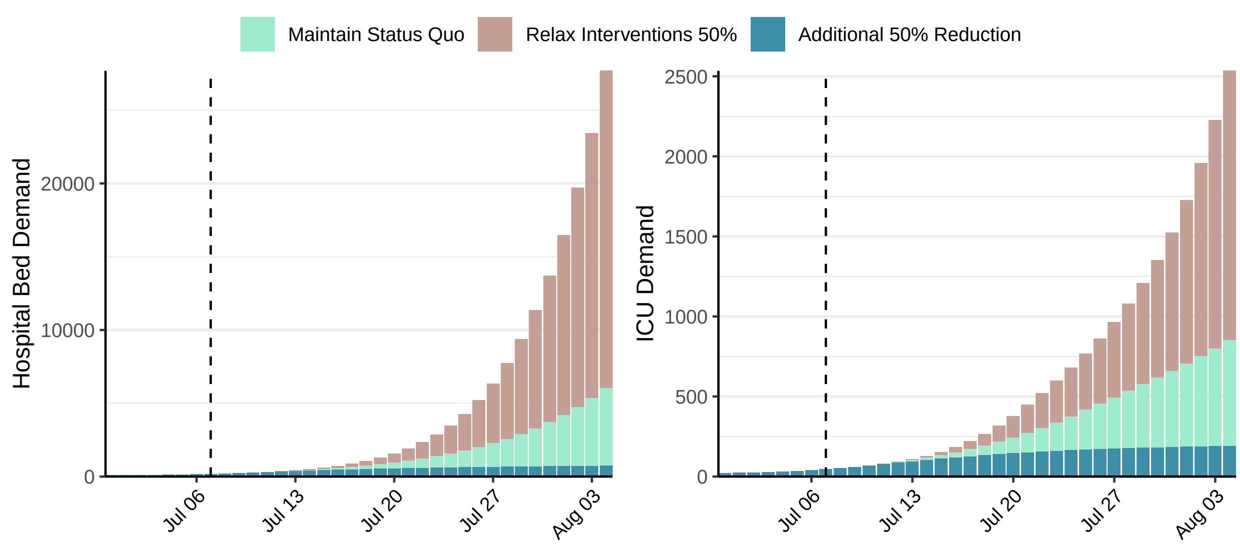

Figure 5: **Healthcare demands in the next 28 days.** Individuals needing an ICU bed are assumed to need mechanical ventilation. Projected demand for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

The impact of each scenario has a more immediate effect on the daily number of infections. The figure below shows the impact of each scenario on the estimated daily incidence of new infections. If interventions are scaled up (Scenario 2), the daily number of infections will change from 2,535 (95% CI: 2,193-2,877) at the current date to 3,544 (95% CI: 2,715-4,373) by 2020-08-04. If current interventions were relaxed by 50%, we estimate the daily number of infections will change from 2,535 (95% CI: 2,193-2,877) at the current date to 516,425 (95% CI: 438,673-594,178) by 2020-08-04.

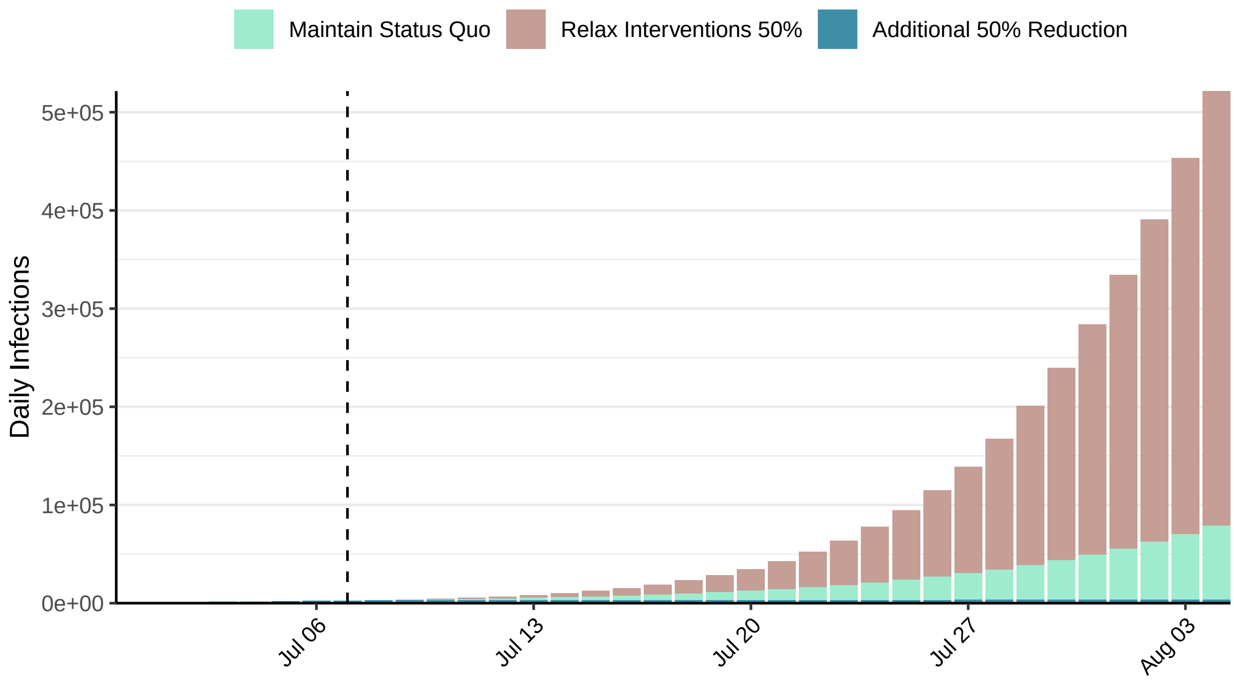

Figure 6: **Daily number of infections estimated by fitting to deaths.** Projected infections for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

To explore different scenarios, we recommend using our COVID-19 Scenario Analysis Tool - https://covidsim.org/, which can be used to simulate different intervention scenarios and explore the long term impact on healthcare demand.

Situation Report for COVID-19: Moldova, 2020-07-07

Download the report for Moldova, 2020-07-07 here. This report uses data from the European Centre for Disease Control. These data are updated daily and whilst there may be a short delay, they are generally consistent with Ministry reports. These data are then used to back-calculate an 'inferred number of COVID-19 infections' using mathematical modelling techniques (see Report 12 for further details) to estimate the number of people that have been infected and to make short-term projections for future healthcare needs.

Epidemiological Situation

Total Reported Cases	New Reported Cases	Total Reported Deaths	New Reported Deaths	Estimated R_t
17,906	92	595	10	1.16 (95% CI: 1.06-1.27)

The figure below shows the cumulative reported deaths as a function of the time since the 10th death was reported. Dashed lines show the expected trajectory for different doubling times of the epidemic. For example, with a doubling time of 3 days, if there are currently a total of 20 deaths reported, we would expect there to be 40 deaths in total reported in 3 days-time, 80 deaths in 6 days-time, 160 deaths in 9 days-time etc. For most epidemics, in the absence of interventions, we expect a doubling time of 3-4 days for this disease.

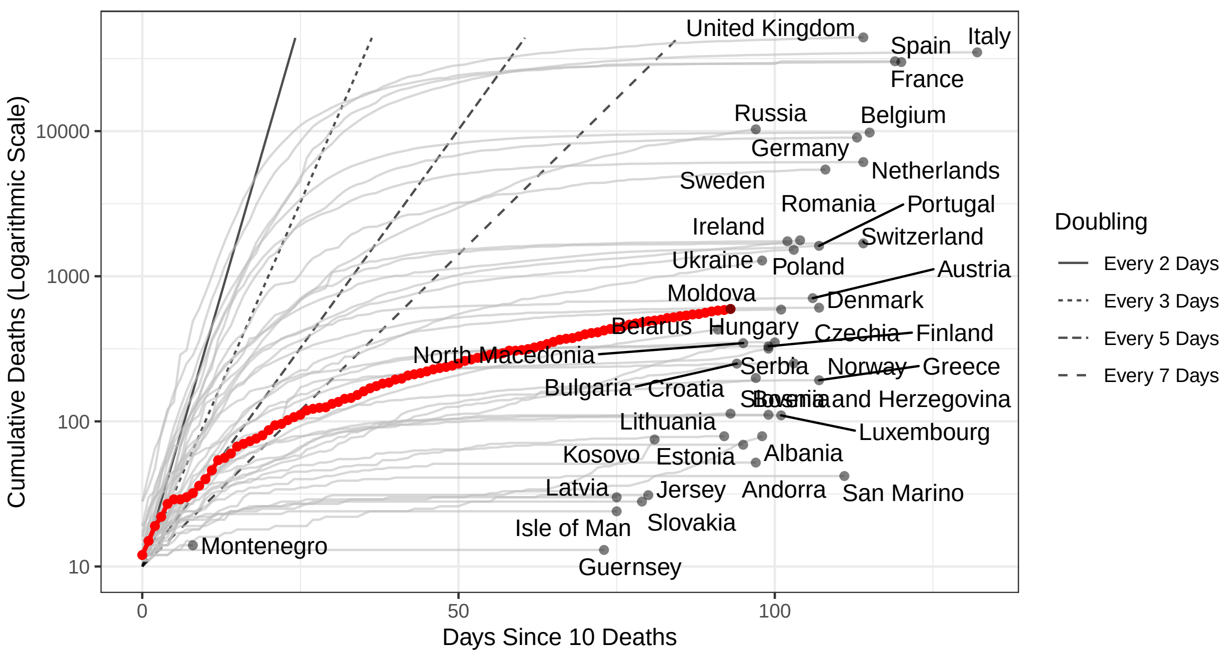

Figure 1: **Cumulative Deaths since 10 deaths.** Country not shown if fewer than 10 deaths.

COVID-19 Transmission Modelling

We assume that the deaths reported to date provide the best indication of the stage of the epidemic, as deaths are more consistently and accurately reported. Our current working estimate is that 1 death indicates that approximately 100 people will have been infected with the other 99 recovering (based on an infection fatality ratio of ~1%). These infections will have happened approximately 21 days previously – capturing a 5-day period from infection to onset of symptoms (the incubation period), 4 days from onset of symptoms to hospitalisation, and 12 days in hospital before death. With a 3-day doubling time, 100 infections that occurred 15 days ago will have generated 200 infections 12 days ago, 400 infections 9 days ago, 800 infections 6 days ago and 1,600 infections 3 days ago resulting in approximately 3,200 infections at the time the first death is observed.

To explore this, we fit our age-structured SEIR model (see Methods) to the time series of deaths in a country, in order to estimate the start date of the epidemic and the baseline R0. We assume that 100% of COVID-19 related deaths have been reported. We have also included the impact of interventions that have been put in place and their effect on human mobility and transmission based on the Google COVID-19 Community Mobility Reports. Using our mathematical model that formalises this approach, we estimate that there has been a total of 82,677 (95% CI: 76,800-88,554) infections over the past 4 weeks.

The figure below shows the estimated number of people infected over the past 4 weeks. The bar charts show, for comparison, the number of reported cases. The right-hand plot shows these data on a different scale as the estimated infections are likely to be much larger than the reported cases. **Importantly**, the estimated infections includes both asymptomatic and mild cases that would not necessarily be identified through surveillance. Consequently, the estimated infections are likely to be significantly higher than the reported cases (see our FAQ for further explanation of these differences and why the reported cases and estimated infections are unlikely to match).

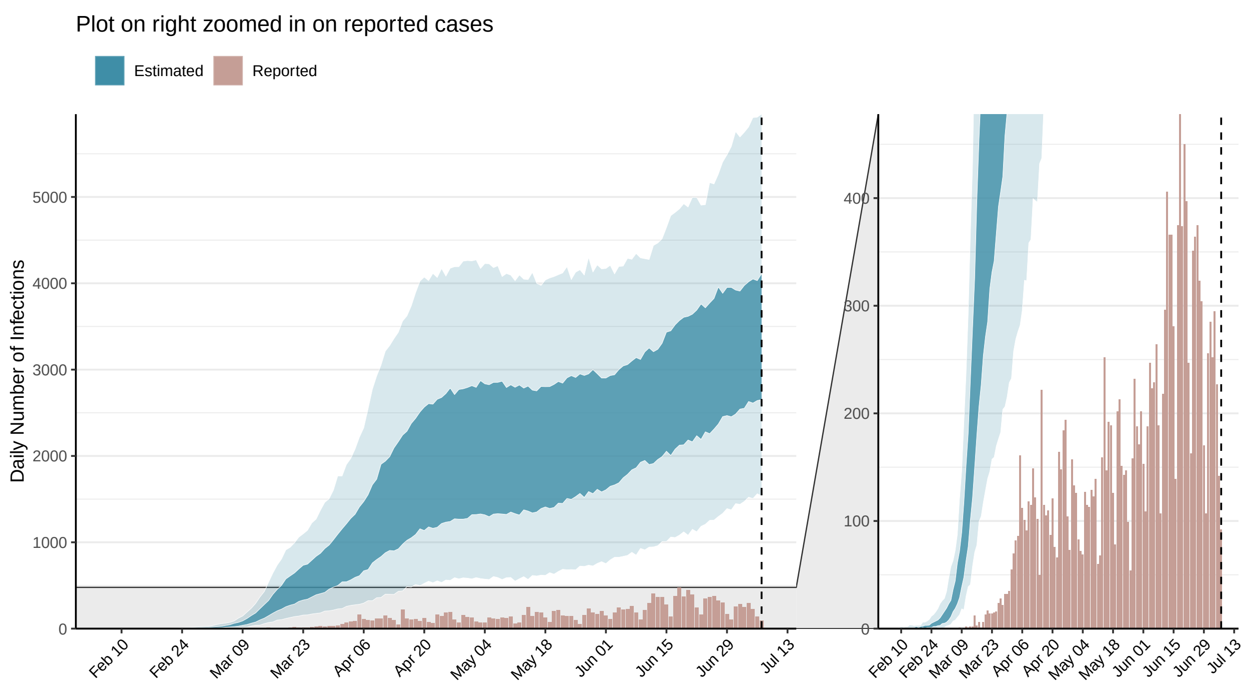

Figure 2: **Daily number of infections estimated by fitting to the current total of deaths.** Reported cases are shown in red. Model estimated infections are shown in blue (dark blue 50% interquartile range, light blue 95% quantile). The dashed line shows the current day.

By fitting to the time series of deaths, we are able to estimate a time-varying reproduction number, R_t. R_t is the the average number of secondary infections caused by a single infected person at a given time. If R_t is above 1, the rate of transmission is increasing and the number of new infections is increasing. R_t is assumed to change in relation to mobility fall in proportion. When fitting our model we assume that 100% of COVID-19 related deaths have been reported (please see our FAQ section for more information about this assumption). We also assume a fixed date at which the impact of mobility on transmission changes from pre-lockdown levels to post-lockdown levels, which may cause large changes in Rt. We are working to refine how this switch occurs and to formally calculate its shape.

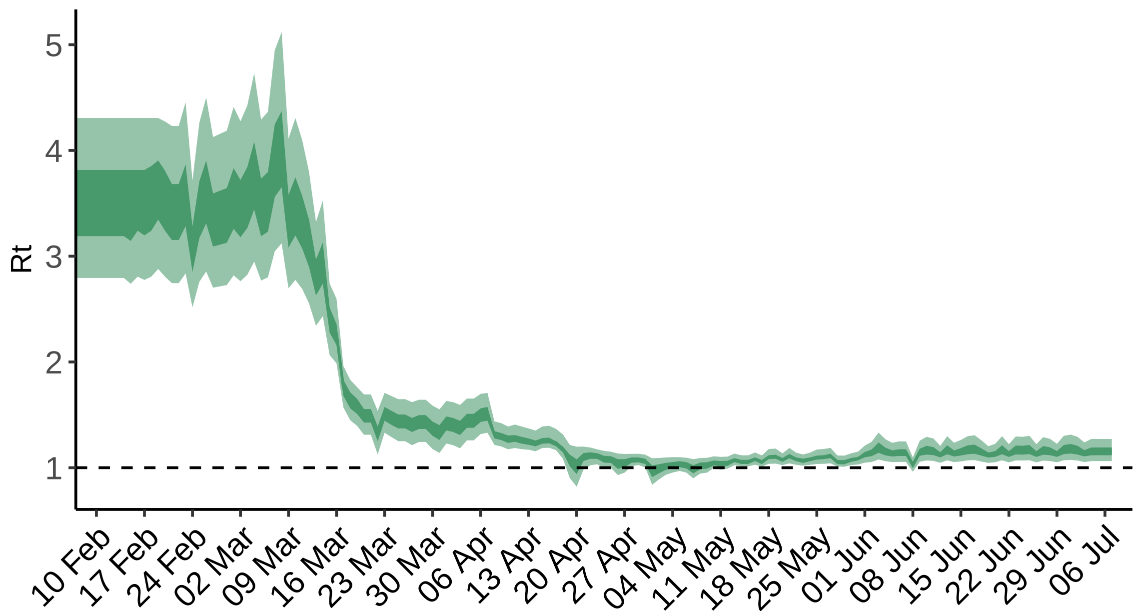

Figure 3: **Time-varying reproduction number, R_t.** R_t is the average number of secondary infections caused by a single infected person at time equal to t. $R_t < 1$ indicates a slowing epidemic in which new infections are not increasing. $R_t > 1$ indicates a growing epidemic in which new infections are increasing over time. Dark green shows the 50% CI and light green shows the 95% CI.

Using the model fit, we can forecast the expected trajectory for cumulative deaths, which is shown in the figure below. This assumes a severity pattern by age that is consistent with that observed in China, Europe and the U.S to date. This projection assumes that transmission is maintained at the current level of transmission as estimated by the final R_t value.

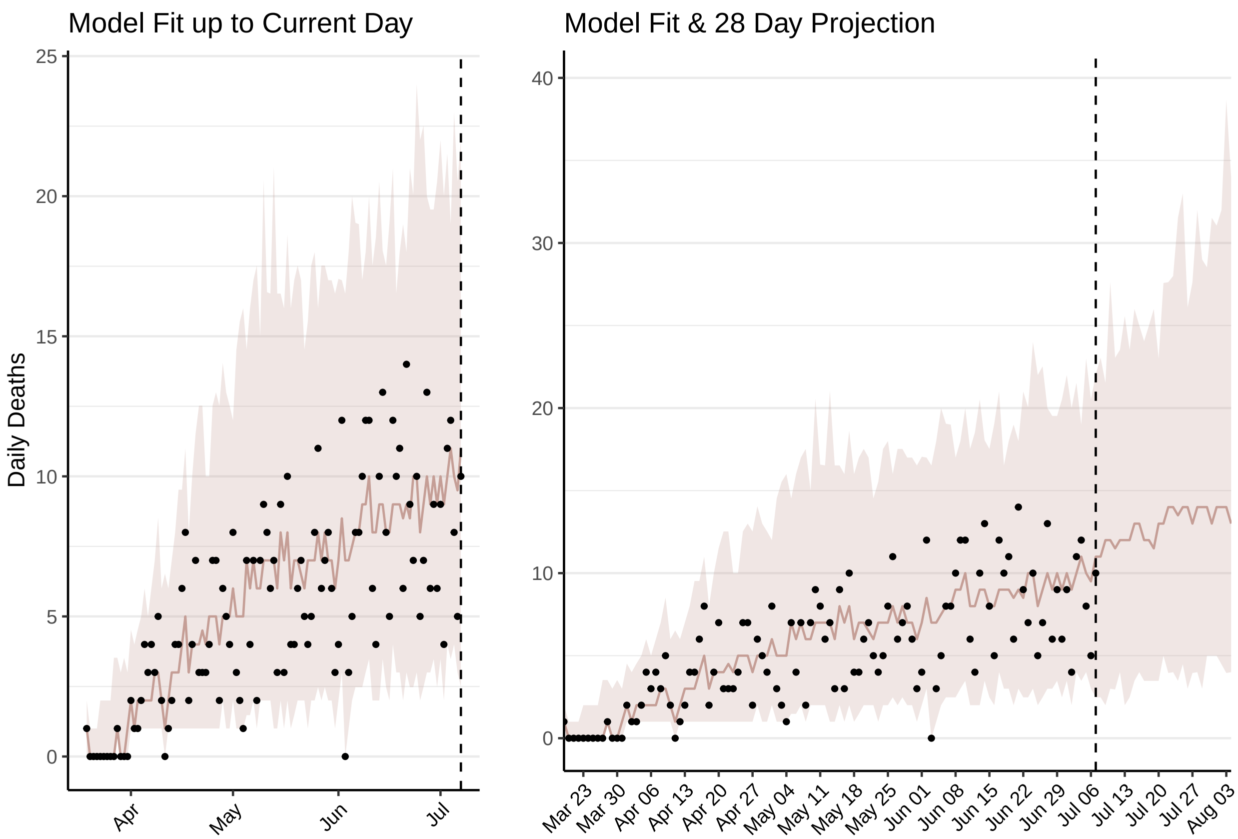

Figure 4: **Estimated daily deaths.** Projected deaths assuming the current level of interventions are maintained are shown in red (median and 95% quantile). Reported deaths are plotted in black. The plot on the left is focussed on the model fit prior to today, while the plot on the right forecasts the next 28 days.

Short-term Epidemic Scenarios

We make the following short-term projections of healthcare demand and new infections under the following three scenarios:

- **Scenario 1.** The epidemic continues to grow at the current rate.
- **Scenario 2.** Countries will further scale up interventions (either increasing current strategies or implementing new interventions) leading to a further 50% reduction in transmission.
- **Scenario 3.** Countries will relax current interventions by 50%

N.B. These scenarios currently assume that the impact of mobility on transmission will remain the same in the future as it has in the past. We are working to extend methods to estimate the impact of increases in mobility on transmission as lockdown and interventions are reversed. Consequently, projection are likely to represent an upper estimate of the healthcare demand and case load for each scenario

We estimate that over the next 4 weeks demand for hospital beds will change from 646 (95% CI: 598-693) patients requiring treatment with high-pressure oxygen at the current date to 838 (95% CI: 769-908) hospital beds being required on 2020-08-04 if no further interventions are introduced (Scenario 1). Similarly, we estimate that over the next 4 weeks demand for critical care (ICU) beds will change from 169 (95% CI: 156-182) patients requiring treatment with mechanical ventilation at the current date to 222 (95% CI: 204-240) by 2020-08-04. These projections assume that approximately 5% of all infections will require treatment with high-pressure oxygen and that approximately 30% of hospitalised cases will require treatment with mechanical ventilation (based on analysis of ongoing epidemics in Europe). **N.B. These scenarios are unlikely to show significant differences for the first week since there is a delay of approximately 10 days between infection and hospital admission. Consequently, the effectiveness of a change in policy is likely to be better captured by hospital admission data approximately 2 weeks after the policy change is implemented.**

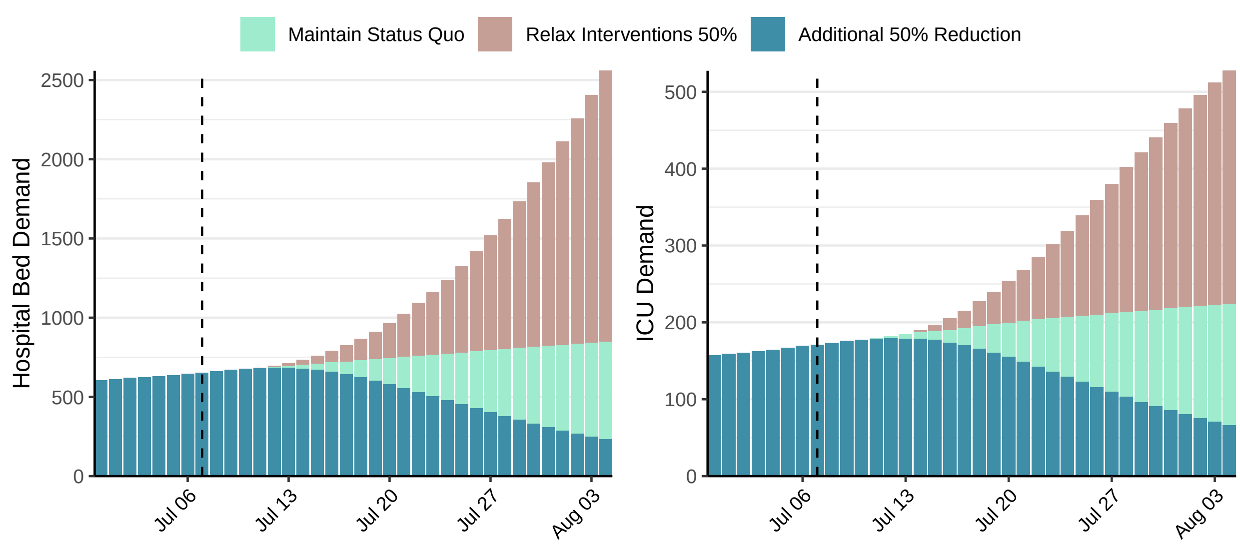

Figure 5: **Healthcare demands in the next 28 days.** Individuals needing an ICU bed are assumed to need mechanical ventilation. Projected demand for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

The impact of each scenario has a more immediate effect on the daily number of infections. The figure below shows the impact of each scenario on the estimated daily incidence of new infections. If interventions are scaled up (Scenario 2), the daily number of infections will change from 3,385 (95% CI: 3,139-3,630) at the current date to 349 (95% CI: 319-380) by 2020-08-04. If current interventions were relaxed by 50%, we estimate the daily number of infections will change from 3,385 (95% CI: 3,139-3,630) at the current date to 20,655 (95% CI: 19,067-22,244) by 2020-08-04.

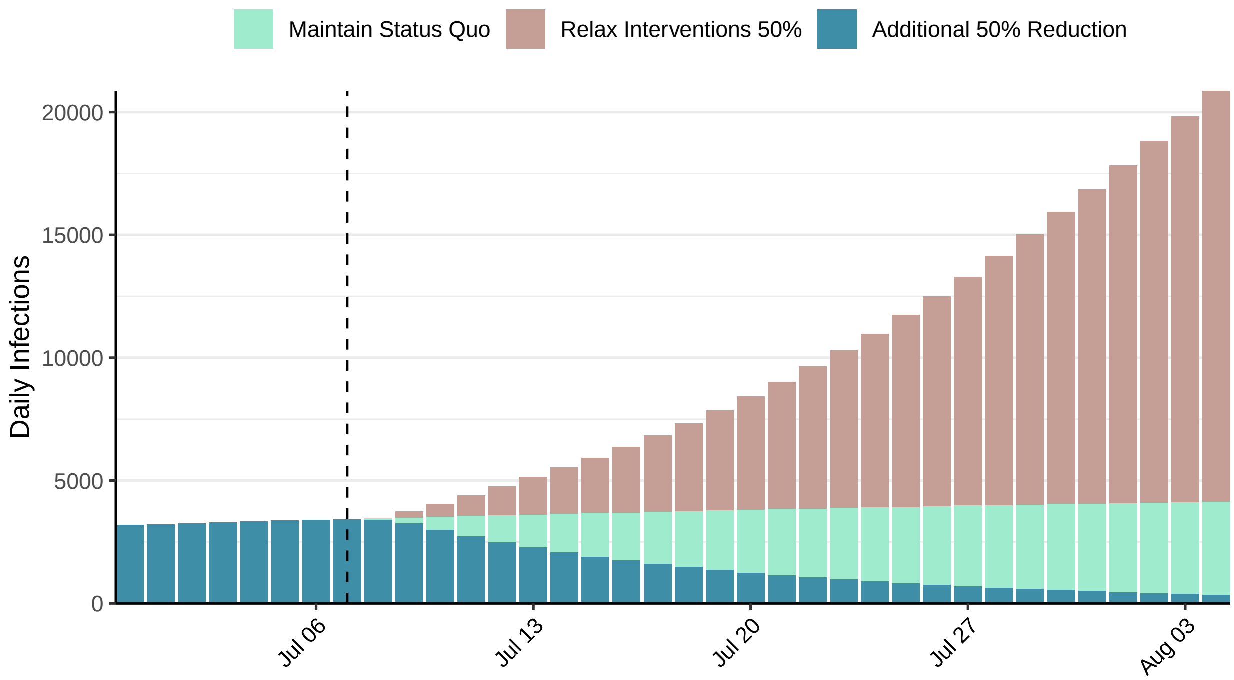

Figure 6: **Daily number of infections estimated by fitting to deaths.** Projected infections for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

To explore different scenarios, we recommend using our COVID-19 Scenario Analysis Tool - https://covidsim.org/, which can be used to simulate different intervention scenarios and explore the long term impact on healthcare demand.

Situation Report for COVID-19: Madagascar, 2020-07-07

Download the report for Madagascar, 2020-07-07 here. This report uses data from the European Centre for Disease Control. These data are updated daily and whilst there may be a short delay, they are generally consistent with Ministry reports. These data are then used to back-calculate an 'inferred number of COVID-19 infections' using mathematical modelling techniques (see Report 12 for further details) to estimate the number of people that have been infected and to make short-term projections for future healthcare needs.

Epidemiological Situation

Total Reported Cases	New Reported Cases	Total Reported Deaths	New Reported Deaths	Estimated R_t
3,250	522	33	4	1.49 (95% CI: 1.3-1.75)

The figure below shows the cumulative reported deaths as a function of the time since the 10th death was reported. Dashed lines show the expected trajectory for different doubling times of the epidemic. For example, with a doubling time of 3 days, if there are currently a total of 20 deaths reported, we would expect there to be 40 deaths in total reported in 3 days-time, 80 deaths in 6 days-time, 160 deaths in 9 days-time etc. For most epidemics, in the absence of interventions, we expect a doubling time of 3-4 days for this disease.

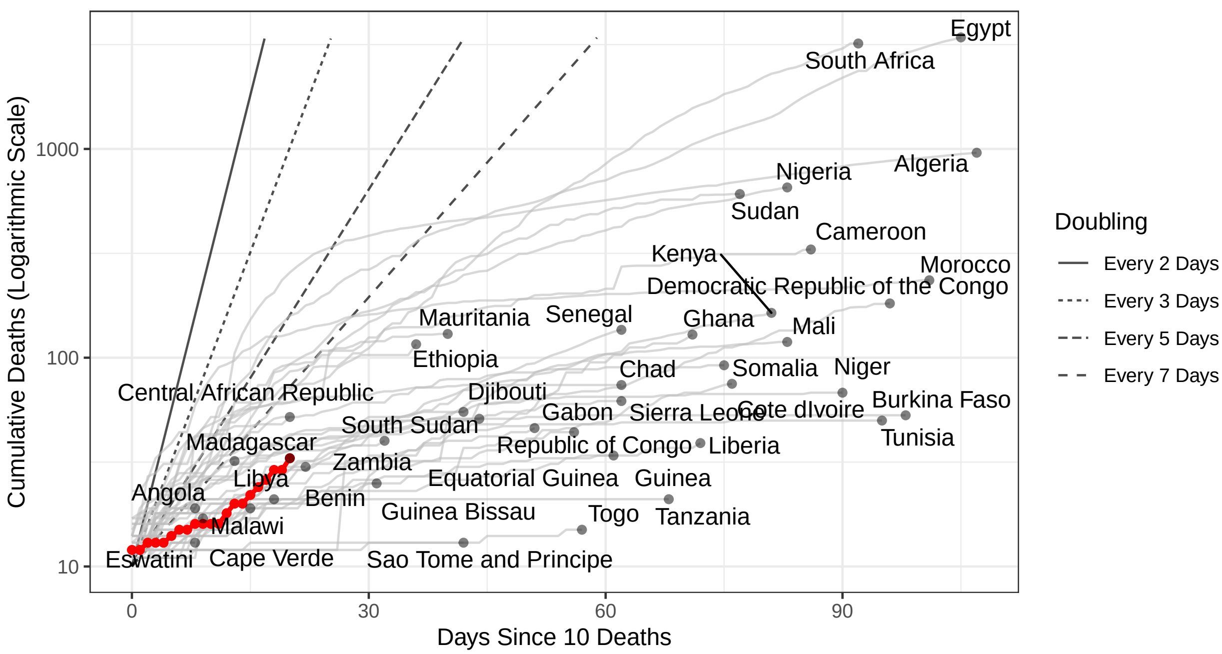

Figure 1: **Cumulative Deaths since 10 deaths.** Country not shown if fewer than 10 deaths.

COVID-19 Transmission Modelling

We assume that the deaths reported to date provide the best indication of the stage of the epidemic, as deaths are more consistently and accurately reported. Our current working estimate is that 1 death indicates that approximately 100 people will have been infected with the other 99 recovering (based on an infection fatality ratio of ~1%). These infections will have happened approximately 21 days previously – capturing a 5-day period from infection to onset of symptoms (the incubation period), 4 days from onset of symptoms to hospitalisation, and 12 days in hospital before death. With a 3-day doubling time, 100 infections that occurred 15 days ago will have generated 200 infections 12 days ago, 400 infections 9 days ago, 800 infections 6 days ago and 1,600 infections 3 days ago resulting in approximately 3,200 infections at the time the first death is observed.

To explore this, we fit our age-structured SEIR model (see Methods) to the time series of deaths in a country, in order to estimate the start date of the epidemic and the baseline R0. We assume that 100% of COVID-19 related deaths have been reported. We have also included the impact of interventions that have been put in place and their effect on human mobility and transmission based on the Google COVID-19 Community Mobility Reports. Using our mathematical model that formalises this approach, we estimate that there has been a total of 29,145 (95% CI: 25,127-33,162) infections over the past 4 weeks.

The figure below shows the estimated number of people infected over the past 4 weeks. The bar charts show, for comparison, the number of reported cases. The right-hand plot shows these data on a different scale as the estimated infections are likely to be much larger than the reported cases. **Importantly**, the estimated infections includes both asymptomatic and mild cases that would not necessarily be identified through surveillance. Consequently, the estimated infections are likely to be significantly higher than the reported cases (see our FAQ for further explanation of these differences and why the reported cases and estimated infections are unlikely to match).

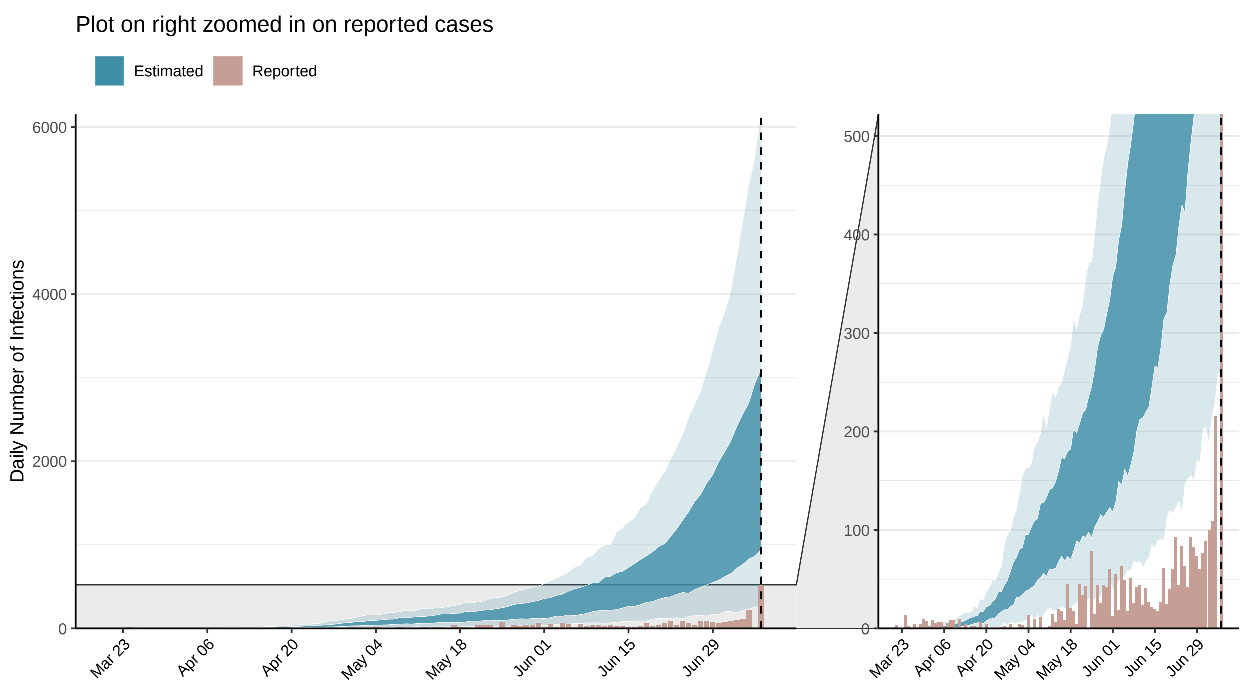

Figure 2: **Daily number of infections estimated by fitting to the current total of deaths.** Reported cases are shown in red. Model estimated infections are shown in blue (dark blue 50% interquartile range, light blue 95% quantile). The dashed line shows the current day.

By fitting to the time series of deaths, we are able to estimate a time-varying reproduction number, R_t. R_t is the the average number of secondary infections caused by a single infected person at a given time. If R_t is above 1, the rate of transmission is increasing and the number of new infections is increasing. R_t is assumed to change in relation to mobility fall in proportion. When fitting our model we assume that 100% of COVID-19 related deaths have been reported (please see our FAQ section for more information about this assumption). We also assume a fixed date at which the impact of mobility on transmission changes from pre-lockdown levels to post-lockdown levels, which may cause large changes in Rt. We are working to refine how this switch occurs and to formally calculate its shape.

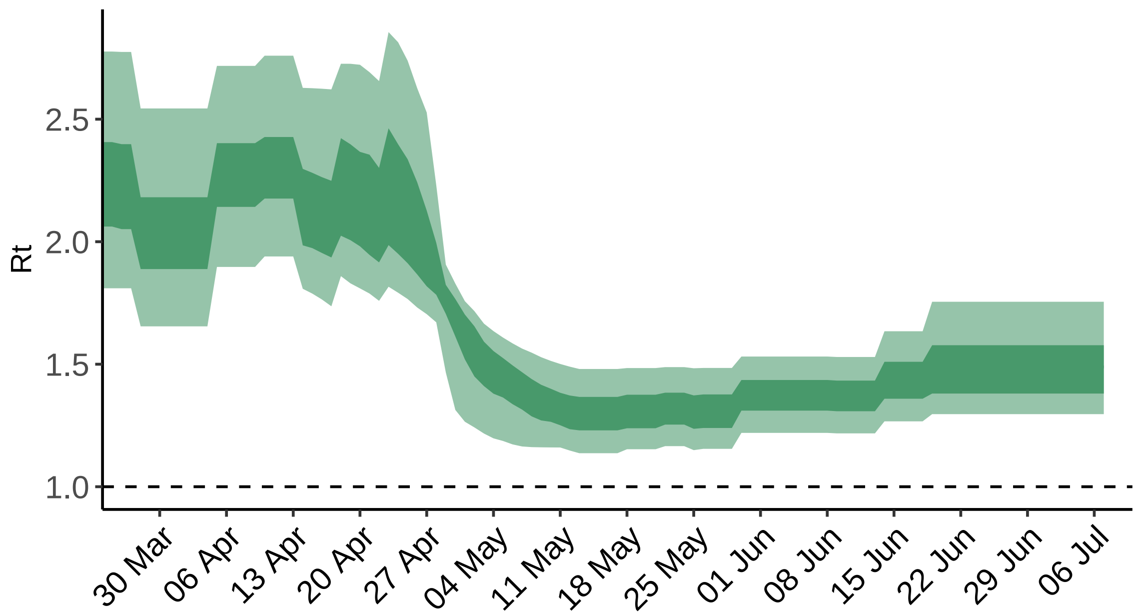

Figure 3: **Time-varying reproduction number, R_t.** R_t is the average number of secondary infections caused by a single infected person at time equal to t. $R_t < 1$ indicates a slowing epidemic in which new infections are not increasing. $R_t > 1$ indicates a growing epidemic in which new infections are increasing over time. Dark green shows the 50% CI and light green shows the 95% CI.

Using the model fit, we can forecast the expected trajectory for cumulative deaths, which is shown in the figure below. This assumes a severity pattern by age that is consistent with that observed in China, Europe and the U.S to date. This projection assumes that transmission is maintained at the current level of transmission as estimated by the final R_t value.

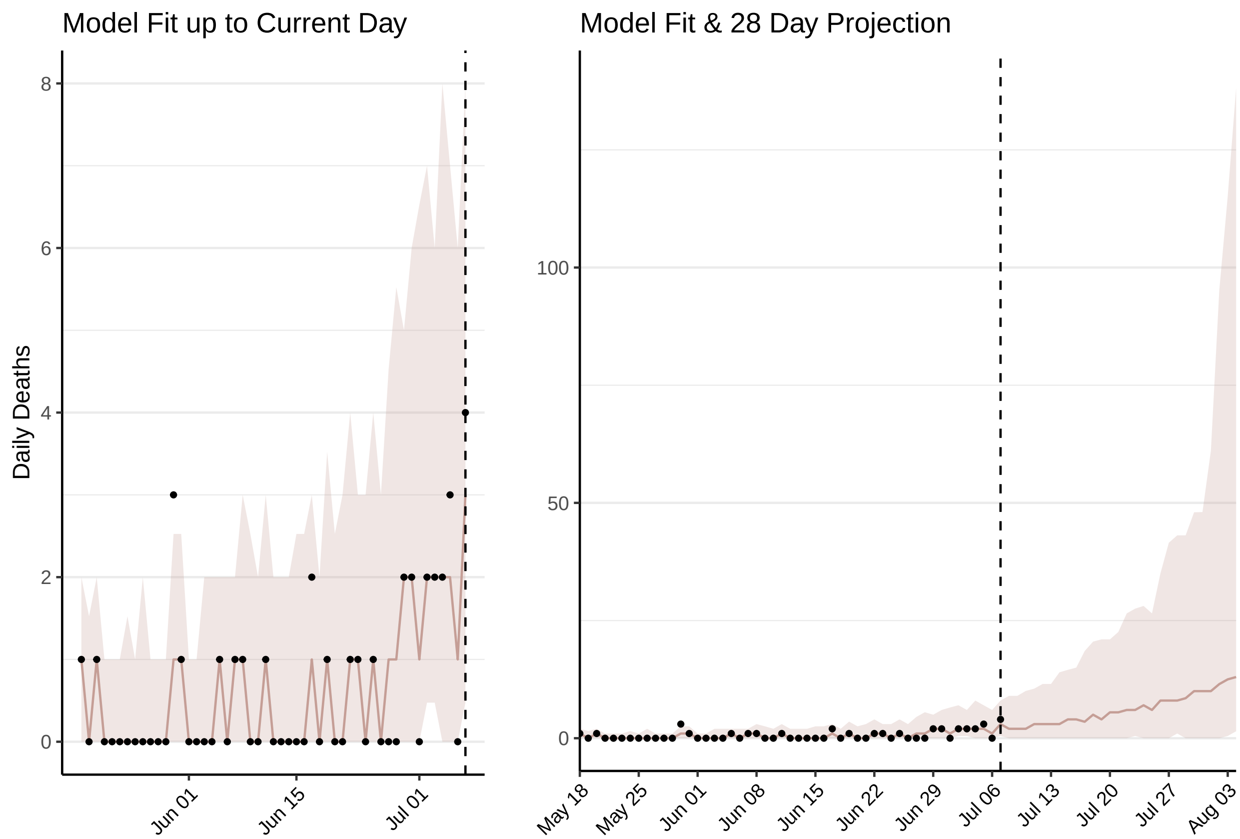

Figure 4: **Estimated daily deaths.** Projected deaths assuming the current level of interventions are maintained are shown in red (median and 95% quantile). Reported deaths are plotted in black. The plot on the left is focussed on the model fit prior to today, while the plot on the right forecasts the next 28 days.

Short-term Epidemic Scenarios

We make the following short-term projections of healthcare demand and new infections under the following three scenarios:

- **Scenario 1.** The epidemic continues to grow at the current rate.
- **Scenario 2.** Countries will further scale up interventions (either increasing current strategies or implementing new interventions) leading to a further 50% reduction in transmission.
- **Scenario 3.** Countries will relax current interventions by 50%

N.B. These scenarios currently assume that the impact of mobility on transmission will remain the same in the future as it has in the past. We are working to extend methods to estimate the impact of increases in mobility on transmission as lockdown and interventions are reversed. Consequently, projection are likely to represent an upper estimate of the healthcare demand and case load for each scenario

We estimate that over the next 4 weeks demand for hospital beds will change from 170 (95% CI: 145-194) patients requiring treatment with high-pressure oxygen at the current date to 1,178 (95% CI: 952-1,403) hospital beds being required on 2020-08-04 if no further interventions are introduced (Scenario 1). Similarly, we estimate that over the next 4 weeks demand for critical care (ICU) beds will change from 45 (95% CI: 39-52) patients requiring treatment with mechanical ventilation at the current date to 298 (95% CI: 246-350) by 2020-08-04. These projections assume that approximately 5% of all infections will require treatment with high-pressure oxygen and that approximately 30% of hospitalised cases will require treatment with mechanical ventilation (based on analysis of ongoing epidemics in Europe). **N.B. These scenarios are unlikely to show significant differences for the first week since there is a delay of approximately 10 days between infection and hospital admission. Consequently, the effectiveness of a change in policy is likely to be better captured by hospital admission data approximately 2 weeks after the policy change is implemented.**

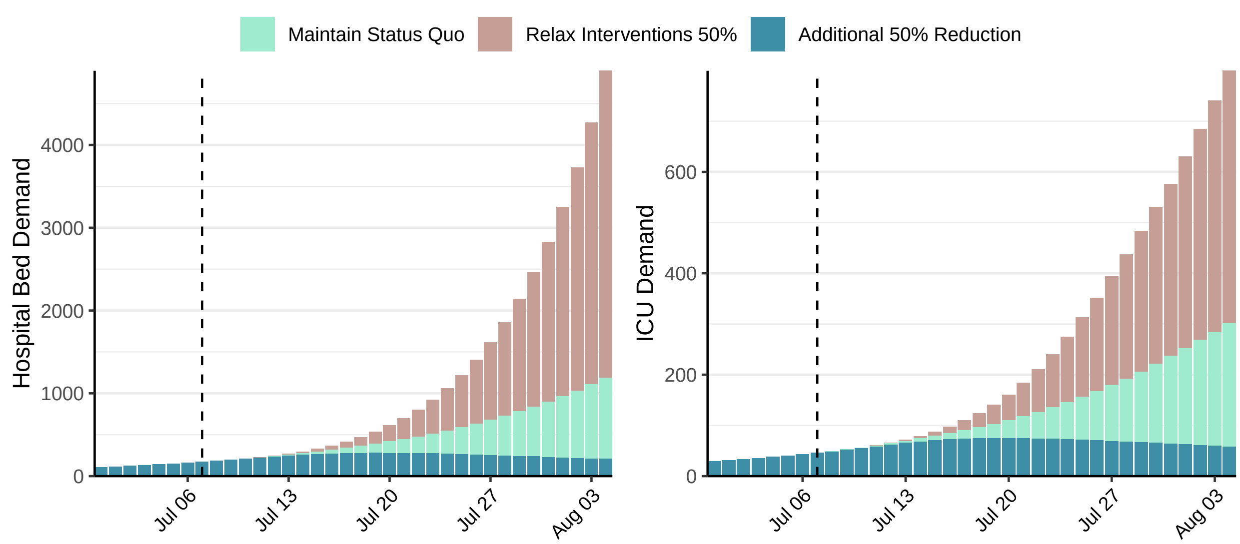

Figure 5: **Healthcare demands in the next 28 days.** Individuals needing an ICU bed are assumed to need mechanical ventilation. Projected demand for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

The impact of each scenario has a more immediate effect on the daily number of infections. The figure below shows the impact of each scenario on the estimated daily incidence of new infections. If interventions are scaled up (Scenario 2), the daily number of infections will change from 2,234 (95% CI: 1,890-2,578) at the current date to 915 (95% CI: 732-1,097) by 2020-08-04. If current interventions were relaxed by 50%, we estimate the daily number of infections will change from 2,234 (95% CI: 1,890-2,578) at the current date to 108,629 (95% CI: 86,654-130,604) by 2020-08-04.

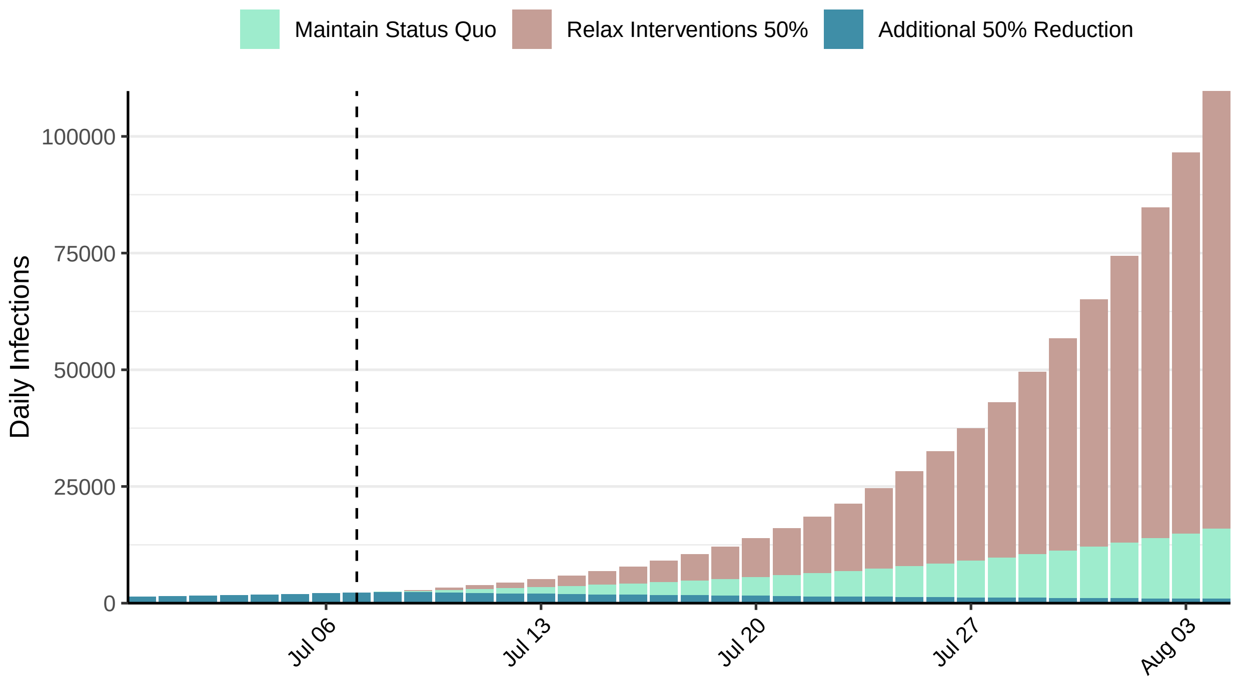

Figure 6: **Daily number of infections estimated by fitting to deaths.** Projected infections for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

To explore different scenarios, we recommend using our COVID-19 Scenario Analysis Tool - https://covidsim.org/, which can be used to simulate different intervention scenarios and explore the long term impact on healthcare demand.

Situation Report for COVID-19: Maldives, 2020-07-07

Download the report for Maldives, 2020-07-07 here. This report uses data from the European Centre for Disease Control. These data are updated daily and whilst there may be a short delay, they are generally consistent with Ministry reports. These data are then used to back-calculate an 'inferred number of COVID-19 infections' using mathematical modelling techniques (see Report 12 for further details) to estimate the number of people that have been infected and to make short-term projections for future healthcare needs.

Epidemiological Situation

Total Reported Cases	New Reported Cases	Total Reported Deaths	New Reported Deaths	Estimated R_t
2,491	23	12	1	1.31 (95% CI: 1.22-1.4)

The figure below shows the cumulative reported deaths as a function of the time since the 10th death was reported. Dashed lines show the expected trajectory for different doubling times of the epidemic. For example, with a doubling time of 3 days, if there are currently a total of 20 deaths reported, we would expect there to be 40 deaths in total reported in 3 days-time, 80 deaths in 6 days-time, 160 deaths in 9 days-time etc. For most epidemics, in the absence of interventions, we expect a doubling time of 3-4 days for this disease.

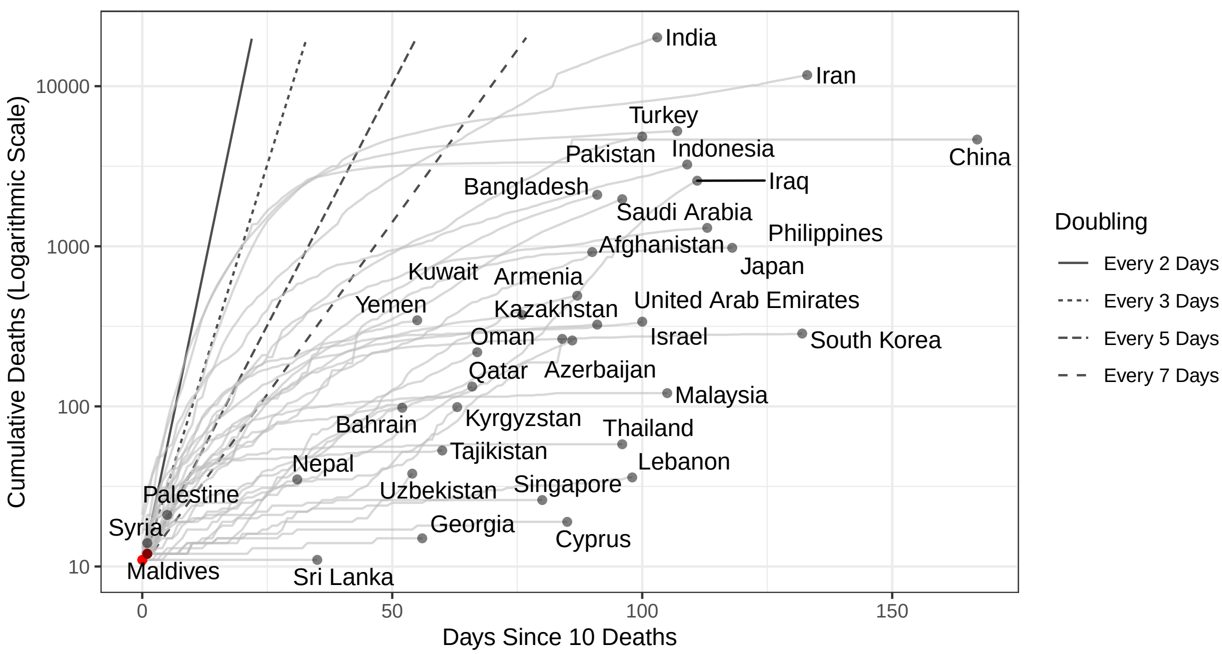

Figure 1: **Cumulative Deaths since 10 deaths.** Country not shown if fewer than 10 deaths.

COVID-19 Transmission Modelling

We assume that the deaths reported to date provide the best indication of the stage of the epidemic, as deaths are more consistently and accurately reported. Our current working estimate is that 1 death indicates that approximately 100 people will have been infected with the other 99 recovering (based on an infection fatality ratio of ~1%). These infections will have happened approximately 21 days previously – capturing a 5-day period from infection to onset of symptoms (the incubation period), 4 days from onset of symptoms to hospitalisation, and 12 days in hospital before death. With a 3-day doubling time, 100 infections that occurred 15 days ago will have generated 200 infections 12 days ago, 400 infections 9 days ago, 800 infections 6 days ago and 1,600 infections 3 days ago resulting in approximately 3,200 infections at the time the first death is observed.

To explore this, we fit our age-structured SEIR model (see Methods) to the time series of deaths in a country, in order to estimate the start date of the epidemic and the baseline R0. We assume that 100% of COVID-19 related deaths have been reported. We have also included the impact of interventions that have been put in place and their effect on human mobility and transmission based on the Google COVID-19 Community Mobility Reports. Using our mathematical model that formalises this approach, we estimate that there has been a total of 3,278 (95% CI: 2,845-3,711) infections over the past 4 weeks.

The figure below shows the estimated number of people infected over the past 4 weeks. The bar charts show, for comparison, the number of reported cases. The right-hand plot shows these data on a different scale as the estimated infections are likely to be much larger than the reported cases. **Importantly**, the estimated infections includes both asymptomatic and mild cases that would not necessarily be identified through surveillance. Consequently, the estimated infections are likely to be significantly higher than the reported cases (see our FAQ for further explanation of these differences and why the reported cases and estimated infections are unlikely to match).

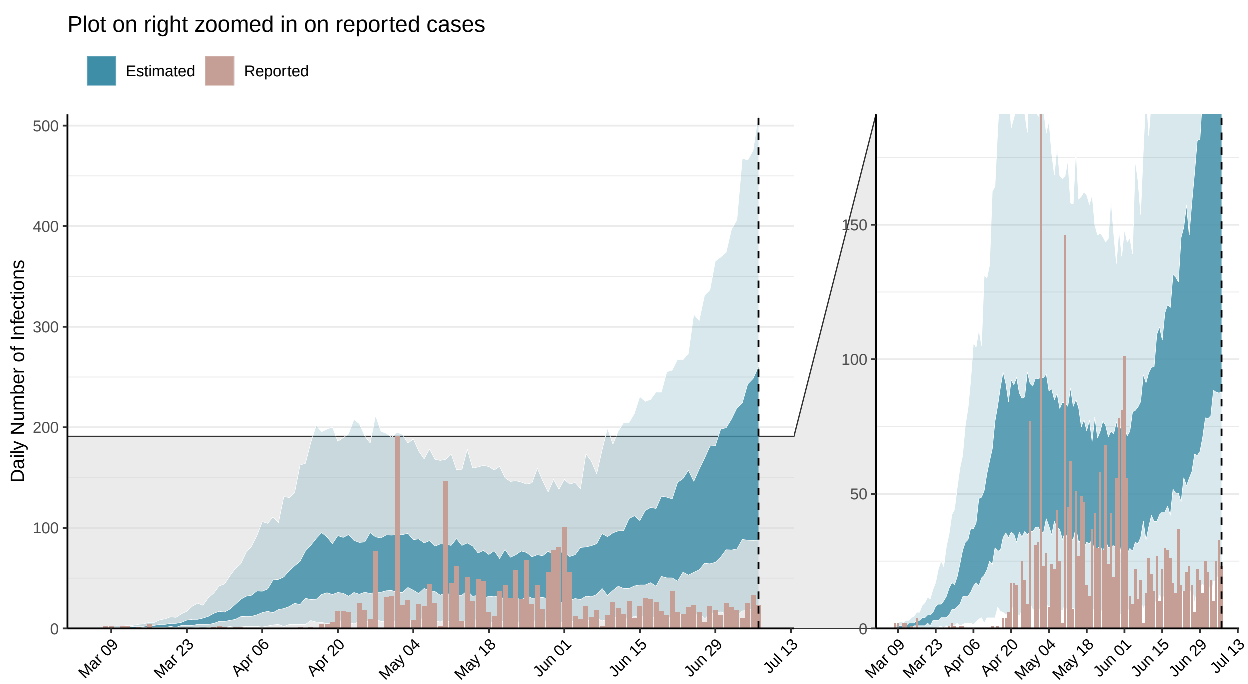

Figure 2: **Daily number of infections estimated by fitting to the current total of deaths.** Reported cases are shown in red. Model estimated infections are shown in blue (dark blue 50% interquartile range, light blue 95% quantile). The dashed line shows the current day.

By fitting to the time series of deaths, we are able to estimate a time-varying reproduction number, R_t. R_t is the the average number of secondary infections caused by a single infected person at a given time. If R_t is above 1, the rate of transmission is increasing and the number of new infections is increasing. R_t is assumed to change in relation to mobility fall in proportion. When fitting our model we assume that 100% of COVID-19 related deaths have been reported (please see our FAQ section for more information about this assumption). We also assume a fixed date at which the impact of mobility on transmission changes from pre-lockdown levels to post-lockdown levels, which may cause large changes in Rt. We are working to refine how this switch occurs and to formally calculate its shape.

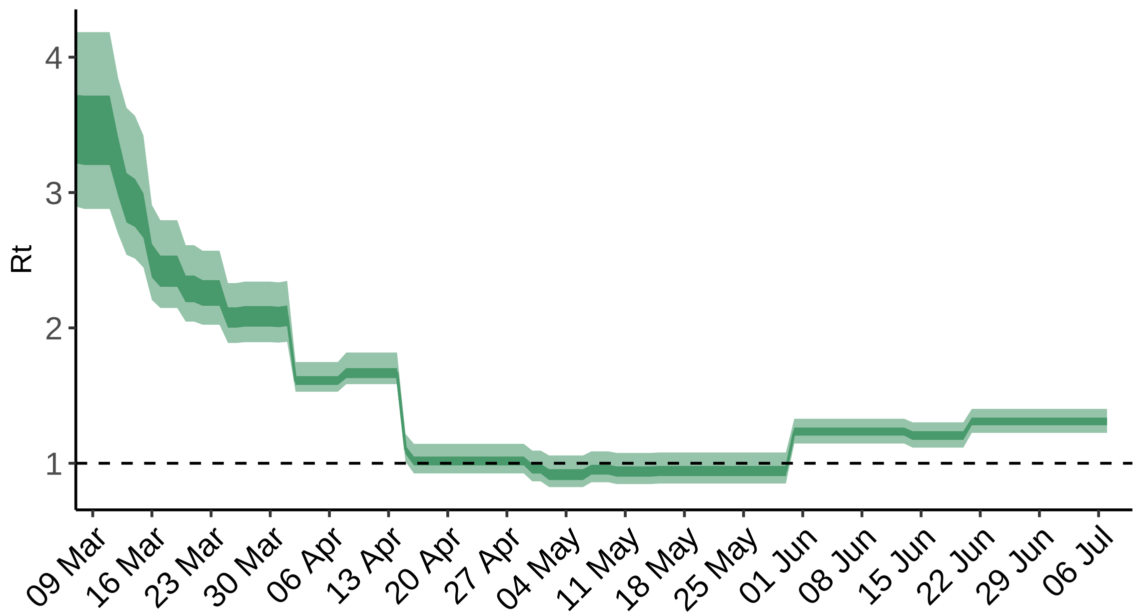

Figure 3: **Time-varying reproduction number, R_t.** R_t is the average number of secondary infections caused by a single infected person at time equal to t. $R_t < 1$ indicates a slowing epidemic in which new infections are not increasing. $R_t > 1$ indicates a growing epidemic in which new infections are increasing over time. Dark green shows the 50% CI and light green shows the 95% CI.

Using the model fit, we can forecast the expected trajectory for cumulative deaths, which is shown in the figure below. This assumes a severity pattern by age that is consistent with that observed in China, Europe and the U.S to date. This projection assumes that transmission is maintained at the current level of transmission as estimated by the final R_t value.

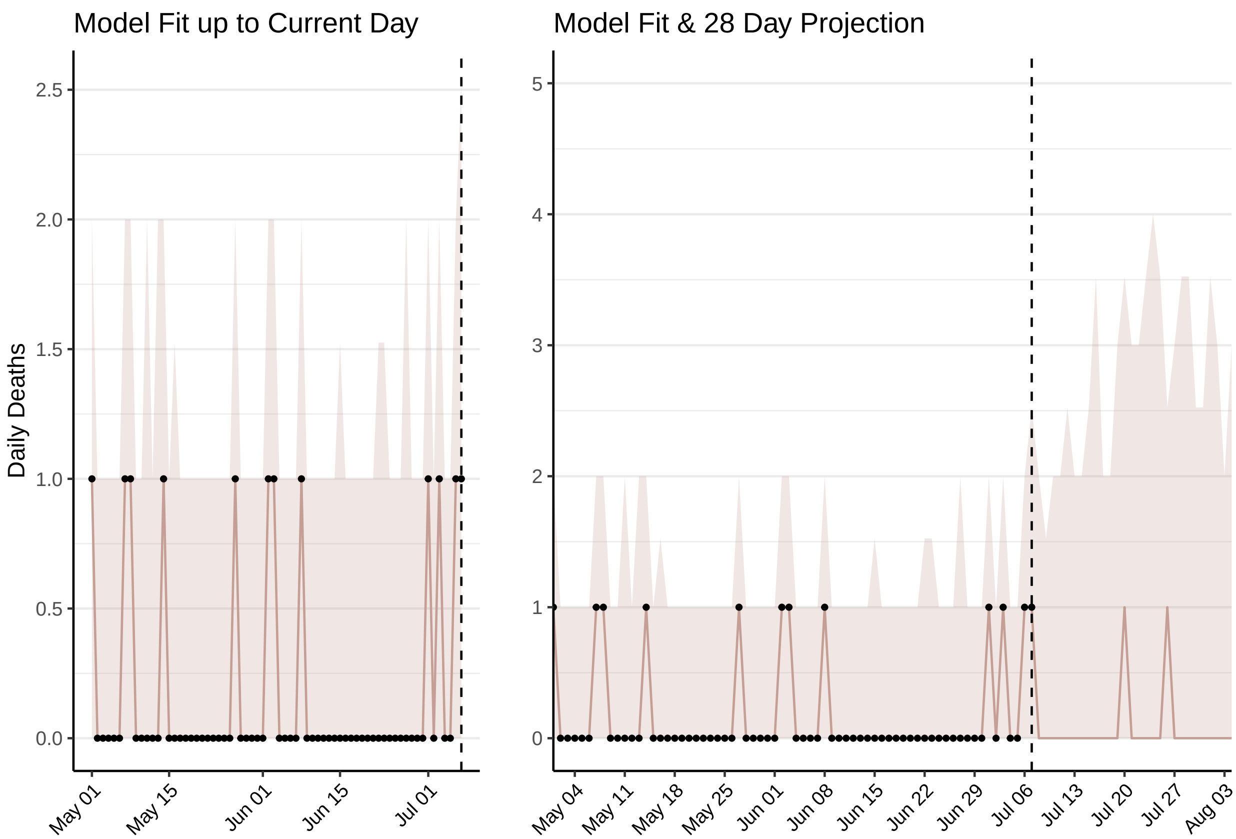

Figure 4: **Estimated daily deaths.** Projected deaths assuming the current level of interventions are maintained are shown in red (median and 95% quantile). Reported deaths are plotted in black. The plot on the left is focussed on the model fit prior to today, while the plot on the right forecasts the next 28 days.

Short-term Epidemic Scenarios

We make the following short-term projections of healthcare demand and new infections under the following three scenarios:

- **Scenario 1.** The epidemic continues to grow at the current rate.
- **Scenario 2.** Countries will further scale up interventions (either increasing current strategies or implementing new interventions) leading to a further 50% reduction in transmission.
- **Scenario 3.** Countries will relax current interventions by 50%

N.B. These scenarios currently assume that the impact of mobility on transmission will remain the same in the future as it has in the past. We are working to extend methods to estimate the impact of increases in mobility on transmission as lockdown and interventions are reversed. Consequently, projection are likely to represent an upper estimate of the healthcare demand and case load for each scenario

We estimate that over the next 4 weeks demand for hospital beds will change from 23 (95% CI: 20-27) patients requiring treatment with high-pressure oxygen at the current date to 34 (95% CI: 28-41) hospital beds being required on 2020-08-04 if no further interventions are introduced (Scenario 1). Similarly, we estimate that over the next 4 weeks demand for critical care (ICU) beds will change from 6 (95% CI: 5-7) patients requiring treatment with mechanical ventilation at the current date to 10 (95% CI: 8-11) by 2020-08-04. These projections assume that approximately 5% of all infections will require treatment with high-pressure oxygen and that approximately 30% of hospitalised cases will require treatment with mechanical ventilation (based on analysis of ongoing epidemics in Europe). **N.B. These scenarios are unlikely to show significant differences for the first week since there is a delay of approximately 10 days between infection and hospital admission. Consequently, the effectiveness of a change in policy is likely to be better captured by hospital admission data approximately 2 weeks after the policy change is implemented.**

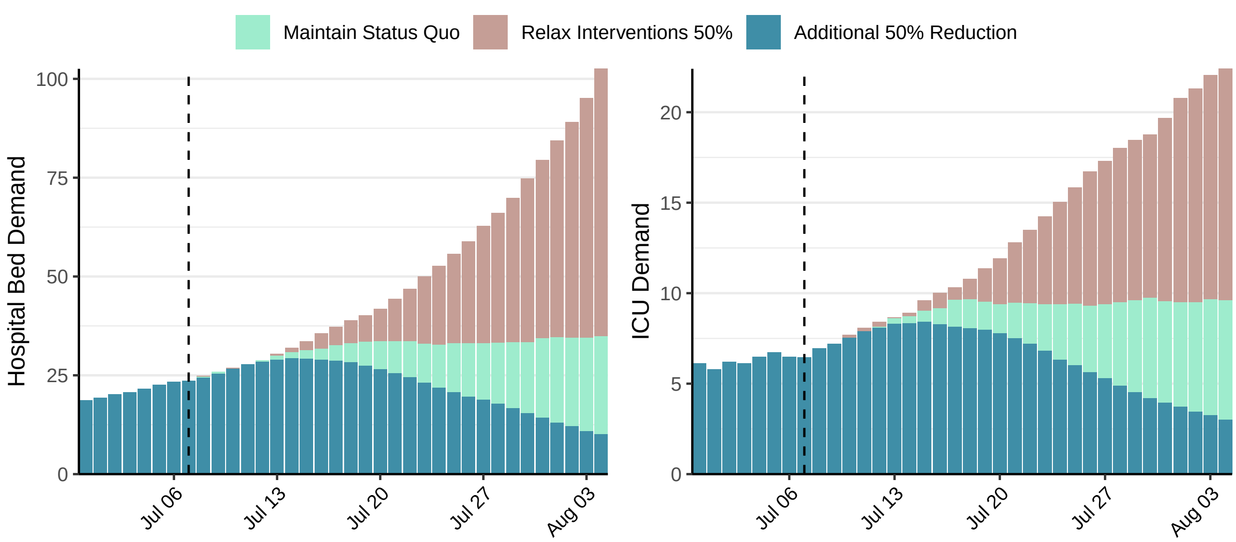

Figure 5: **Healthcare demands in the next 28 days.** Individuals needing an ICU bed are assumed to need mechanical ventilation. Projected demand for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

The impact of each scenario has a more immediate effect on the daily number of infections. The figure below shows the impact of each scenario on the estimated daily incidence of new infections. If interventions are scaled up (Scenario 2), the daily number of infections will change from 188 (95% CI: 163-213) at the current date to 16 (95% CI: 12-20) by 2020-08-04. If current interventions were relaxed by 50%, we estimate the daily number of infections will change from 188 (95% CI: 163-213) at the current date to 1,062 (95% CI: 785-1,339) by 2020-08-04.

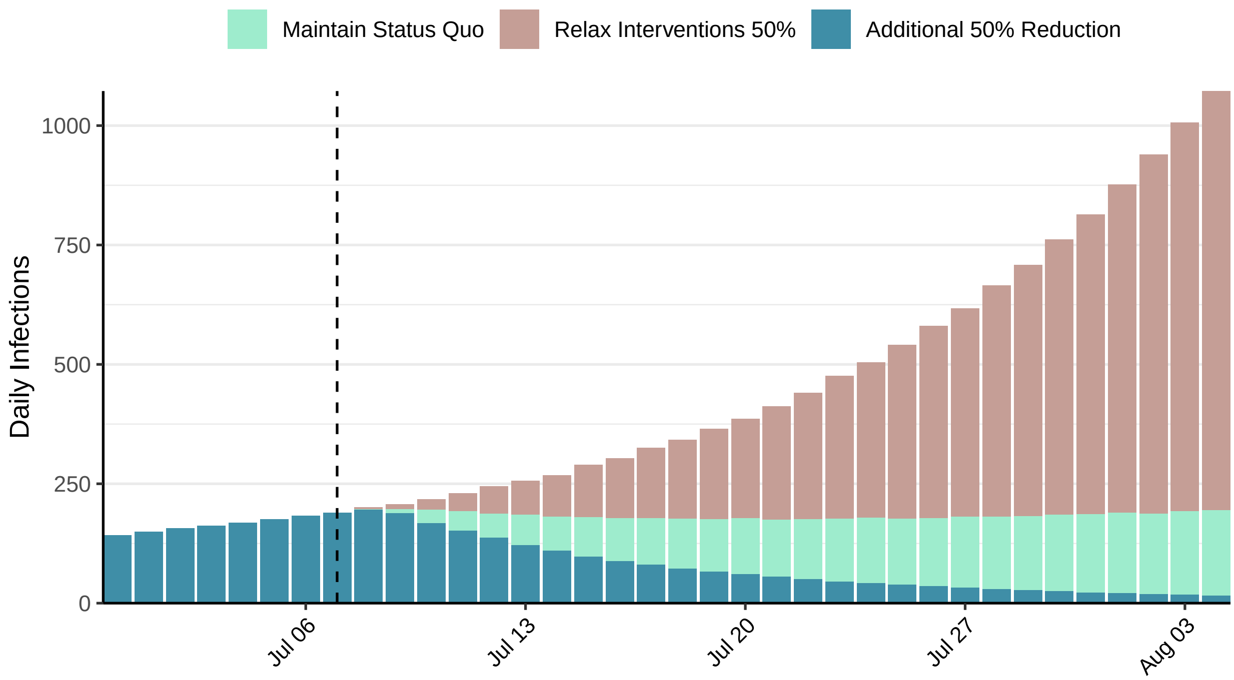

Figure 6: **Daily number of infections estimated by fitting to deaths.** Projected infections for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

To explore different scenarios, we recommend using our COVID-19 Scenario Analysis Tool - https://covidsim.org/, which can be used to simulate different intervention scenarios and explore the long term impact on healthcare demand.

Situation Report for COVID-19: Mexico, 2020-07-07

Download the report for Mexico, 2020-07-07 here. This report uses data from the European Centre for Disease Control. These data are updated daily and whilst there may be a short delay, they are generally consistent with Ministry reports. These data are then used to back-calculate an 'inferred number of COVID-19 infections' using mathematical modelling techniques (see Report 12 for further details) to estimate the number of people that have been infected and to make short-term projections for future healthcare needs.

Epidemiological Situation

Total Reported Cases	New Reported Cases	Total Reported Deaths	New Reported Deaths	Estimated R_t
261,750	4,902	31,119	480	1.17 (95% CI: 1.11-1.24)

The figure below shows the cumulative reported deaths as a function of the time since the 10th death was reported. Dashed lines show the expected trajectory for different doubling times of the epidemic. For example, with a doubling time of 3 days, if there are currently a total of 20 deaths reported, we would expect there to be 40 deaths in total reported in 3 days-time, 80 deaths in 6 days-time, 160 deaths in 9 days-time etc. For most epidemics, in the absence of interventions, we expect a doubling time of 3-4 days for this disease.

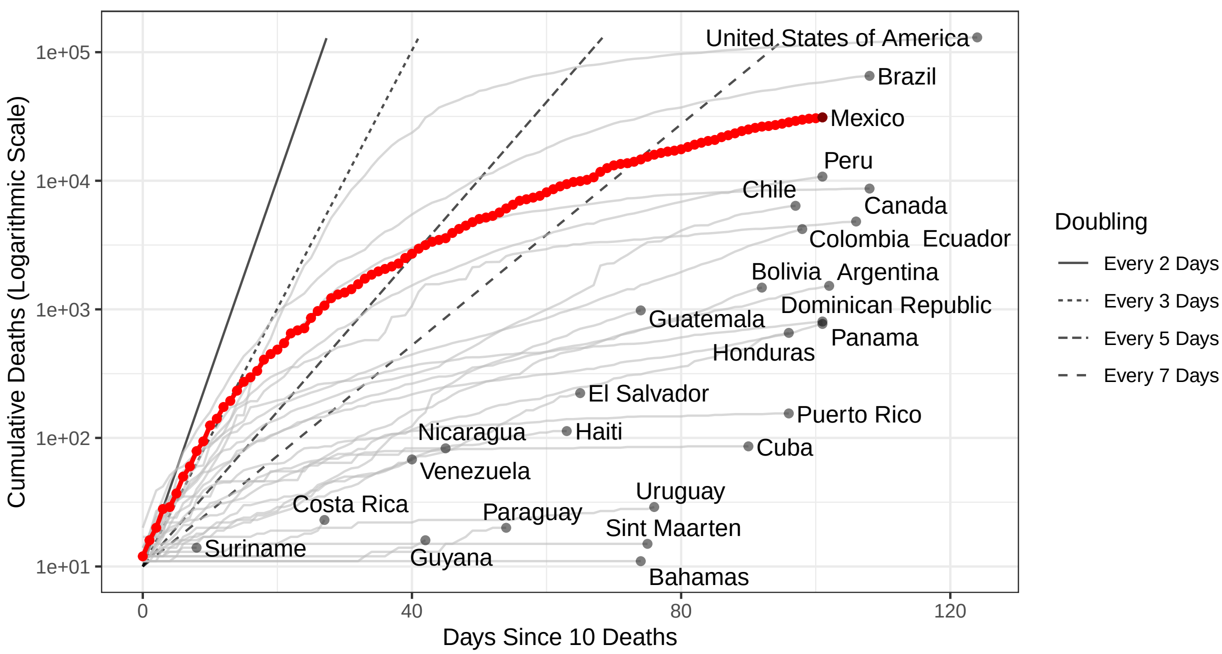

Figure 1: **Cumulative Deaths since 10 deaths.** Country not shown if fewer than 10 deaths.

COVID-19 Transmission Modelling

We assume that the deaths reported to date provide the best indication of the stage of the epidemic, as deaths are more consistently and accurately reported. Our current working estimate is that 1 death indicates that approximately 100 people will have been infected with the other 99 recovering (based on an infection fatality ratio of ~1%). These infections will have happened approximately 21 days previously – capturing a 5-day period from infection to onset of symptoms (the incubation period), 4 days from onset of symptoms to hospitalisation, and 12 days in hospital before death. With a 3-day doubling time, 100 infections that occurred 15 days ago will have generated 200 infections 12 days ago, 400 infections 9 days ago, 800 infections 6 days ago and 1,600 infections 3 days ago resulting in approximately 3,200 infections at the time the first death is observed.

To explore this, we fit our age-structured SEIR model (see Methods) to the time series of deaths in a country, in order to estimate the start date of the epidemic and the baseline R0. We assume that 100% of COVID-19 related deaths have been reported. We have also included the impact of interventions that have been put in place and their effect on human mobility and transmission based on the Google COVID-19 Community Mobility Reports. Using our mathematical model that formalises this approach, we estimate that there has been a total of 5,326,665 (95% CI: 5,138,821-5,514,509) infections over the past 4 weeks.

The figure below shows the estimated number of people infected over the past 4 weeks. The bar charts show, for comparison, the number of reported cases. The right-hand plot shows these data on a different scale as the estimated infections are likely to be much larger than the reported cases. **Importantly**, the estimated infections includes both asymptomatic and mild cases that would not necessarily be identified through surveillance. Consequently, the estimated infections are likely to be significantly higher than the reported cases (see our FAQ for further explanation of these differences and why the reported cases and estimated infections are unlikely to match).

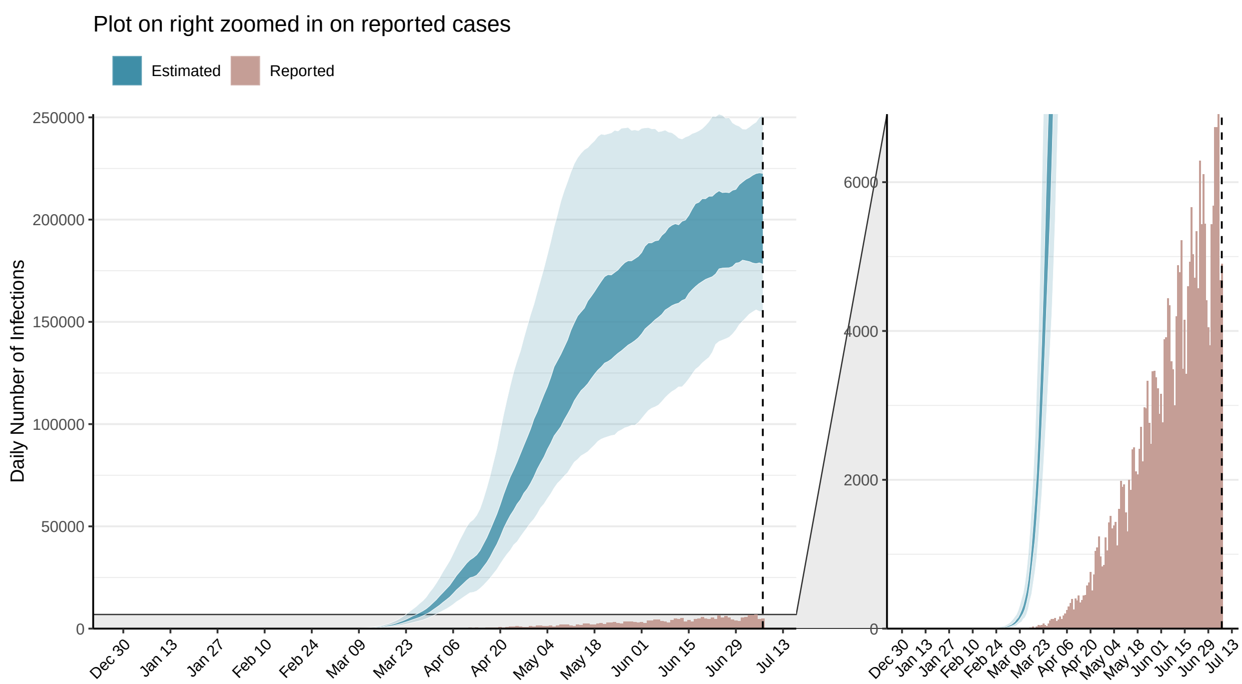

Figure 2: **Daily number of infections estimated by fitting to the current total of deaths.** Reported cases are shown in red. Model estimated infections are shown in blue (dark blue 50% interquartile range, light blue 95% quantile). The dashed line shows the current day.

By fitting to the time series of deaths, we are able to estimate a time-varying reproduction number, R_t. R_t is the the average number of secondary infections caused by a single infected person at a given time. If R_t is above 1, the rate of transmission is increasing and the number of new infections is increasing. R_t is assumed to change in relation to mobility fall in proportion. When fitting our model we assume that 100% of COVID-19 related deaths have been reported (please see our FAQ section for more information about this assumption). We also assume a fixed date at which the impact of mobility on transmission changes from pre-lockdown levels to post-lockdown levels, which may cause large changes in Rt. We are working to refine how this switch occurs and to formally calculate its shape.

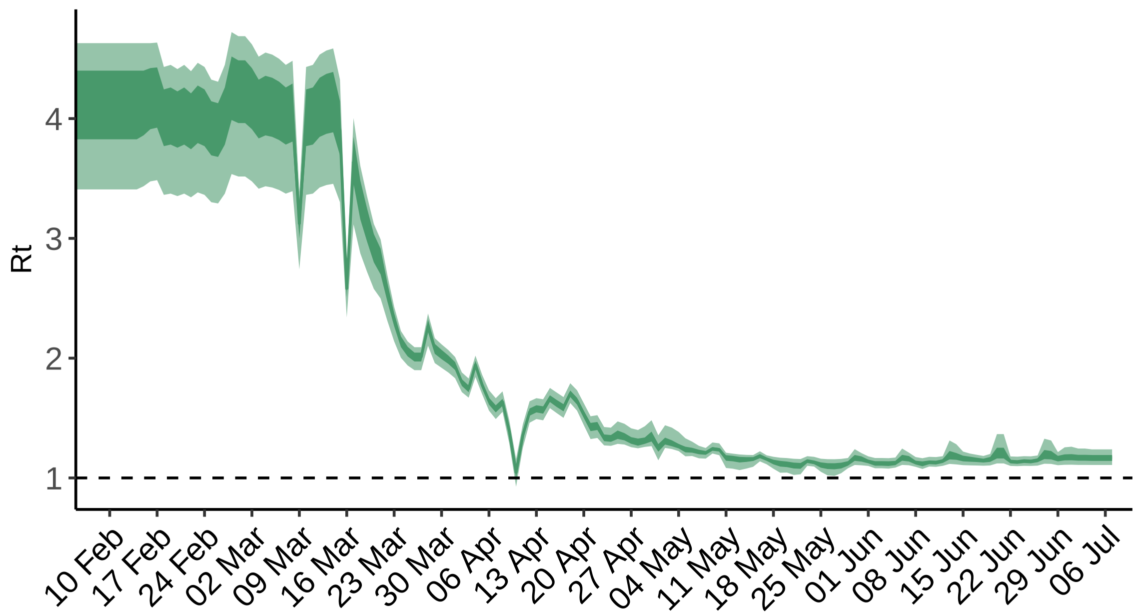

Figure 3: **Time-varying reproduction number, R_t.** R_t is the average number of secondary infections caused by a single infected person at time equal to t. $R_t < 1$ indicates a slowing epidemic in which new infections are not increasing. $R_t > 1$ indicates a growing epidemic in which new infections are increasing over time. Dark green shows the 50% CI and light green shows the 95% CI.

Using the model fit, we can forecast the expected trajectory for cumulative deaths, which is shown in the figure below. This assumes a severity pattern by age that is consistent with that observed in China, Europe and the U.S to date. This projection assumes that transmission is maintained at the current level of transmission as estimated by the final R_t value. **N.B. Mexico is forecast to be close to or surpassing our best estimates for healthcare capacity in the next 28 days.** Estimates of deaths in the next 28 days may be inaccurate due to our working assumptions for mortality in individuals who do not receive appropriate treatment. See our methods for more information.

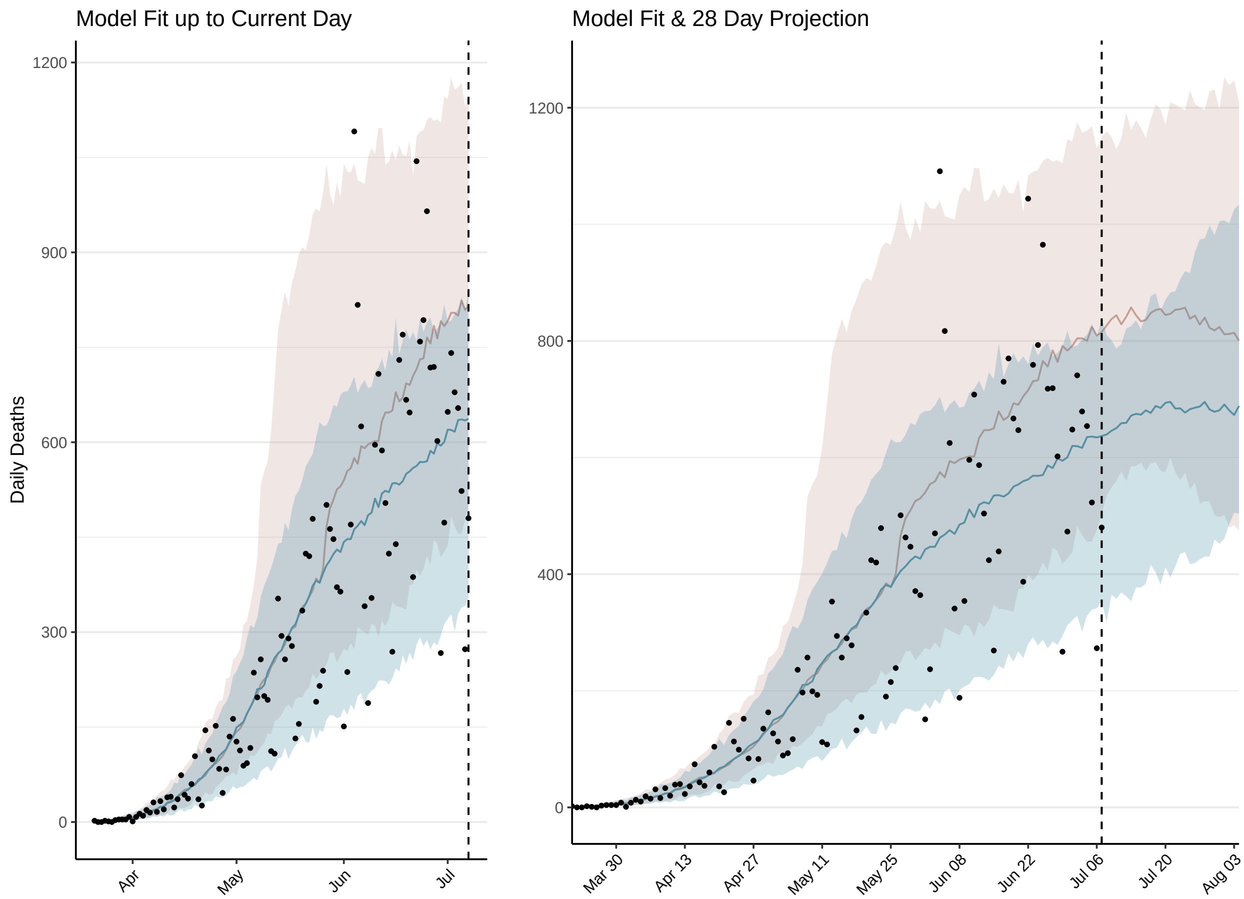

Figure 4: **Estimated daily deaths.** Projected deaths assuming the current level of interventions are maintained are shown in red (median and 95% quantile). Reported deaths are plotted in black. The plot on the left is focussed on the model fit prior to today, while the plot on the right forecasts the next 28 days. The forecasted deaths in blue assumes healthcare capacity has been surged to ensure sufficient supply of ICU and hospital beds. The red curve assumes no surging in healthcare capacity and subsequently projects increased deaths.

Short-term Epidemic Scenarios

We make the following short-term projections of healthcare demand and new infections under the following three scenarios:

- **Scenario 1.** The epidemic continues to grow at the current rate.
- **Scenario 2.** Countries will further scale up interventions (either increasing current strategies or implementing new interventions) leading to a further 50% reduction in transmission.
- **Scenario 3.** Countries will relax current interventions by 50%

N.B. These scenarios currently assume that the impact of mobility on transmission will remain the same in the future as it has in the past. We are working to extend methods to estimate the impact of increases in mobility on transmission as lockdown and interventions are reversed. Consequently, projection are likely to represent an upper estimate of the healthcare demand and case load for each scenario

We estimate that over the next 4 weeks demand for hospital beds will change from 30,062 (95% CI: 28,975-31,150) patients requiring treatment with high-pressure oxygen at the current date to 30,704 (95% CI: 29,481-31,927) hospital beds being required on 2020-08-04 if no further interventions are introduced (Scenario 1). Similarly, we estimate that over the next 4 weeks demand for critical care (ICU) beds will change from 6,356 (95% CI: 6,218-6,494) patients requiring treatment with mechanical ventilation at the current date to 6,343 (95% CI: 6,209-6,477) by 2020-08-04. These projections assume that approximately 5% of all infections will require treatment with high-pressure oxygen and that approximately 30% of hospitalised cases will require treatment with mechanical ventilation (based on analysis of ongoing epidemics in Europe). **N.B. These scenarios are unlikely to show significant differences for the first week since there is a delay of approximately 10 days between infection and hospital admission. Consequently, the effectiveness of a change in policy is likely to be better captured by hospital admission data approximately 2 weeks after the policy change is implemented.**

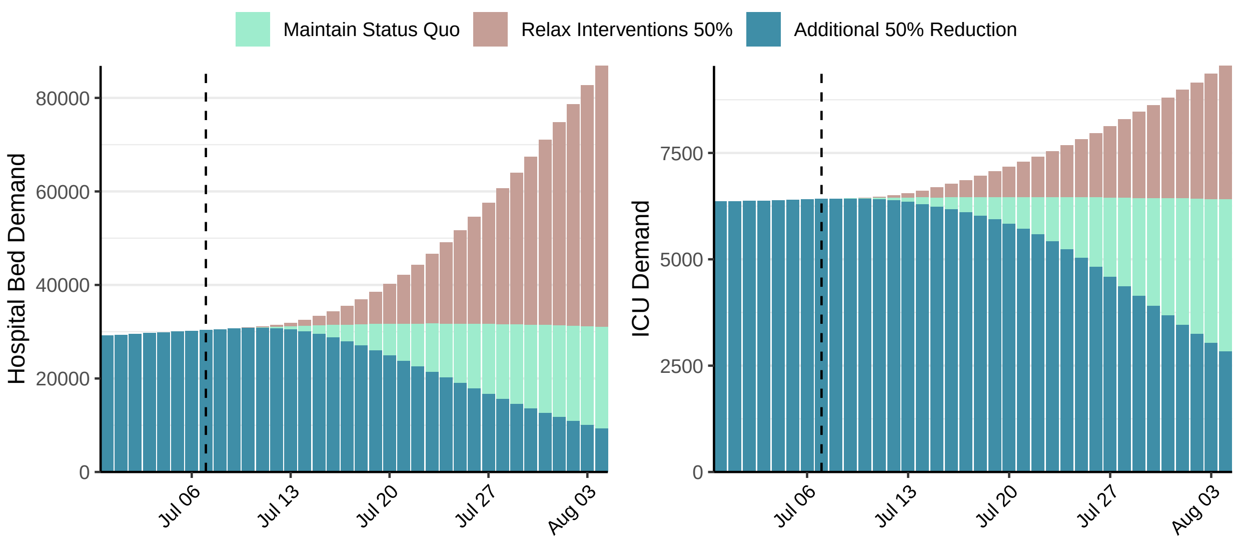

Figure 5: **Healthcare demands in the next 28 days.** Individuals needing an ICU bed are assumed to need mechanical ventilation. Projected demand for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

The impact of each scenario has a more immediate effect on the daily number of infections. The figure below shows the impact of each scenario on the estimated daily incidence of new infections. If interventions are scaled up (Scenario 2), the daily number of infections will change from 198,967 (95% CI: 192,088-205,846) at the current date to 16,297 (95% CI: 15,576-17,017) by 2020-08-04. If current interventions were relaxed by 50%, we estimate the daily number of infections will change from 198,967 (95% CI: 192,088-205,846) at the current date to 806,511 (95% CI: 772,539-840,483) by 2020-08-04.

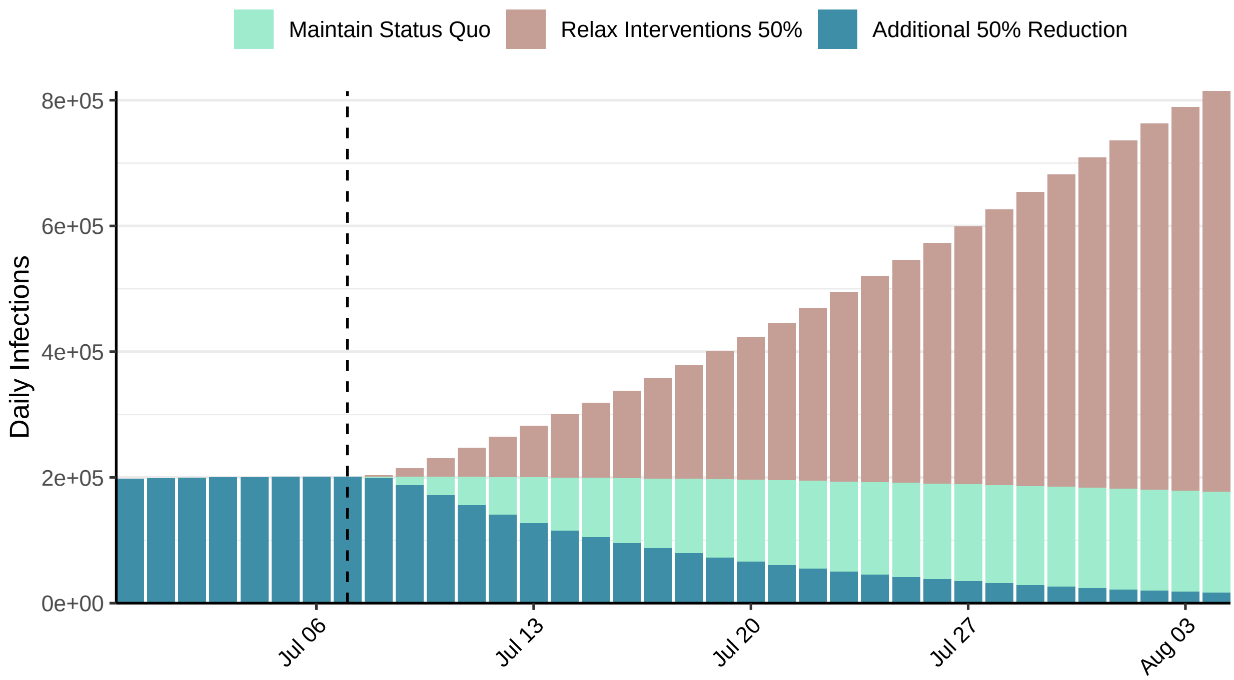

Figure 6: **Daily number of infections estimated by fitting to deaths.** Projected infections for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

To explore different scenarios, we recommend using our COVID-19 Scenario Analysis Tool - https://covidsim.org/, which can be used to simulate different intervention scenarios and explore the long term impact on healthcare demand.

Situation Report for COVID-19: North Macedonia, 2020-07-07

Download the report for North Macedonia, 2020-07-07 here. This report uses data from the European Centre for Disease Control. These data are updated daily and whilst there may be a short delay, they are generally consistent with Ministry reports. These data are then used to back-calculate an 'inferred number of COVID-19 infections' using mathematical modelling techniques (see Report 12 for further details) to estimate the number of people that have been infected and to make short-term projections for future healthcare needs.

Epidemiological Situation

Total Reported Cases	New Reported Cases	Total Reported Deaths	New Reported Deaths	Estimated R_t
7,122	76	346	5	1.49 (95% CI: 1.32-1.66)

The figure below shows the cumulative reported deaths as a function of the time since the 10th death was reported. Dashed lines show the expected trajectory for different doubling times of the epidemic. For example, with a doubling time of 3 days, if there are currently a total of 20 deaths reported, we would expect there to be 40 deaths in total reported in 3 days-time, 80 deaths in 6 days-time, 160 deaths in 9 days-time etc. For most epidemics, in the absence of interventions, we expect a doubling time of 3-4 days for this disease.

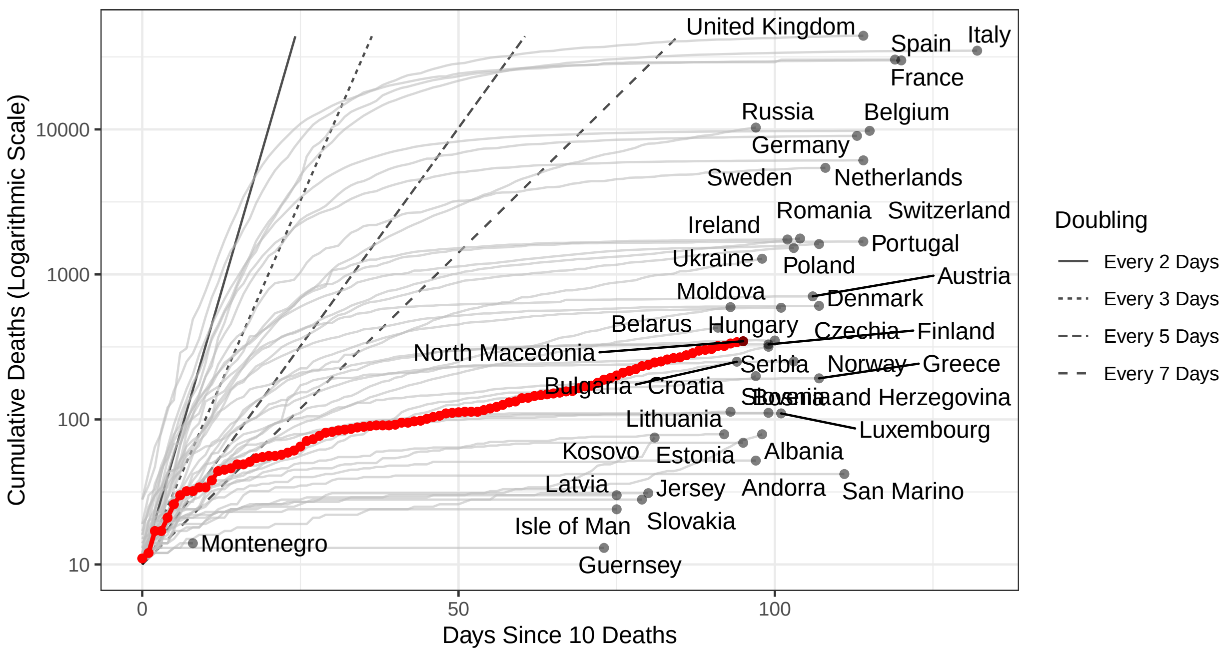

Figure 1: **Cumulative Deaths since 10 deaths.** Country not shown if fewer than 10 deaths.

COVID-19 Transmission Modelling

We assume that the deaths reported to date provide the best indication of the stage of the epidemic, as deaths are more consistently and accurately reported. Our current working estimate is that 1 death indicates that approximately 100 people will have been infected with the other 99 recovering (based on an infection fatality ratio of ~1%). These infections will have happened approximately 21 days previously – capturing a 5-day period from infection to onset of symptoms (the incubation period), 4 days from onset of symptoms to hospitalisation, and 12 days in hospital before death. With a 3-day doubling time, 100 infections that occurred 15 days ago will have generated 200 infections 12 days ago, 400 infections 9 days ago, 800 infections 6 days ago and 1,600 infections 3 days ago resulting in approximately 3,200 infections at the time the first death is observed.

To explore this, we fit our age-structured SEIR model (see Methods) to the time series of deaths in a country, in order to estimate the start date of the epidemic and the baseline R0. We assume that 100% of COVID-19 related deaths have been reported. We have also included the impact of interventions that have been put in place and their effect on human mobility and transmission based on the Google COVID-19 Community Mobility Reports. Using our mathematical model that formalises this approach, we estimate that there has been a total of 103,914 (95% CI: 98,527-109,300) infections over the past 4 weeks.

The figure below shows the estimated number of people infected over the past 4 weeks. The bar charts show, for comparison, the number of reported cases. The right-hand plot shows these data on a different scale as the estimated infections are likely to be much larger than the reported cases. **Importantly**, the estimated infections includes both asymptomatic and mild cases that would not necessarily be identified through surveillance. Consequently, the estimated infections are likely to be significantly higher than the reported cases (see our FAQ for further explanation of these differences and why the reported cases and estimated infections are unlikely to match).

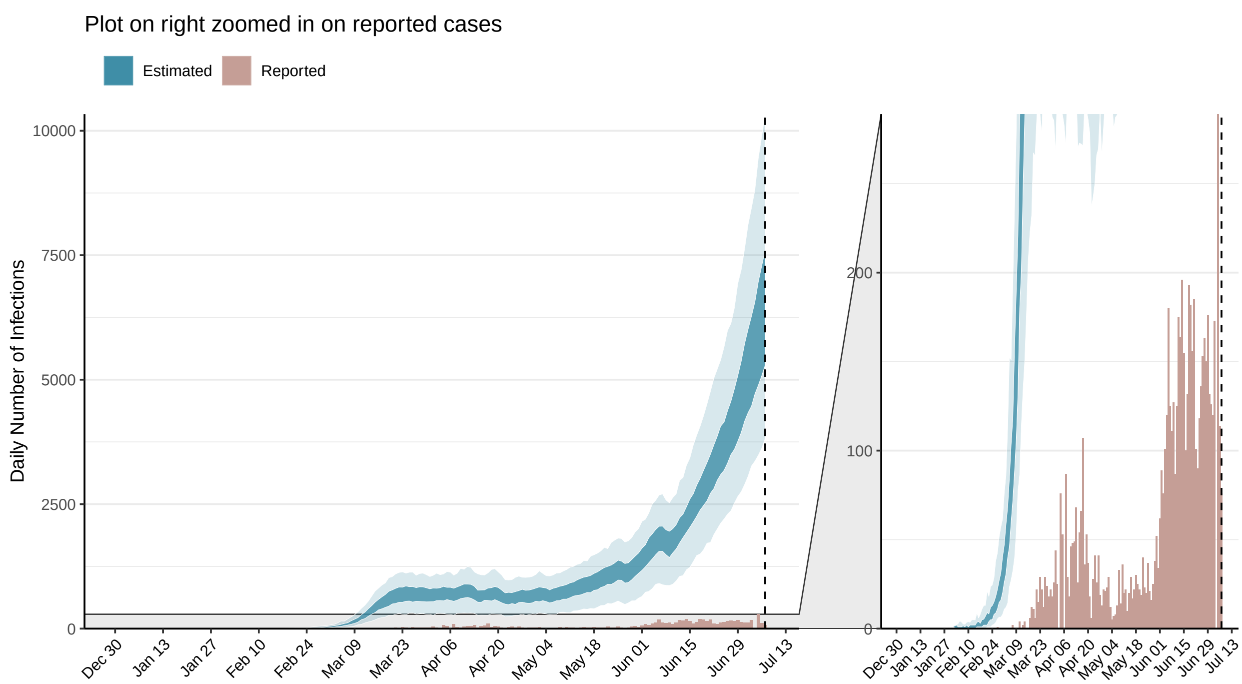

Figure 2: **Daily number of infections estimated by fitting to the current total of deaths.** Reported cases are shown in red. Model estimated infections are shown in blue (dark blue 50% interquartile range, light blue 95% quantile). The dashed line shows the current day.

By fitting to the time series of deaths, we are able to estimate a time-varying reproduction number, R_t. R_t is the the average number of secondary infections caused by a single infected person at a given time. If R_t is above 1, the rate of transmission is increasing and the number of new infections is increasing. R_t is assumed to change in relation to mobility fall in proportion. When fitting our model we assume that 100% of COVID-19 related deaths have been reported (please see our FAQ section for more information about this assumption). We also assume a fixed date at which the impact of mobility on transmission changes from pre-lockdown levels to post-lockdown levels, which may cause large changes in Rt. We are working to refine how this switch occurs and to formally calculate its shape.

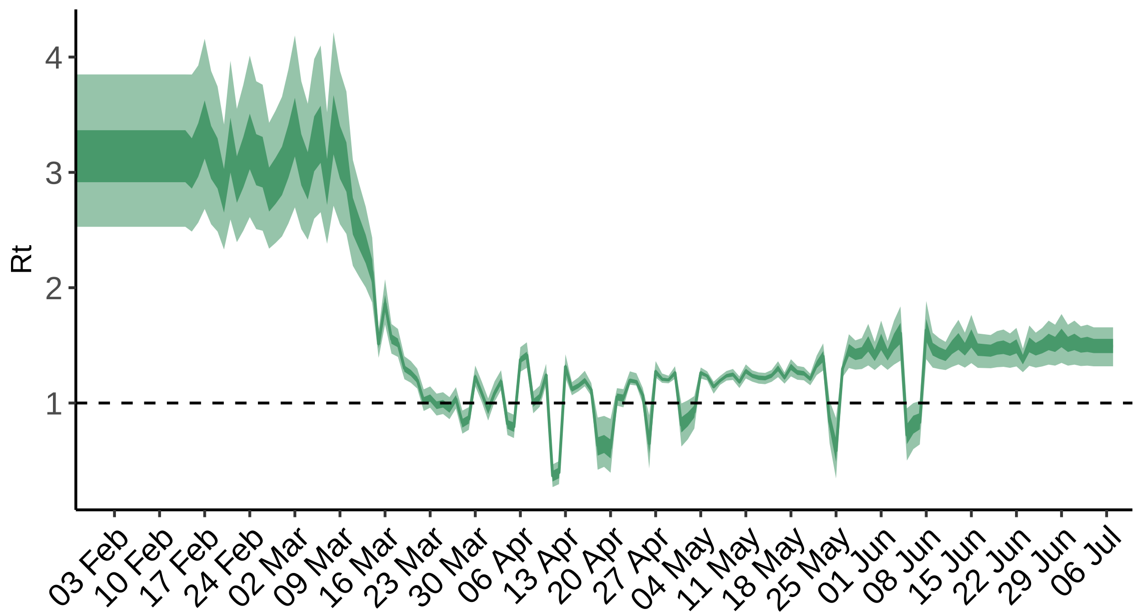

Figure 3: **Time-varying reproduction number, R_t.** R_t is the average number of secondary infections caused by a single infected person at time equal to t. $R_t < 1$ indicates a slowing epidemic in which new infections are not increasing. $R_t > 1$ indicates a growing epidemic in which new infections are increasing over time. Dark green shows the 50% CI and light green shows the 95% CI.

Using the model fit, we can forecast the expected trajectory for cumulative deaths, which is shown in the figure below. This assumes a severity pattern by age that is consistent with that observed in China, Europe and the U.S to date. This projection assumes that transmission is maintained at the current level of transmission as estimated by the final R_t value. **N.B. North Macedonia is forecast to be close to or surpassing our best estimates for healthcare capacity in the next 28 days.** Estimates of deaths in the next 28 days may be inaccurate due to our working assumptions for mortality in individuals who do not receive appropriate treatment. See our methods for more information.

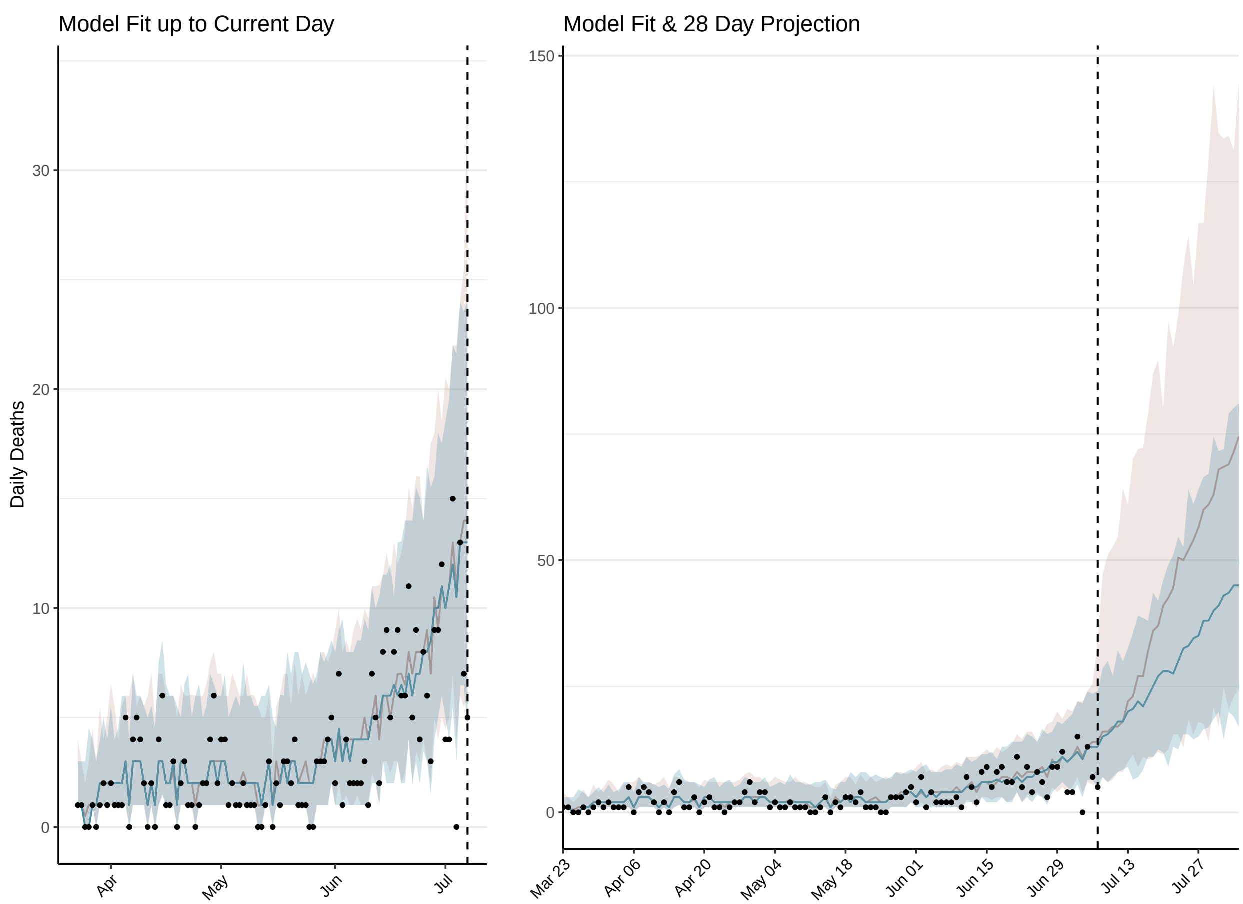

Figure 4: **Estimated daily deaths.** Projected deaths assuming the current level of interventions are maintained are shown in red (median and 95% quantile). Reported deaths are plotted in black. The plot on the left is focussed on the model fit prior to today, while the plot on the right forecasts the next 28 days. The forecasted deaths in blue assumes healthcare capacity has been surged to ensure sufficient supply of ICU and hospital beds. The red curve assumes no surging in healthcare capacity and subsequently projects increased deaths.

Short-term Epidemic Scenarios

We make the following short-term projections of healthcare demand and new infections under the following three scenarios:

- **Scenario 1.** The epidemic continues to grow at the current rate.
- **Scenario 2.** Countries will further scale up interventions (either increasing current strategies or implementing new interventions) leading to a further 50% reduction in transmission.
- **Scenario 3.** Countries will relax current interventions by 50%

N.B. These scenarios currently assume that the impact of mobility on transmission will remain the same in the future as it has in the past. We are working to extend methods to estimate the impact of increases in mobility on transmission as lockdown and interventions are reversed. Consequently, projection are likely to represent an upper estimate of the healthcare demand and case load for each scenario

We estimate that over the next 4 weeks demand for hospital beds will change from 883 (95% CI: 834-933) patients requiring treatment with high-pressure oxygen at the current date to 2,449 (95% CI: 2,281-2,616) hospital beds being required on 2020-08-04 if no further interventions are introduced (Scenario 1). Similarly, we estimate that over the next 4 weeks demand for critical care (ICU) beds will change from 235 (95% CI: 222-248) patients requiring treatment with mechanical ventilation at the current date to 397 (95% CI: 386-408) by 2020-08-04. These projections assume that approximately 5% of all infections will require treatment with high-pressure oxygen and that approximately 30% of hospitalised cases will require treatment with mechanical ventilation (based on analysis of ongoing epidemics in Europe). **N.B. These scenarios are unlikely to show significant differences for the first week since there is a delay of approximately 10 days between infection and hospital admission. Consequently, the effectiveness of a change in policy is likely to be better captured by hospital admission data approximately 2 weeks after the policy change is implemented.**

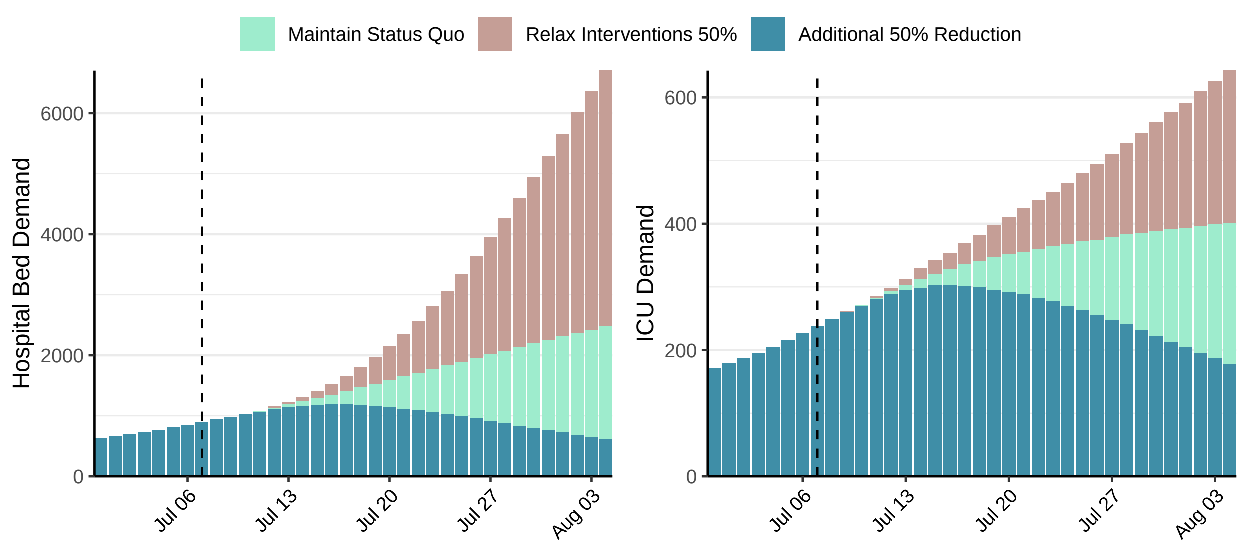

Figure 5: **Healthcare demands in the next 28 days.** Individuals needing an ICU bed are assumed to need mechanical ventilation. Projected demand for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

The impact of each scenario has a more immediate effect on the daily number of infections. The figure below shows the impact of each scenario on the estimated daily incidence of new infections. If interventions are scaled up (Scenario 2), the daily number of infections will change from 6,463 (95% CI: 6,069-6,858) at the current date to 1,190 (95% CI: 1,098-1,282) by 2020-08-04. If current interventions were relaxed by 50%, we estimate the daily number of infections will change from 6,463 (95% CI: 6,069-6,858) at the current date to 36,413 (95% CI: 35,136-37,690) by 2020-08-04.

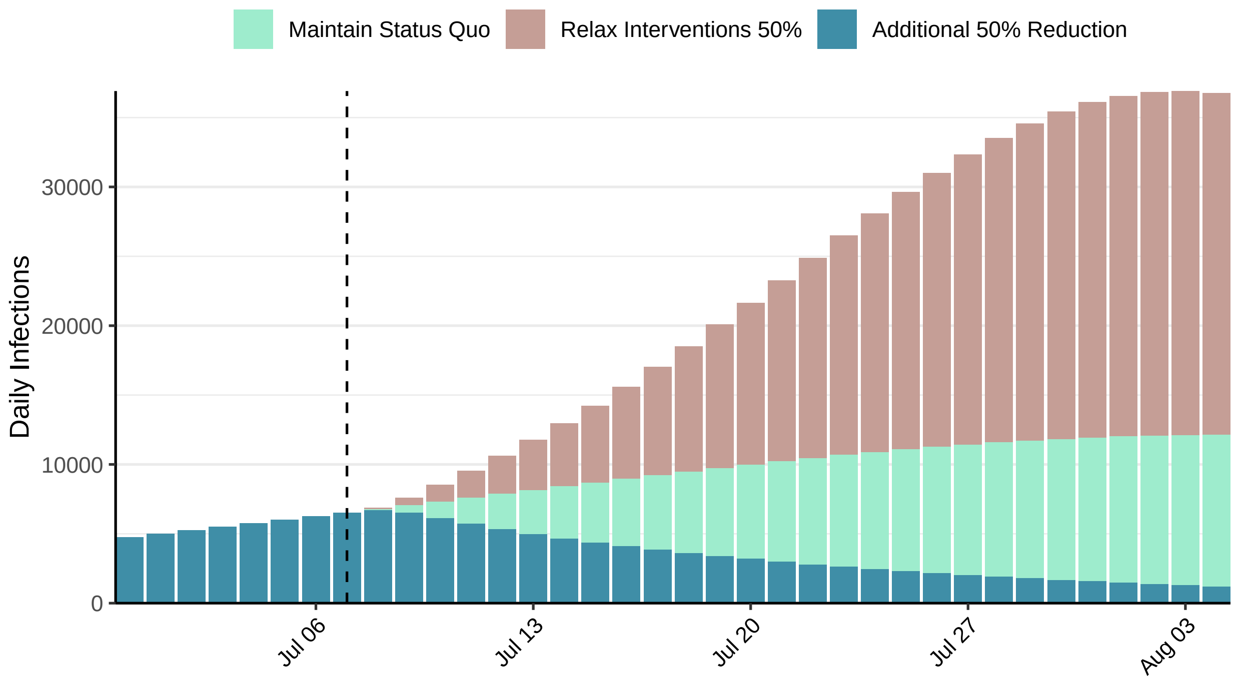

Figure 6: **Daily number of infections estimated by fitting to deaths.** Projected infections for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

To explore different scenarios, we recommend using our COVID-19 Scenario Analysis Tool - https://covidsim.org/, which can be used to simulate different intervention scenarios and explore the long term impact on healthcare demand.

Situation Report for COVID-19: Mali, 2020-07-07

Download the report for Mali, 2020-07-07 here. This report uses data from the European Centre for Disease Control. These data are updated daily and whilst there may be a short delay, they are generally consistent with Ministry reports. These data are then used to back-calculate an 'inferred number of COVID-19 infections' using mathematical modelling techniques (see Report 12 for further details) to estimate the number of people that have been infected and to make short-term projections for future healthcare needs.

Epidemiological Situation

Total Reported Cases	New Reported Cases	Total Reported Deaths	New Reported Deaths	Estimated R_t
2,331	1	119	0	0.96 (95% CI: 0.9-1.04)

The figure below shows the cumulative reported deaths as a function of the time since the 10th death was reported. Dashed lines show the expected trajectory for different doubling times of the epidemic. For example, with a doubling time of 3 days, if there are currently a total of 20 deaths reported, we would expect there to be 40 deaths in total reported in 3 days-time, 80 deaths in 6 days-time, 160 deaths in 9 days-time etc. For most epidemics, in the absence of interventions, we expect a doubling time of 3-4 days for this disease.

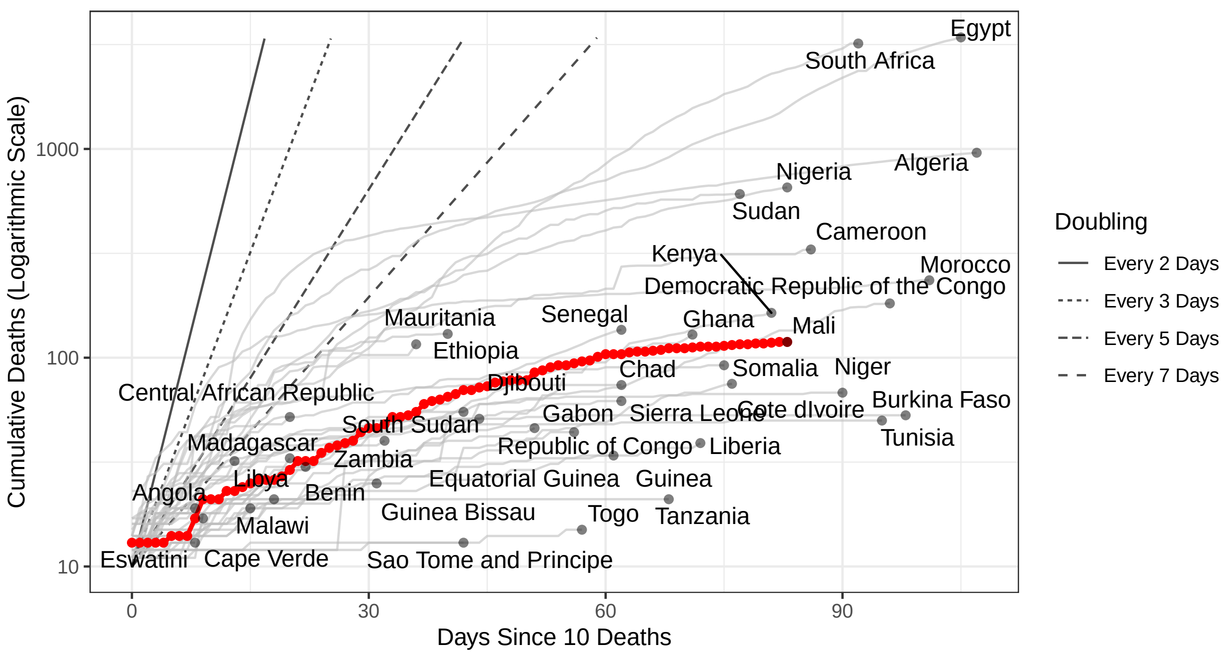

Figure 1: **Cumulative Deaths since 10 deaths.** Country not shown if fewer than 10 deaths.

COVID-19 Transmission Modelling

We assume that the deaths reported to date provide the best indication of the stage of the epidemic, as deaths are more consistently and accurately reported. Our current working estimate is that 1 death indicates that approximately 100 people will have been infected with the other 99 recovering (based on an infection fatality ratio of ~1%). These infections will have happened approximately 21 days previously – capturing a 5-day period from infection to onset of symptoms (the incubation period), 4 days from onset of symptoms to hospitalisation, and 12 days in hospital before death. With a 3-day doubling time, 100 infections that occurred 15 days ago will have generated 200 infections 12 days ago, 400 infections 9 days ago, 800 infections 6 days ago and 1,600 infections 3 days ago resulting in approximately 3,200 infections at the time the first death is observed.

To explore this, we fit our age-structured SEIR model (see Methods) to the time series of deaths in a country, in order to estimate the start date of the epidemic and the baseline R0. We assume that 100% of COVID-19 related deaths have been reported. We have also included the impact of interventions that have been put in place and their effect on human mobility and transmission based on the Google COVID-19 Community Mobility Reports. Using our mathematical model that formalises this approach, we estimate that there has been a total of 18,355 (95% CI: 16,579-20,130) infections over the past 4 weeks.

The figure below shows the estimated number of people infected over the past 4 weeks. The bar charts show, for comparison, the number of reported cases. The right-hand plot shows these data on a different scale as the estimated infections are likely to be much larger than the reported cases. **Importantly**, the estimated infections includes both asymptomatic and mild cases that would not necessarily be identified through surveillance. Consequently, the estimated infections are likely to be significantly higher than the reported cases (see our FAQ for further explanation of these differences and why the reported cases and estimated infections are unlikely to match).

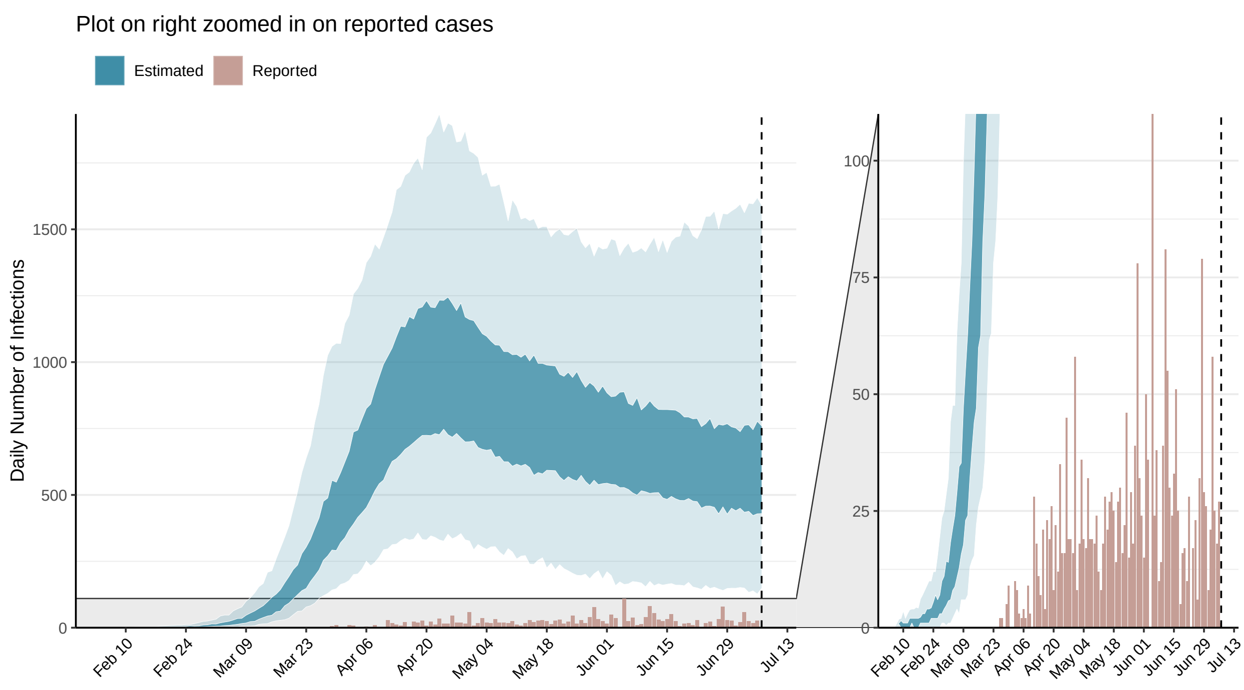

Figure 2: **Daily number of infections estimated by fitting to the current total of deaths.** Reported cases are shown in red. Model estimated infections are shown in blue (dark blue 50% interquartile range, light blue 95% quantile). The dashed line shows the current day.

By fitting to the time series of deaths, we are able to estimate a time-varying reproduction number, R_t. R_t is the the average number of secondary infections caused by a single infected person at a given time. If R_t is above 1, the rate of transmission is increasing and the number of new infections is increasing. R_t is assumed to change in relation to mobility fall in proportion. When fitting our model we assume that 100% of COVID-19 related deaths have been reported (please see our FAQ section for more information about this assumption). We also assume a fixed date at which the impact of mobility on transmission changes from pre-lockdown levels to post-lockdown levels, which may cause large changes in Rt. We are working to refine how this switch occurs and to formally calculate its shape.

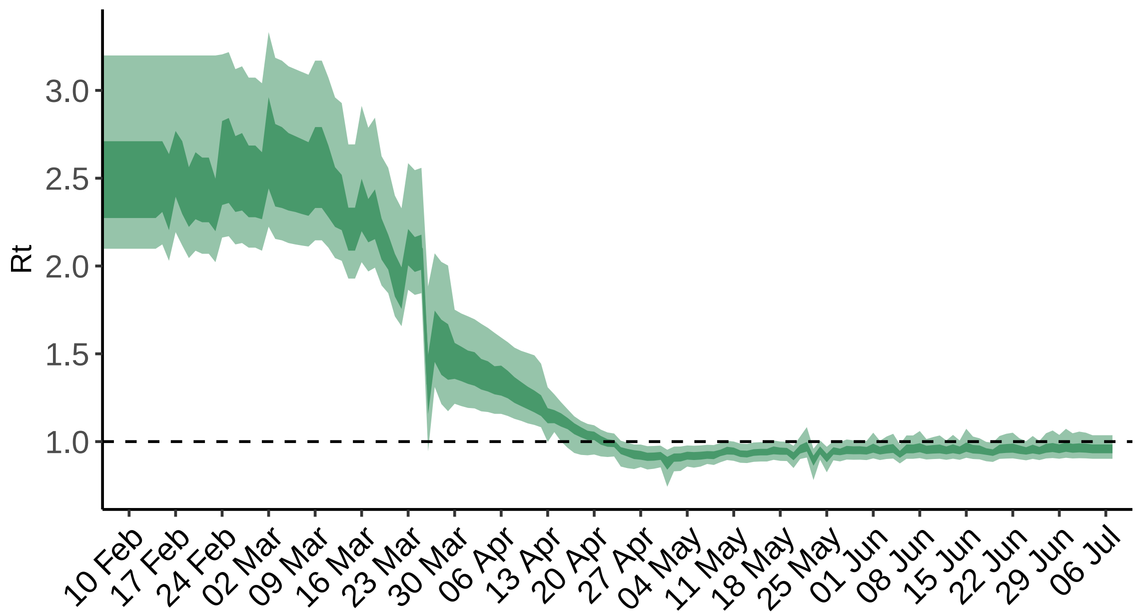

Figure 3: **Time-varying reproduction number, R_t.** R_t is the average number of secondary infections caused by a single infected person at time equal to t. $R_t < 1$ indicates a slowing epidemic in which new infections are not increasing. $R_t > 1$ indicates a growing epidemic in which new infections are increasing over time. Dark green shows the 50% CI and light green shows the 95% CI.

Using the model fit, we can forecast the expected trajectory for cumulative deaths, which is shown in the figure below. This assumes a severity pattern by age that is consistent with that observed in China, Europe and the U.S to date. This projection assumes that transmission is maintained at the current level of transmission as estimated by the final R_t value.

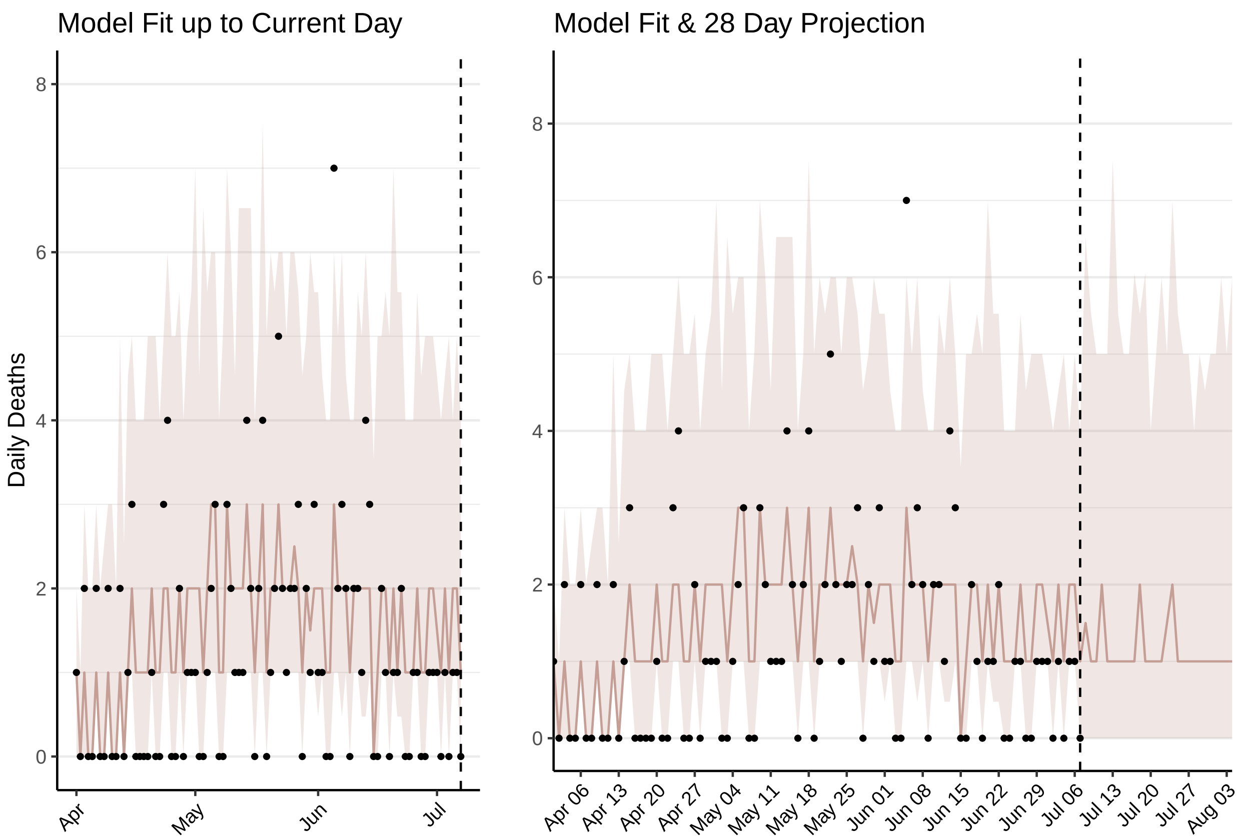

Figure 4: **Estimated daily deaths.** Projected deaths assuming the current level of interventions are maintained are shown in red (median and 95% quantile). Reported deaths are plotted in black. The plot on the left is focussed on the model fit prior to today, while the plot on the right forecasts the next 28 days.

Short-term Epidemic Scenarios

We make the following short-term projections of healthcare demand and new infections under the following three scenarios:

- **Scenario 1.** The epidemic continues to grow at the current rate.
- **Scenario 2.** Countries will further scale up interventions (either increasing current strategies or implementing new interventions) leading to a further 50% reduction in transmission.
- **Scenario 3.** Countries will relax current interventions by 50%

N.B. These scenarios currently assume that the impact of mobility on transmission will remain the same in the future as it has in the past. We are working to extend methods to estimate the impact of increases in mobility on transmission as lockdown and interventions are reversed. Consequently, projection are likely to represent an upper estimate of the healthcare demand and case load for each scenario

We estimate that over the next 4 weeks demand for hospital beds will change from 88 (95% CI: 80-97) patients requiring treatment with high-pressure oxygen at the current date to 85 (95% CI: 74-96) hospital beds being required on 2020-08-04 if no further interventions are introduced (Scenario 1). Similarly, we estimate that over the next 4 weeks demand for critical care (ICU) beds will change from 25 (95% CI: 22-28) patients requiring treatment with mechanical ventilation at the current date to 22 (95% CI: 19-25) by 2020-08-04. These projections assume that approximately 5% of all infections will require treatment with high-pressure oxygen and that approximately 30% of hospitalised cases will require treatment with mechanical ventilation (based on analysis of ongoing epidemics in Europe). **N.B. These scenarios are unlikely to show significant differences for the first week since there is a delay of approximately 10 days between infection and hospital admission. Consequently, the effectiveness of a change in policy is likely to be better captured by hospital admission data approximately 2 weeks after the policy change is implemented.**

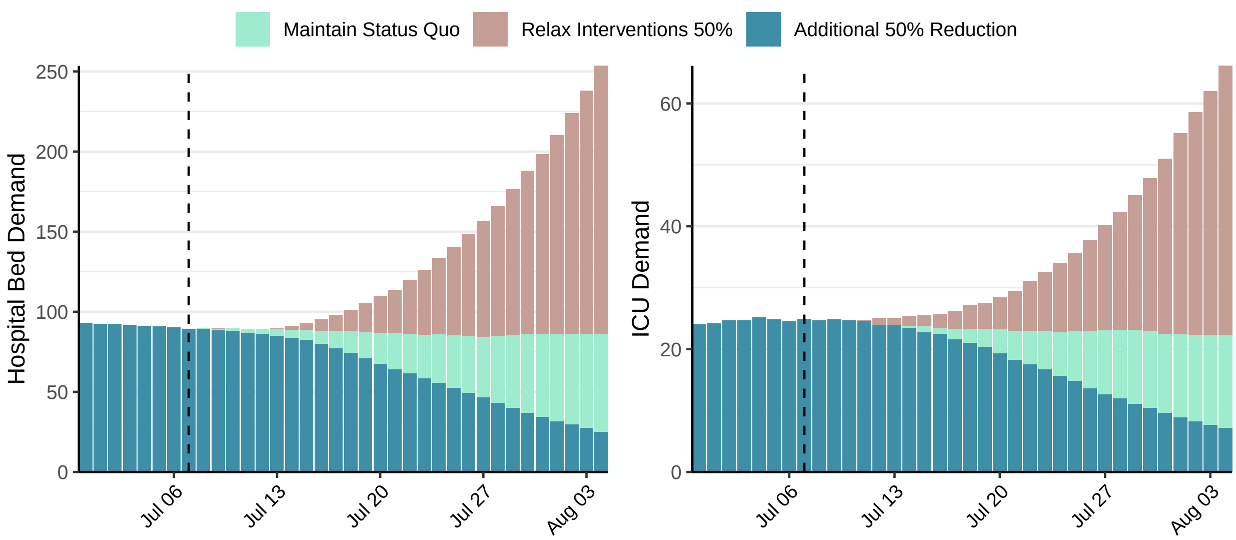

Figure 5: **Healthcare demands in the next 28 days.** Individuals needing an ICU bed are assumed to need mechanical ventilation. Projected demand for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

The impact of each scenario has a more immediate effect on the daily number of infections. The figure below shows the impact of each scenario on the estimated daily incidence of new infections. If interventions are scaled up (Scenario 2), the daily number of infections will change from 630 (95% CI: 561-699) at the current date to 51 (95% CI: 44-59) by 2020-08-04. If current interventions were relaxed by 50%, we estimate the daily number of infections will change from 630 (95% CI: 561-699) at the current date to 3,352 (95% CI: 2,834-3,870) by 2020-08-04.

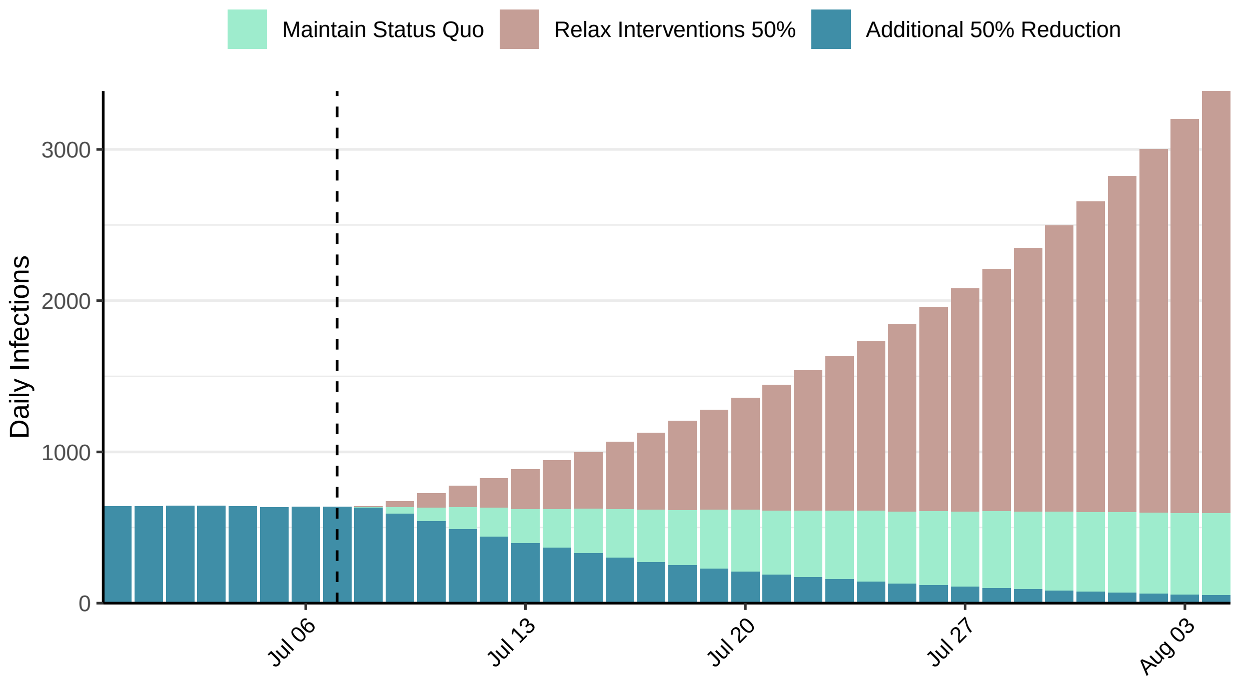

Figure 6: **Daily number of infections estimated by fitting to deaths.** Projected infections for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

To explore different scenarios, we recommend using our COVID-19 Scenario Analysis Tool - https://covidsim.org/, which can be used to simulate different intervention scenarios and explore the long term impact on healthcare demand.

Situation Report for COVID-19: Myanmar, 2020-07-07

Download the report for Myanmar, 2020-07-07 here. This report uses data from the European Centre for Disease Control. These data are updated daily and whilst there may be a short delay, they are generally consistent with Ministry reports. These data are then used to back-calculate an 'inferred number of COVID-19 infections' using mathematical modelling techniques (see Report 12 for further details) to estimate the number of people that have been infected and to make short-term projections for future healthcare needs.

Epidemiological Situation

Total Reported Cases	New Reported Cases	Total Reported Deaths	New Reported Deaths	Estimated R_t
316	3	6	0	0.67 (95% CI: 0.2-1.44)

The figure below shows the cumulative reported deaths as a function of the time since the 10th death was reported. Dashed lines show the expected trajectory for different doubling times of the epidemic. For example, with a doubling time of 3 days, if there are currently a total of 20 deaths reported, we would expect there to be 40 deaths in total reported in 3 days-time, 80 deaths in 6 days-time, 160 deaths in 9 days-time etc. For most epidemics, in the absence of interventions, we expect a doubling time of 3-4 days for this disease. **N.B. Myanmar is not shown in the following plot as only 6 deaths have been reported to date**

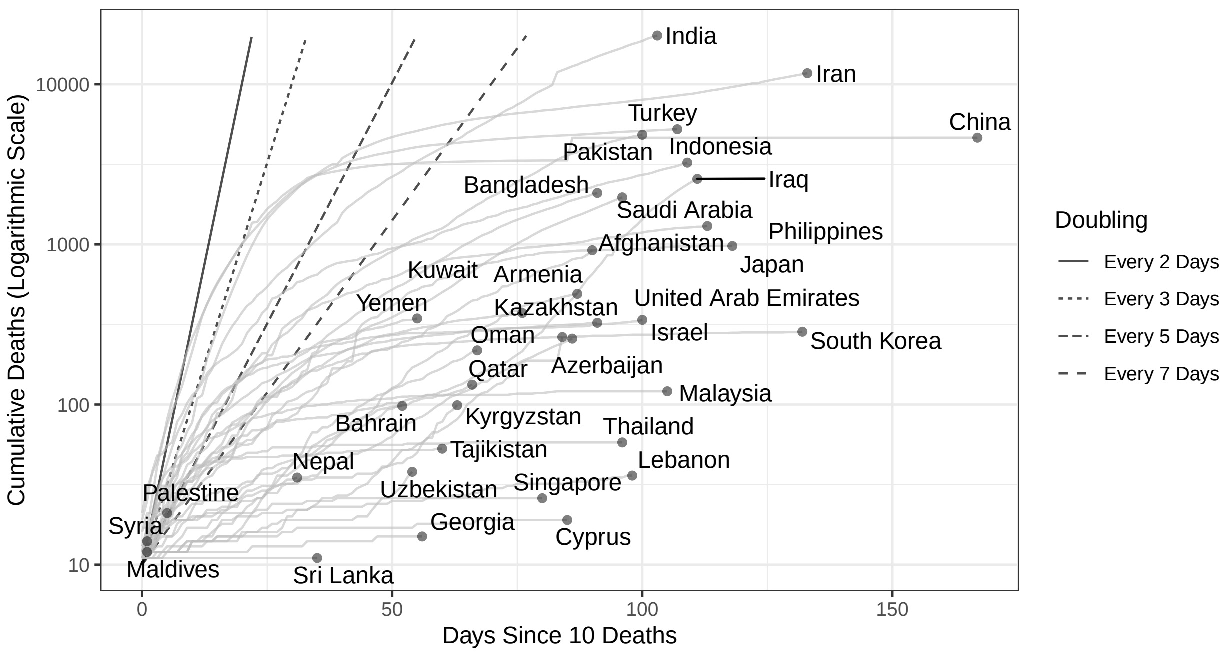

Figure 1: **Cumulative Deaths since 10 deaths.** Country not shown if fewer than 10 deaths.

COVID-19 Transmission Modelling

We assume that the deaths reported to date provide the best indication of the stage of the epidemic, as deaths are more consistently and accurately reported. Our current working estimate is that 1 death indicates that approximately 100 people will have been infected with the other 99 recovering (based on an infection fatality ratio of ~1%). These infections will have happened approximately 21 days previously – capturing a 5-day period from infection to onset of symptoms (the incubation period), 4 days from onset of symptoms to hospitalisation, and 12 days in hospital before death. With a 3-day doubling time, 100 infections that occurred 15 days ago will have generated 200 infections 12 days ago, 400 infections 9 days ago, 800 infections 6 days ago and 1,600 infections 3 days ago resulting in approximately 3,200 infections at the time the first death is observed.

To explore this, we fit our age-structured SEIR model (see Methods) to the time series of deaths in a country, in order to estimate the start date of the epidemic and the baseline R0. We assume that 100% of COVID-19 related deaths have been reported. We have also included the impact of interventions that have been put in place and their effect on human mobility and transmission based on the Google COVID-19 Community Mobility Reports. Using our mathematical model that formalises this approach, we estimate that there has been a total of 2 (95% CI: 0-4) infections over the past 4 weeks.

The figure below shows the estimated number of people infected over the past 4 weeks. The bar charts show, for comparison, the number of reported cases. The right-hand plot shows these data on a different scale as the estimated infections are likely to be much larger than the reported cases. **Importantly**, the estimated infections includes both asymptomatic and mild cases that would not necessarily be identified through surveillance. Consequently, the estimated infections are likely to be significantly higher than the reported cases (see our FAQ for further explanation of these differences and why the reported cases and estimated infections are unlikely to match).

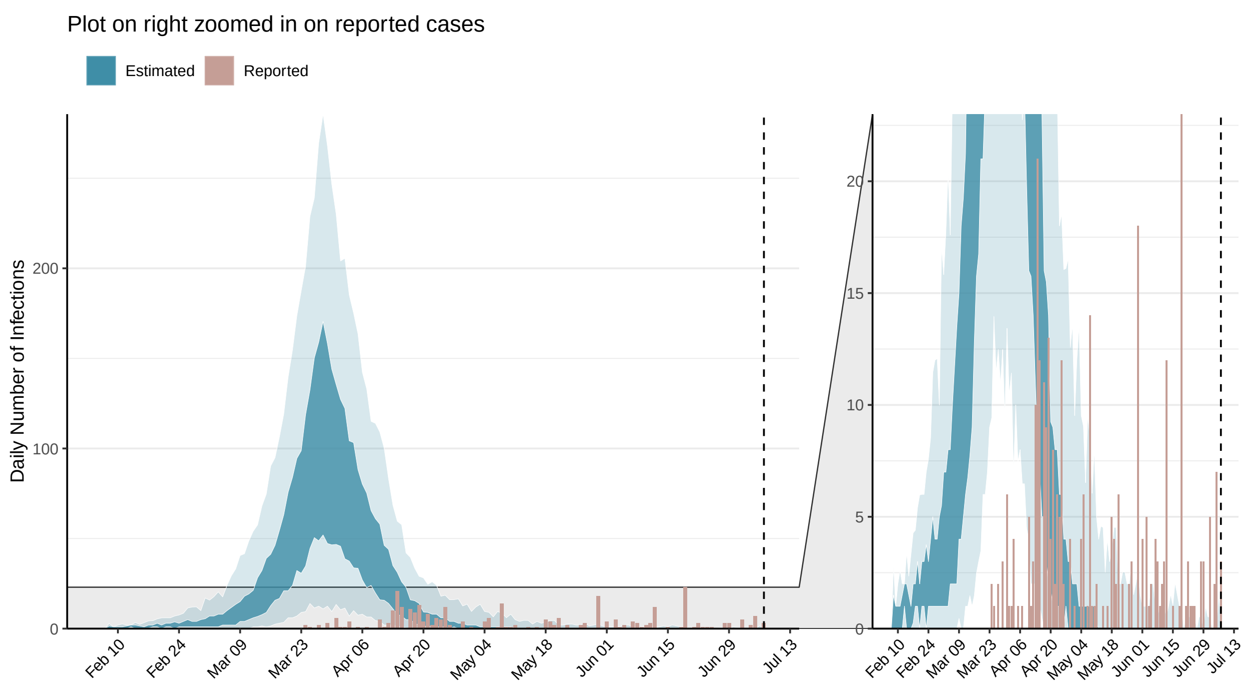

Figure 2: **Daily number of infections estimated by fitting to the current total of deaths.** Reported cases are shown in red. Model estimated infections are shown in blue (dark blue 50% interquartile range, light blue 95% quantile). The dashed line shows the current day.

By fitting to the time series of deaths, we are able to estimate a time-varying reproduction number, R_t. R_t is the the average number of secondary infections caused by a single infected person at a given time. If R_t is above 1, the rate of transmission is increasing and the number of new infections is increasing. R_t is assumed to change in relation to mobility fall in proportion. When fitting our model we assume that 100% of COVID-19 related deaths have been reported (please see our FAQ section for more information about this assumption). We also assume a fixed date at which the impact of mobility on transmission changes from pre-lockdown levels to post-lockdown levels, which may cause large changes in Rt. We are working to refine how this switch occurs and to formally calculate its shape.

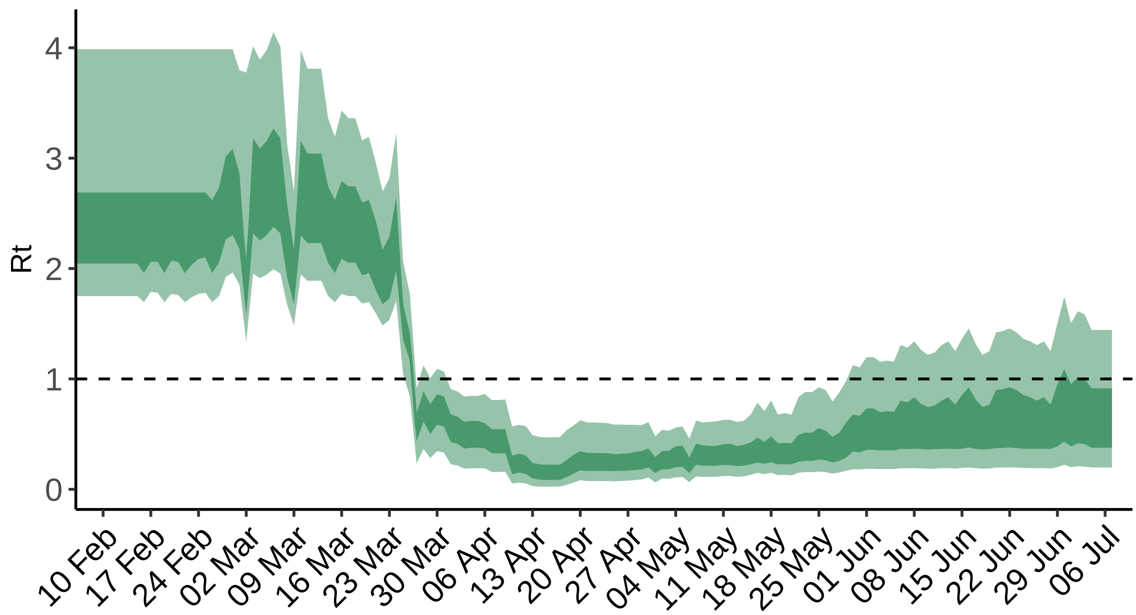

Figure 3: **Time-varying reproduction number, R_t.** R_t is the average number of secondary infections caused by a single infected person at time equal to t. $R_t < 1$ indicates a slowing epidemic in which new infections are not increasing. $R_t > 1$ indicates a growing epidemic in which new infections are increasing over time. Dark green shows the 50% CI and light green shows the 95% CI.

Using the model fit, we can forecast the expected trajectory for cumulative deaths, which is shown in the figure below. This assumes a severity pattern by age that is consistent with that observed in China, Europe and the U.S to date. This projection assumes that transmission is maintained at the current level of transmission as estimated by the final R_t value.

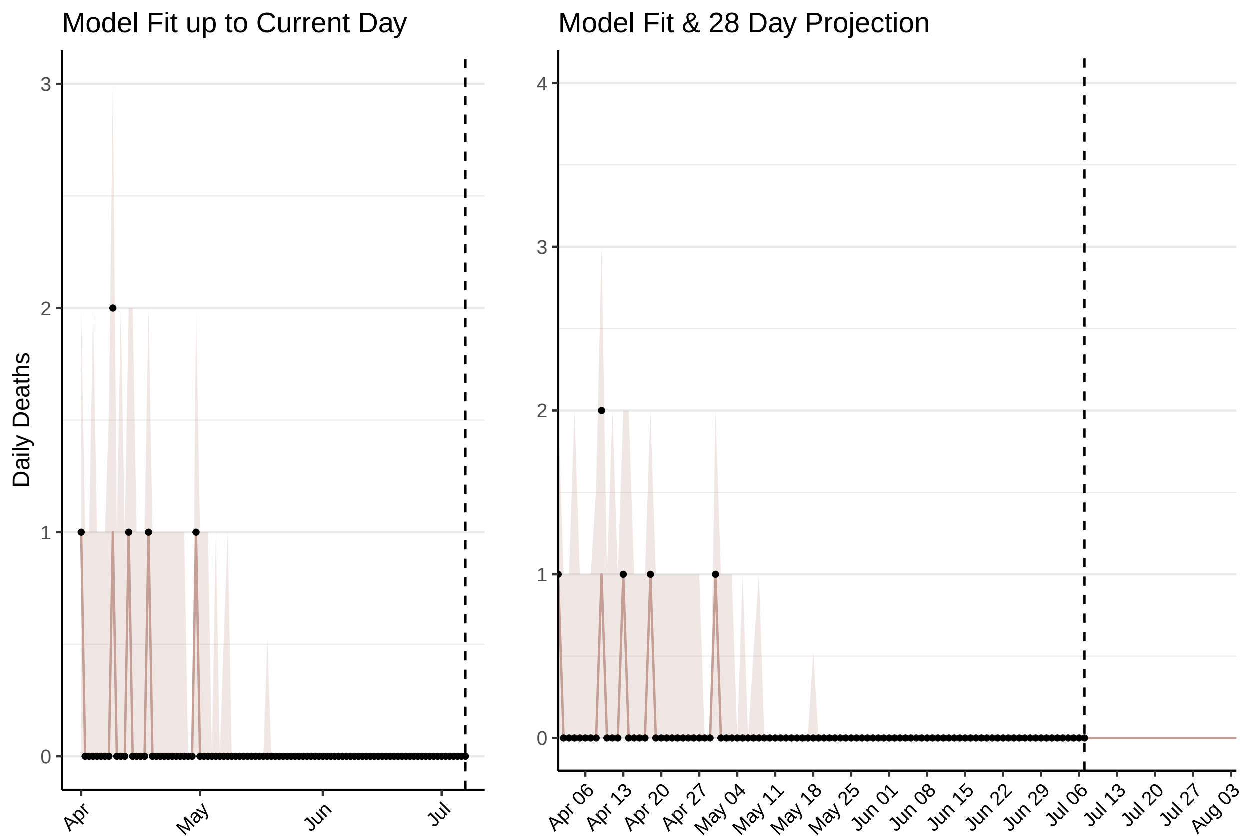

Figure 4: **Estimated daily deaths.** Projected deaths assuming the current level of interventions are maintained are shown in red (median and 95% quantile). Reported deaths are plotted in black. The plot on the left is focussed on the model fit prior to today, while the plot on the right forecasts the next 28 days.

Short-term Epidemic Scenarios

We make the following short-term projections of healthcare demand and new infections under the following three scenarios:

- **Scenario 1.** The epidemic continues to grow at the current rate.
- **Scenario 2.** Countries will further scale up interventions (either increasing current strategies or implementing new interventions) leading to a further 50% reduction in transmission.
- **Scenario 3.** Countries will relax current interventions by 50%

N.B. These scenarios currently assume that the impact of mobility on transmission will remain the same in the future as it has in the past. We are working to extend methods to estimate the impact of increases in mobility on transmission as lockdown and interventions are reversed. Consequently, projection are likely to represent an upper estimate of the healthcare demand and case load for each scenario

We estimate that over the next 4 weeks demand for hospital beds will change from 0 (95% CI: NaN-NaN) patients requiring treatment with high-pressure oxygen at the current date to 0 (95% CI: 0-0) hospital beds being required on 2020-08-04 if no further interventions are introduced (Scenario 1). Similarly, we estimate that over the next 4 weeks demand for critical care (ICU) beds will change from 0 (95% CI: NaN-NaN) patients requiring treatment with mechanical ventilation at the current date to 0 (95% CI: NaN-NaN) by 2020-08-04. These projections assume that approximately 5% of all infections will require treatment with high-pressure oxygen and that approximately 30% of hospitalised cases will require treatment with mechanical ventilation (based on analysis of ongoing epidemics in Europe). **N.B. These scenarios are unlikely to show significant differences for the first week since there is a delay of approximately 10 days between infection and hospital admission. Consequently, the effectiveness of a change in policy is likely to be better captured by hospital admission data approximately 2 weeks after the policy change is implemented.**

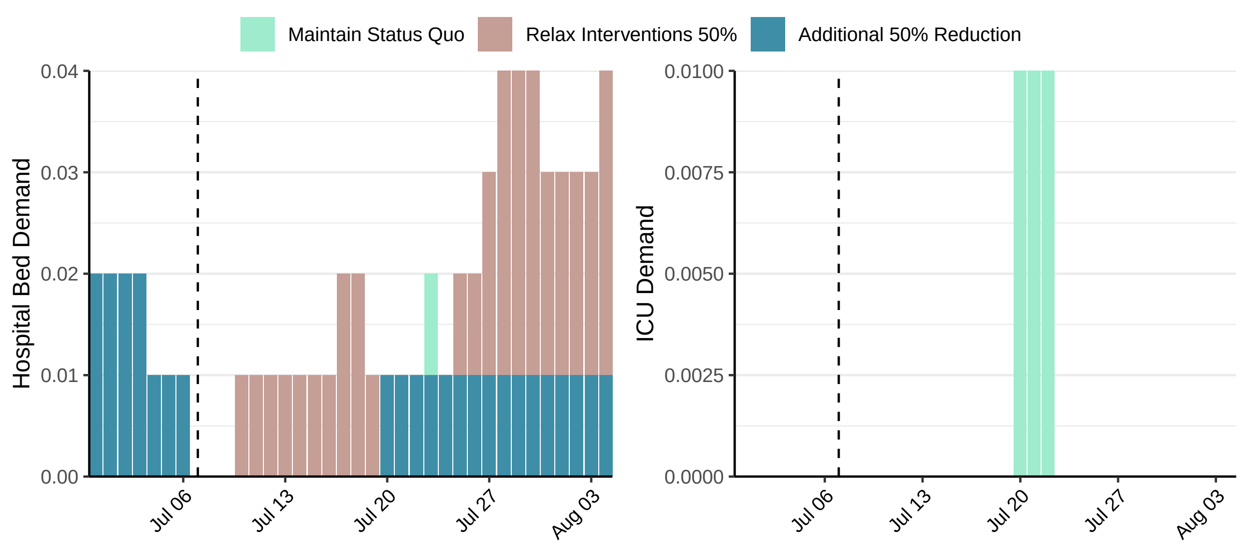

Figure 5: **Healthcare demands in the next 28 days.** Individuals needing an ICU bed are assumed to need mechanical ventilation. Projected demand for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

The impact of each scenario has a more immediate effect on the daily number of infections. The figure below shows the impact of each scenario on the estimated daily incidence of new infections. If interventions are scaled up (Scenario 2), the daily number of infections will change from 0 (95% CI: 0-0) at the current date to 0 (95% CI: NaN-NaN) by 2020-08-04. If current interventions were relaxed by 50%, we estimate the daily number of infections will change from 0 (95% CI: 0-0) at the current date to 0 (95% CI: 0-1) by 2020-08-04.

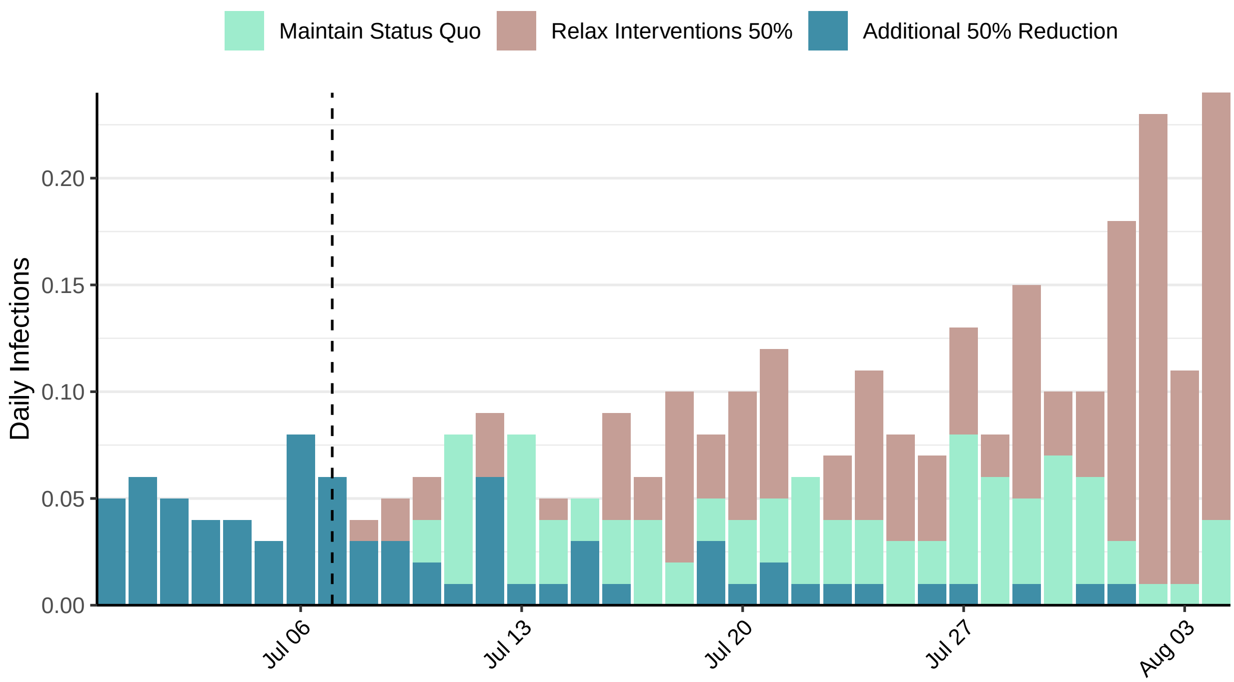

Figure 6: **Daily number of infections estimated by fitting to deaths.** Projected infections for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

To explore different scenarios, we recommend using our COVID-19 Scenario Analysis Tool - https://covidsim.org/, which can be used to simulate different intervention scenarios and explore the long term impact on healthcare demand.

Situation Report for COVID-19: Montenegro, 2020-07-07

Download the report for Montenegro, 2020-07-07 here. This report uses data from the European Centre for Disease Control. These data are updated daily and whilst there may be a short delay, they are generally consistent with Ministry reports. These data are then used to back-calculate an 'inferred number of COVID-19 infections' using mathematical modelling techniques (see Report 12 for further details) to estimate the number of people that have been infected and to make short-term projections for future healthcare needs.

Epidemiological Situation

Total Reported Cases	New Reported Cases	Total Reported Deaths	New Reported Deaths	Estimated R_t
841	60	14	0	1.3 (95% CI: 1.14-1.46)

The figure below shows the cumulative reported deaths as a function of the time since the 10th death was reported. Dashed lines show the expected trajectory for different doubling times of the epidemic. For example, with a doubling time of 3 days, if there are currently a total of 20 deaths reported, we would expect there to be 40 deaths in total reported in 3 days-time, 80 deaths in 6 days-time, 160 deaths in 9 days-time etc. For most epidemics, in the absence of interventions, we expect a doubling time of 3-4 days for this disease.

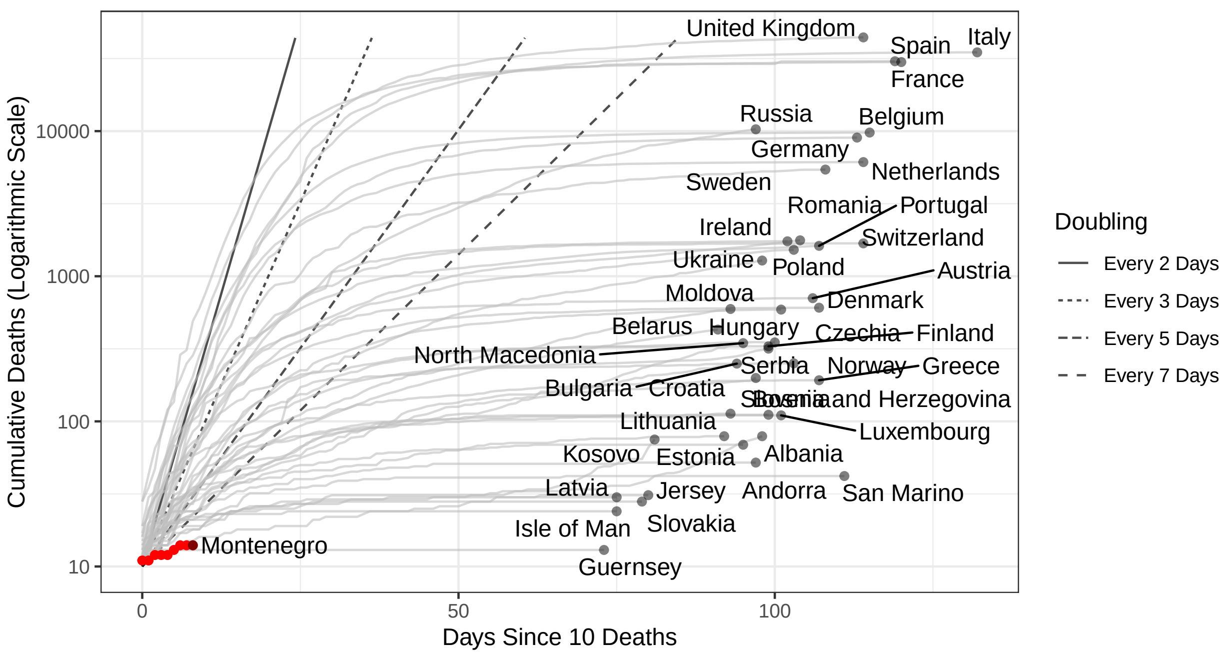

Figure 1: **Cumulative Deaths since 10 deaths.** Country not shown if fewer than 10 deaths.

COVID-19 Transmission Modelling

We assume that the deaths reported to date provide the best indication of the stage of the epidemic, as deaths are more consistently and accurately reported. Our current working estimate is that 1 death indicates that approximately 100 people will have been infected with the other 99 recovering (based on an infection fatality ratio of ~1%). These infections will have happened approximately 21 days previously – capturing a 5-day period from infection to onset of symptoms (the incubation period), 4 days from onset of symptoms to hospitalisation, and 12 days in hospital before death. With a 3-day doubling time, 100 infections that occurred 15 days ago will have generated 200 infections 12 days ago, 400 infections 9 days ago, 800 infections 6 days ago and 1,600 infections 3 days ago resulting in approximately 3,200 infections at the time the first death is observed.

To explore this, we fit our age-structured SEIR model (see Methods) to the time series of deaths in a country, in order to estimate the start date of the epidemic and the baseline R0. We assume that 100% of COVID-19 related deaths have been reported. We have also included the impact of interventions that have been put in place and their effect on human mobility and transmission based on the Google COVID-19 Community Mobility Reports. Using our mathematical model that formalises this approach, we estimate that there has been a total of 2,438 (95% CI: 2,042-2,834) infections over the past 4 weeks.

The figure below shows the estimated number of people infected over the past 4 weeks. The bar charts show, for comparison, the number of reported cases. The right-hand plot shows these data on a different scale as the estimated infections are likely to be much larger than the reported cases. **Importantly**, the estimated infections includes both asymptomatic and mild cases that would not necessarily be identified through surveillance. Consequently, the estimated infections are likely to be significantly higher than the reported cases (see our FAQ for further explanation of these differences and why the reported cases and estimated infections are unlikely to match).

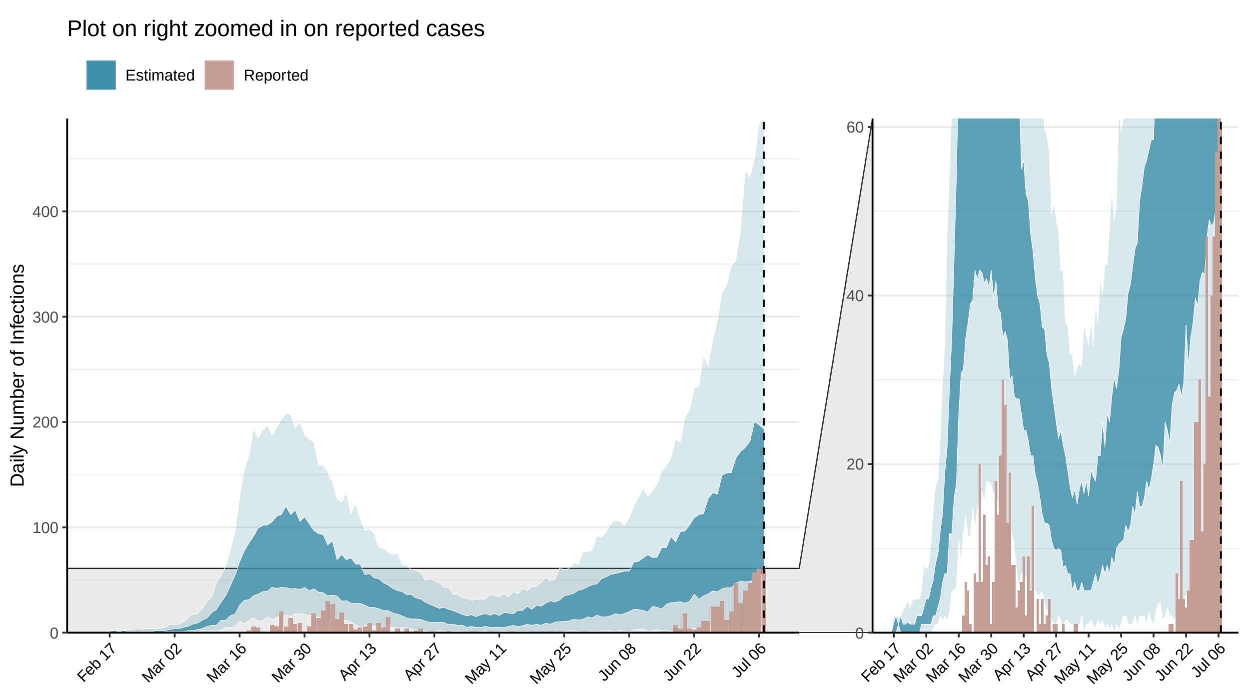

Figure 2: **Daily number of infections estimated by fitting to the current total of deaths.** Reported cases are shown in red. Model estimated infections are shown in blue (dark blue 50% interquartile range, light blue 95% quantile). The dashed line shows the current day.

By fitting to the time series of deaths, we are able to estimate a time-varying reproduction number, R_t. R_t is the the average number of secondary infections caused by a single infected person at a given time. If R_t is above 1, the rate of transmission is increasing and the number of new infections is increasing. R_t is assumed to change in relation to mobility fall in proportion. When fitting our model we assume that 100% of COVID-19 related deaths have been reported (please see our FAQ section for more information about this assumption). We also assume a fixed date at which the impact of mobility on transmission changes from pre-lockdown levels to post-lockdown levels, which may cause large changes in Rt. We are working to refine how this switch occurs and to formally calculate its shape.

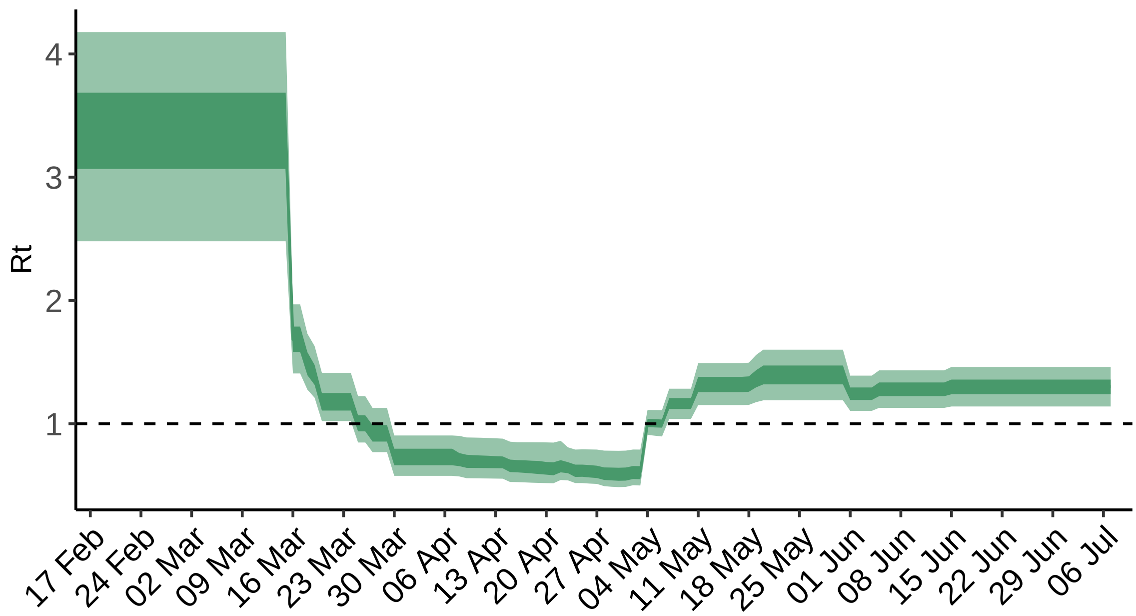

Figure 3: **Time-varying reproduction number, R_t.** R_t is the average number of secondary infections caused by a single infected person at time equal to t. $R_t < 1$ indicates a slowing epidemic in which new infections are not increasing. $R_t > 1$ indicates a growing epidemic in which new infections are increasing over time. Dark green shows the 50% CI and light green shows the 95% CI.

Using the model fit, we can forecast the expected trajectory for cumulative deaths, which is shown in the figure below. This assumes a severity pattern by age that is consistent with that observed in China, Europe and the U.S to date. This projection assumes that transmission is maintained at the current level of transmission as estimated by the final R_t value.

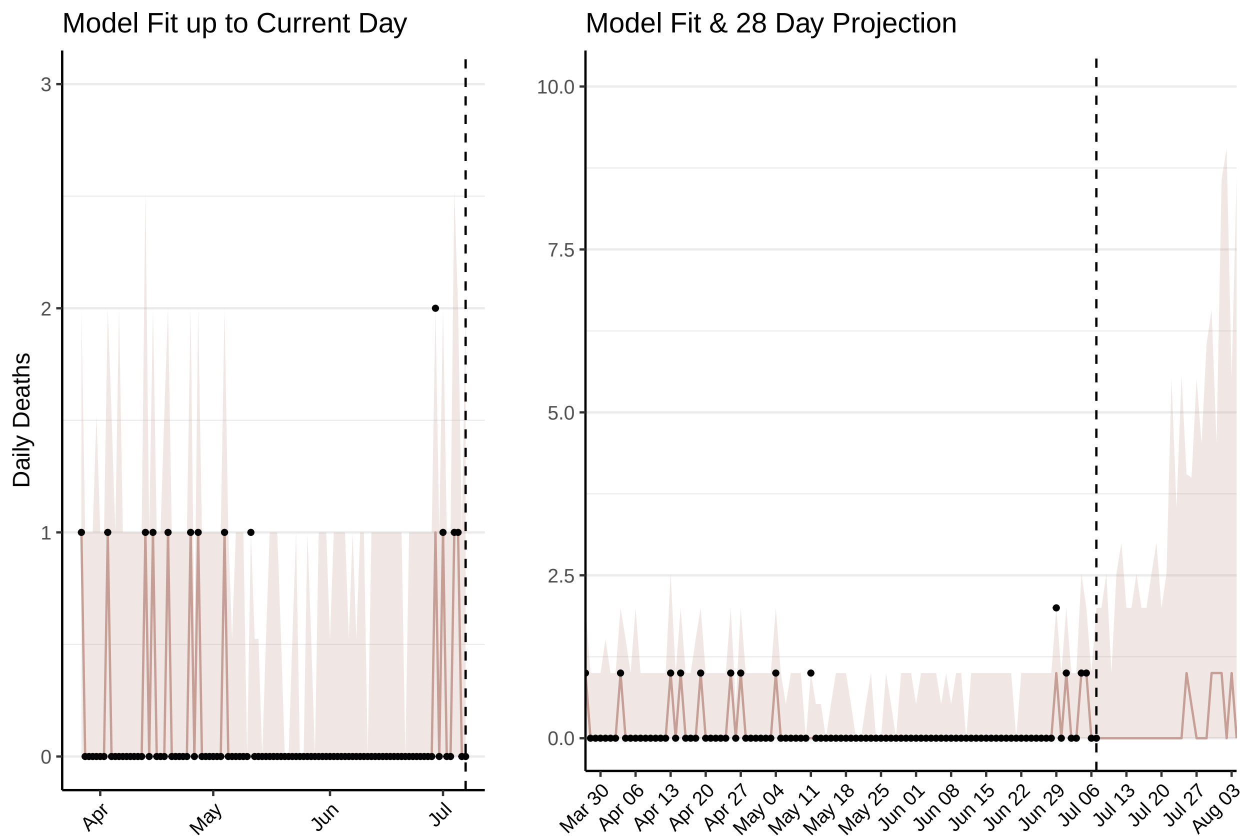

Figure 4: **Estimated daily deaths.** Projected deaths assuming the current level of interventions are maintained are shown in red (median and 95% quantile). Reported deaths are plotted in black. The plot on the left is focussed on the model fit prior to today, while the plot on the right forecasts the next 28 days.

Short-term Epidemic Scenarios

We make the following short-term projections of healthcare demand and new infections under the following three scenarios:

- **Scenario 1.** The epidemic continues to grow at the current rate.
- **Scenario 2.** Countries will further scale up interventions (either increasing current strategies or implementing new interventions) leading to a further 50% reduction in transmission.
- **Scenario 3.** Countries will relax current interventions by 50%

N.B. These scenarios currently assume that the impact of mobility on transmission will remain the same in the future as it has in the past. We are working to extend methods to estimate the impact of increases in mobility on transmission as lockdown and interventions are reversed. Consequently, projection are likely to represent an upper estimate of the healthcare demand and case load for each scenario

We estimate that over the next 4 weeks demand for hospital beds will change from 19 (95% CI: 16-22) patients requiring treatment with high-pressure oxygen at the current date to 62 (95% CI: 50-75) hospital beds being required on 2020-08-04 if no further interventions are introduced (Scenario 1). Similarly, we estimate that over the next 4 weeks demand for critical care (ICU) beds will change from 5 (95% CI: 4-6) patients requiring treatment with mechanical ventilation at the current date to 17 (95% CI: 14-20) by 2020-08-04. These projections assume that approximately 5% of all infections will require treatment with high-pressure oxygen and that approximately 30% of hospitalised cases will require treatment with mechanical ventilation (based on analysis of ongoing epidemics in Europe). **N.B. These scenarios are unlikely to show significant differences for the first week since there is a delay of approximately 10 days between infection and hospital admission. Consequently, the effectiveness of a change in policy is likely to be better captured by hospital admission data approximately 2 weeks after the policy change is implemented.**

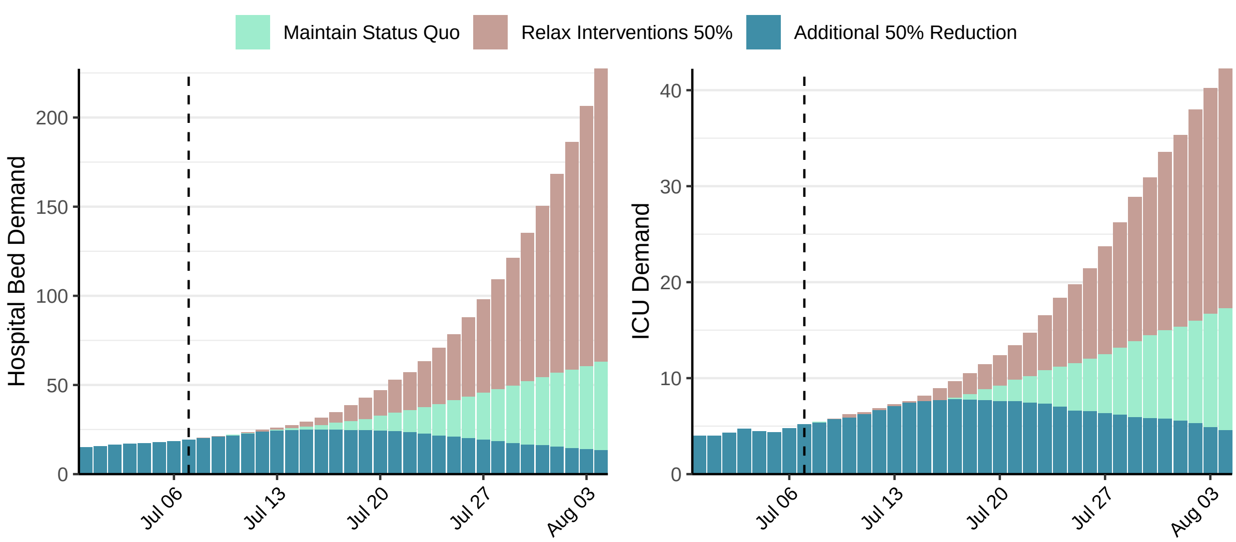

Figure 5: **Healthcare demands in the next 28 days.** Individuals needing an ICU bed are assumed to need mechanical ventilation. Projected demand for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

The impact of each scenario has a more immediate effect on the daily number of infections. The figure below shows the impact of each scenario on the estimated daily incidence of new infections. If interventions are scaled up (Scenario 2), the daily number of infections will change from 145 (95% CI: 119-171) at the current date to 31 (95% CI: 25-38) by 2020-08-04. If current interventions were relaxed by 50%, we estimate the daily number of infections will change from 145 (95% CI: 119-171) at the current date to 2,641 (95% CI: 2,171-3,111) by 2020-08-04.

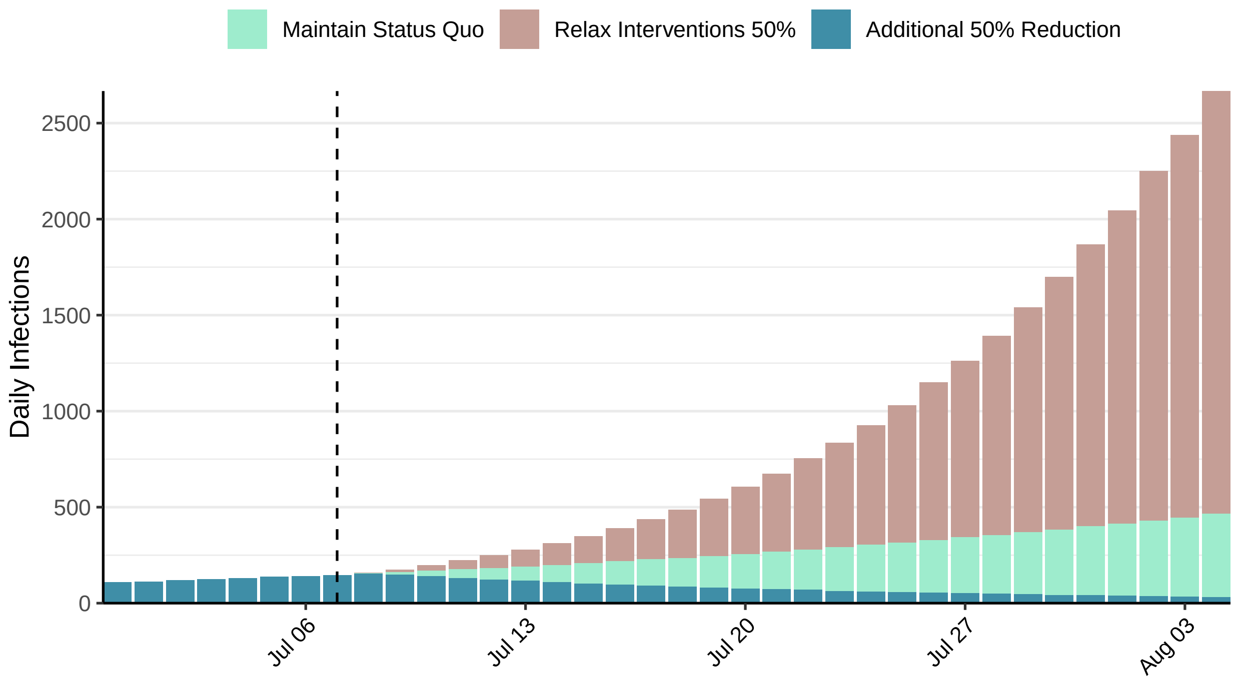

Figure 6: **Daily number of infections estimated by fitting to deaths.** Projected infections for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

To explore different scenarios, we recommend using our COVID-19 Scenario Analysis Tool - https://covidsim.org/, which can be used to simulate different intervention scenarios and explore the long term impact on healthcare demand.

Situation Report for COVID-19: Mozambique, 2020-07-07

Download the report for Mozambique, 2020-07-07 here. This report uses data from the European Centre for Disease Control. These data are updated daily and whilst there may be a short delay, they are generally consistent with Ministry reports. These data are then used to back-calculate an 'inferred number of COVID-19 infections' using mathematical modelling techniques (see Report 12 for further details) to estimate the number of people that have been infected and to make short-term projections for future healthcare needs.

Epidemiological Situation

Total Reported Cases	New Reported Cases	Total Reported Deaths	New Reported Deaths	Estimated R_t
1,012	25	8	0	1.66 (95% CI: 1.49-1.93)

The figure below shows the cumulative reported deaths as a function of the time since the 10th death was reported. Dashed lines show the expected trajectory for different doubling times of the epidemic. For example, with a doubling time of 3 days, if there are currently a total of 20 deaths reported, we would expect there to be 40 deaths in total reported in 3 days-time, 80 deaths in 6 days-time, 160 deaths in 9 days-time etc. For most epidemics, in the absence of interventions, we expect a doubling time of 3-4 days for this disease. **N.B. Mozambique is not shown in the following plot as only 8 deaths have been reported to date**

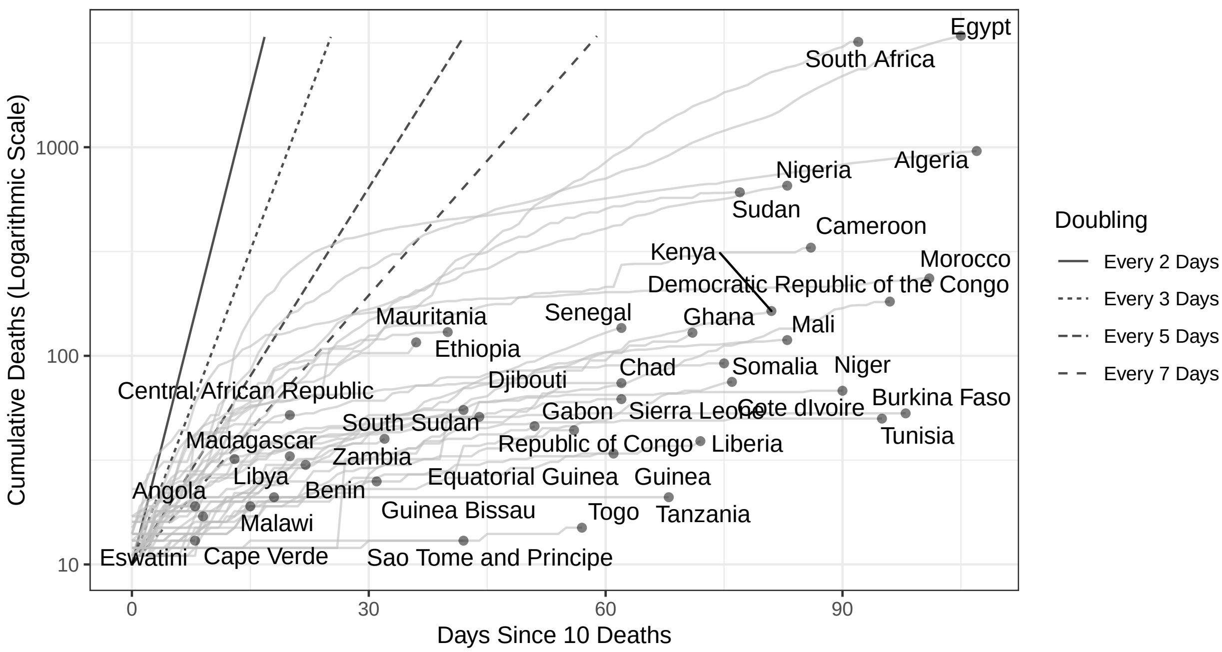

Figure 1: **Cumulative Deaths since 10 deaths.** Country not shown if fewer than 10 deaths.

COVID-19 Transmission Modelling

We assume that the deaths reported to date provide the best indication of the stage of the epidemic, as deaths are more consistently and accurately reported. Our current working estimate is that 1 death indicates that approximately 100 people will have been infected with the other 99 recovering (based on an infection fatality ratio of ~1%). These infections will have happened approximately 21 days previously – capturing a 5-day period from infection to onset of symptoms (the incubation period), 4 days from onset of symptoms to hospitalisation, and 12 days in hospital before death. With a 3-day doubling time, 100 infections that occurred 15 days ago will have generated 200 infections 12 days ago, 400 infections 9 days ago, 800 infections 6 days ago and 1,600 infections 3 days ago resulting in approximately 3,200 infections at the time the first death is observed.

To explore this, we fit our age-structured SEIR model (see Methods) to the time series of deaths in a country, in order to estimate the start date of the epidemic and the baseline R0. We assume that 100% of COVID-19 related deaths have been reported. We have also included the impact of interventions that have been put in place and their effect on human mobility and transmission based on the Google COVID-19 Community Mobility Reports. Using our mathematical model that formalises this approach, we estimate that there has been a total of 9,205 (95% CI: 7,438-10,973) infections over the past 4 weeks.

The figure below shows the estimated number of people infected over the past 4 weeks. The bar charts show, for comparison, the number of reported cases. The right-hand plot shows these data on a different scale as the estimated infections are likely to be much larger than the reported cases. **Importantly**, the estimated infections includes both asymptomatic and mild cases that would not necessarily be identified through surveillance. Consequently, the estimated infections are likely to be significantly higher than the reported cases (see our FAQ for further explanation of these differences and why the reported cases and estimated infections are unlikely to match).

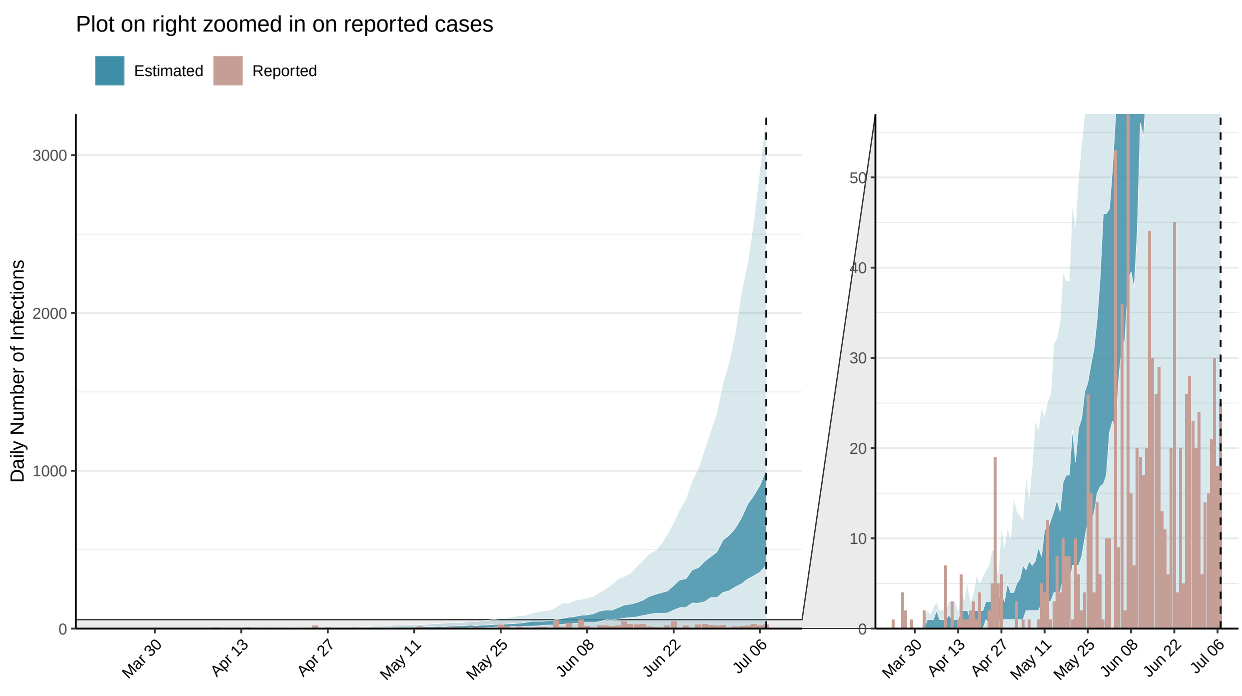

Figure 2: **Daily number of infections estimated by fitting to the current total of deaths.** Reported cases are shown in red. Model estimated infections are shown in blue (dark blue 50% interquartile range, light blue 95% quantile). The dashed line shows the current day.

By fitting to the time series of deaths, we are able to estimate a time-varying reproduction number, R_t. R_t is the the average number of secondary infections caused by a single infected person at a given time. If R_t is above 1, the rate of transmission is increasing and the number of new infections is increasing. R_t is assumed to change in relation to mobility fall in proportion. When fitting our model we assume that 100% of COVID-19 related deaths have been reported (please see our FAQ section for more information about this assumption). We also assume a fixed date at which the impact of mobility on transmission changes from pre-lockdown levels to post-lockdown levels, which may cause large changes in Rt. We are working to refine how this switch occurs and to formally calculate its shape.

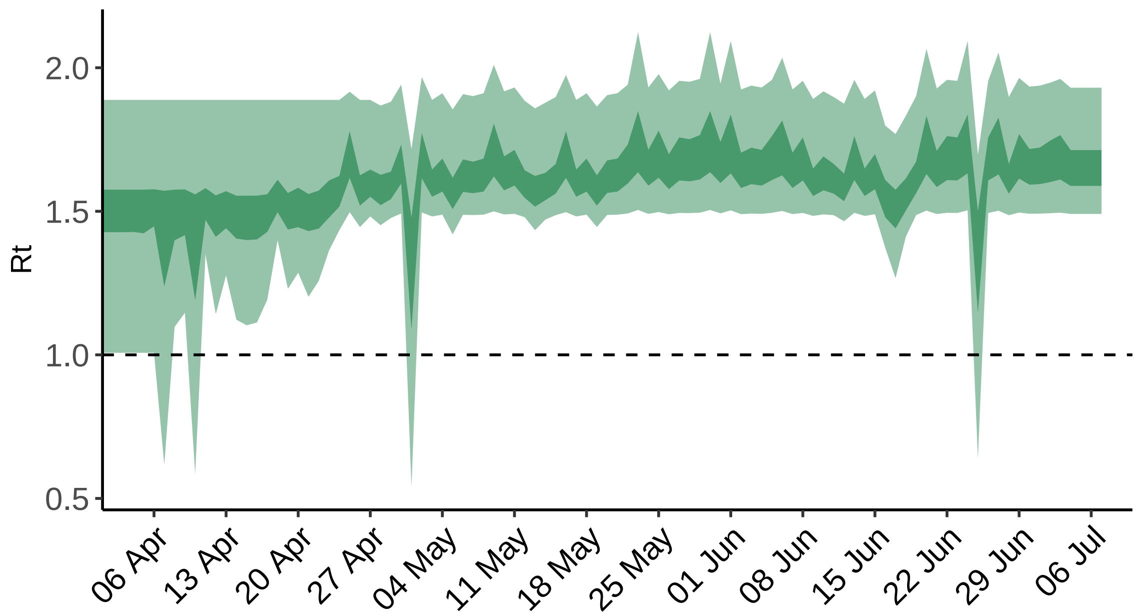

Figure 3: **Time-varying reproduction number, R_t.** R_t is the average number of secondary infections caused by a single infected person at time equal to t. $R_t < 1$ indicates a slowing epidemic in which new infections are not increasing. $R_t > 1$ indicates a growing epidemic in which new infections are increasing over time. Dark green shows the 50% CI and light green shows the 95% CI.

Using the model fit, we can forecast the expected trajectory for cumulative deaths, which is shown in the figure below. This assumes a severity pattern by age that is consistent with that observed in China, Europe and the U.S to date. This projection assumes that transmission is maintained at the current level of transmission as estimated by the final R_t value.

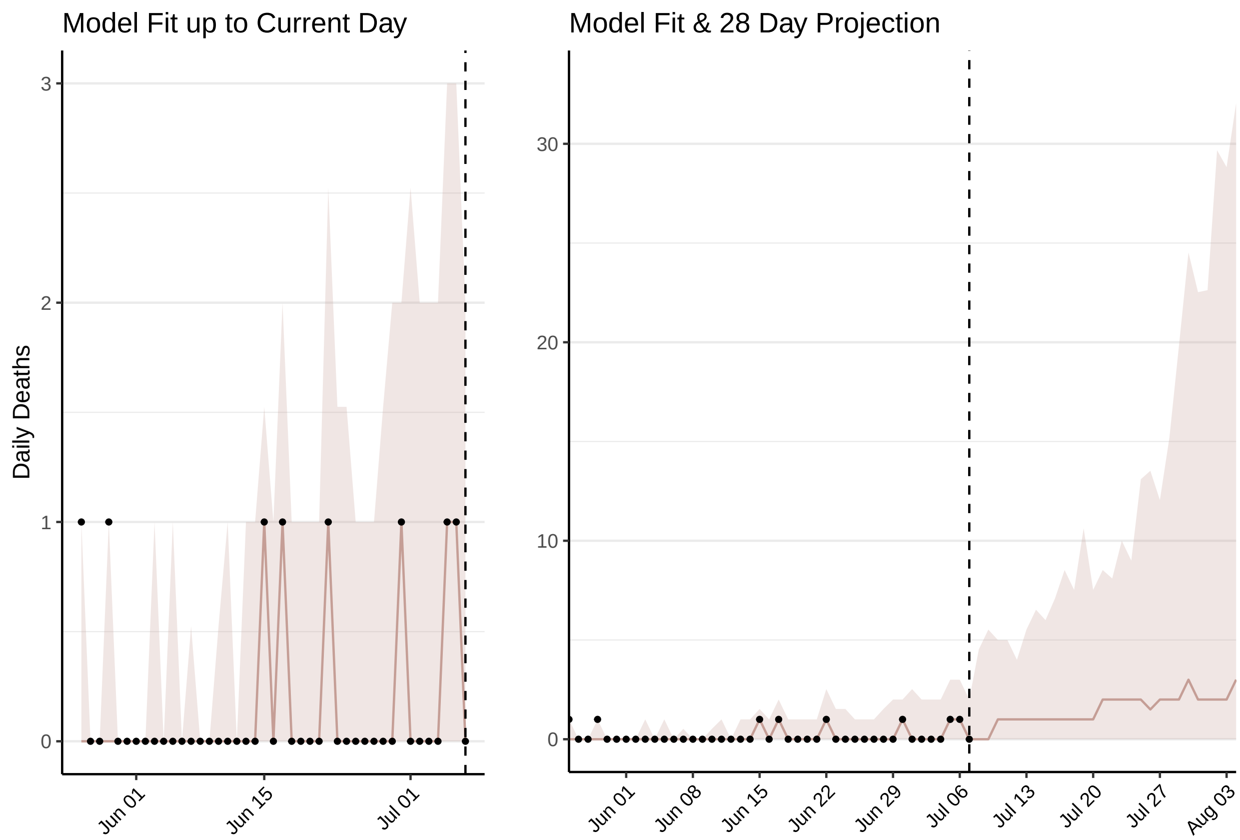

Figure 4: **Estimated daily deaths.** Projected deaths assuming the current level of interventions are maintained are shown in red (median and 95% quantile). Reported deaths are plotted in black. The plot on the left is focussed on the model fit prior to today, while the plot on the right forecasts the next 28 days.

Short-term Epidemic Scenarios

We make the following short-term projections of healthcare demand and new infections under the following three scenarios:

- **Scenario 1.** The epidemic continues to grow at the current rate.
- **Scenario 2.** Countries will further scale up interventions (either increasing current strategies or implementing new interventions) leading to a further 50% reduction in transmission.
- **Scenario 3.** Countries will relax current interventions by 50%

N.B. These scenarios currently assume that the impact of mobility on transmission will remain the same in the future as it has in the past. We are working to extend methods to estimate the impact of increases in mobility on transmission as lockdown and interventions are reversed. Consequently, projection are likely to represent an upper estimate of the healthcare demand and case load for each scenario

We estimate that over the next 4 weeks demand for hospital beds will change from 51 (95% CI: 41-61) patients requiring treatment with high-pressure oxygen at the current date to 320 (95% CI: 214-425) hospital beds being required on 2020-08-04 if no further interventions are introduced (Scenario 1). Similarly, we estimate that over the next 4 weeks demand for critical care (ICU) beds will change from 13 (95% CI: 11-16) patients requiring treatment with mechanical ventilation at the current date to 83 (95% CI: 57-109) by 2020-08-04. These projections assume that approximately 5% of all infections will require treatment with high-pressure oxygen and that approximately 30% of hospitalised cases will require treatment with mechanical ventilation (based on analysis of ongoing epidemics in Europe). **N.B. These scenarios are unlikely to show significant differences for the first week since there is a delay of approximately 10 days between infection and hospital admission. Consequently, the effectiveness of a change in policy is likely to be better captured by hospital admission data approximately 2 weeks after the policy change is implemented.**

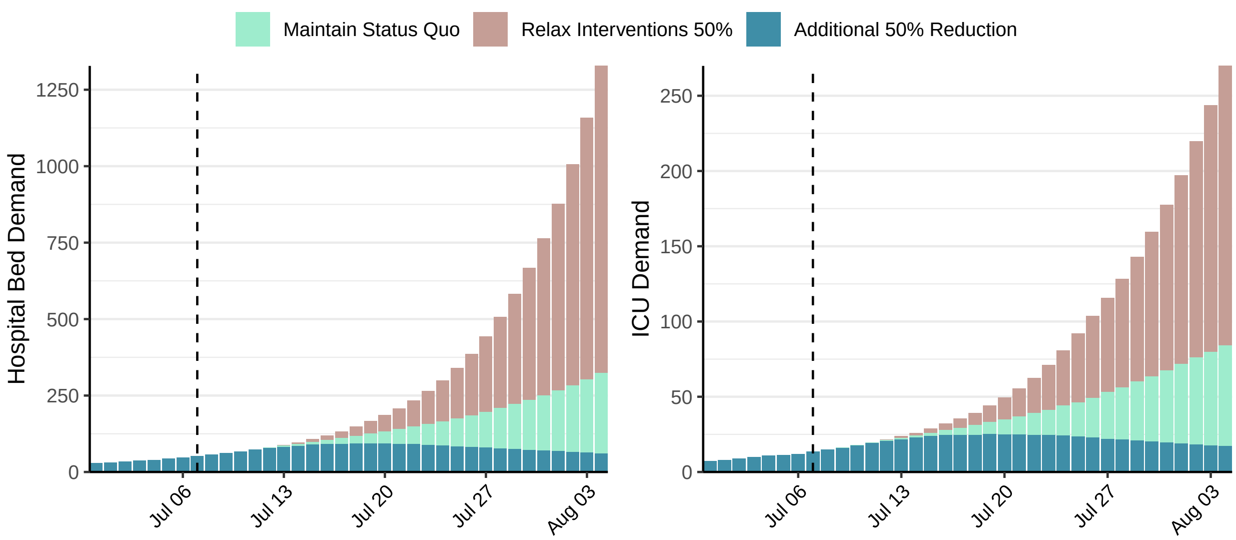

Figure 5: **Healthcare demands in the next 28 days.** Individuals needing an ICU bed are assumed to need mechanical ventilation. Projected demand for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

The impact of each scenario has a more immediate effect on the daily number of infections. The figure below shows the impact of each scenario on the estimated daily incidence of new infections. If interventions are scaled up (Scenario 2), the daily number of infections will change from 841 (95% CI: 659-1,023) at the current date to 259 (95% CI: 166-352) by 2020-08-04. If current interventions were relaxed by 50%, we estimate the daily number of infections will change from 841 (95% CI: 659-1,023) at the current date to 32,599 (95% CI: 19,251-45,947) by 2020-08-04.

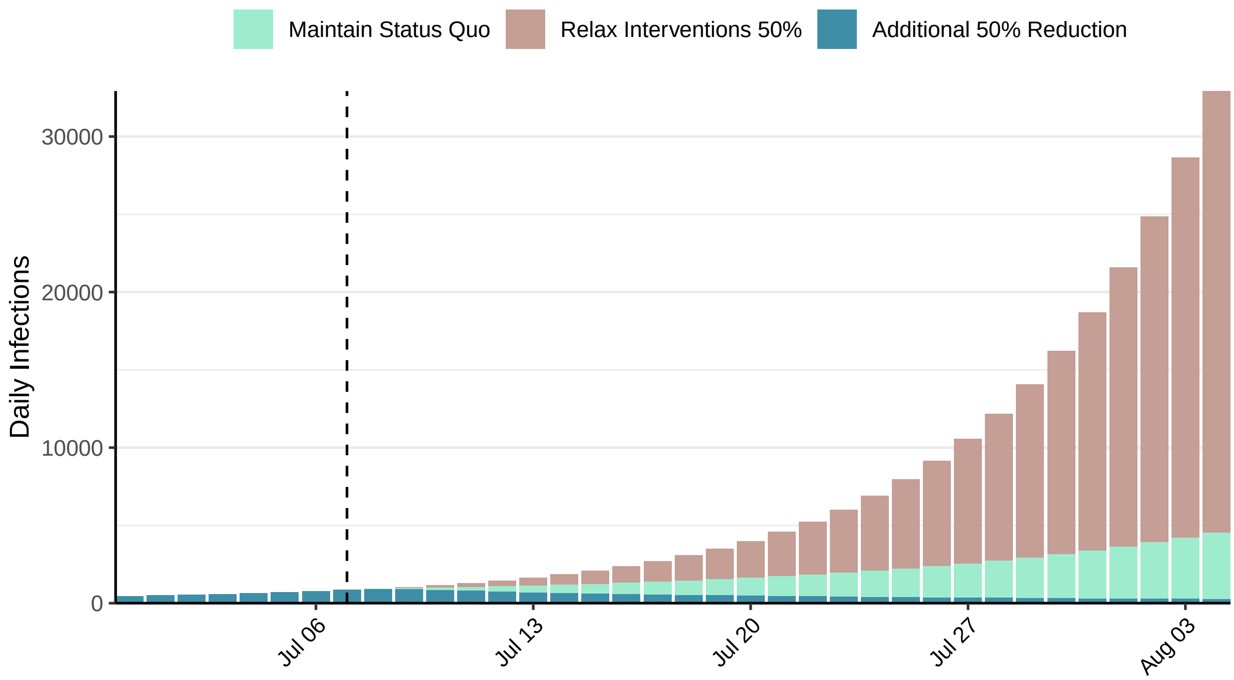

Figure 6: **Daily number of infections estimated by fitting to deaths.** Projected infections for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

To explore different scenarios, we recommend using our COVID-19 Scenario Analysis Tool - https://covidsim.org/, which can be used to simulate different intervention scenarios and explore the long term impact on healthcare demand.

Situation Report for COVID-19: Mauritania, 2020-07-07

Download the report for Mauritania, 2020-07-07 here. This report uses data from the European Centre for Disease Control. These data are updated daily and whilst there may be a short delay, they are generally consistent with Ministry reports. These data are then used to back-calculate an 'inferred number of COVID-19 infections' using mathematical modelling techniques (see Report 12 for further details) to estimate the number of people that have been infected and to make short-term projections for future healthcare needs.

Epidemiological Situation

Total Reported Cases	New Reported Cases	Total Reported Deaths	New Reported Deaths	Estimated R_t
4,879	0	130	0	1.14 (95% CI: 1.04-1.22)

The figure below shows the cumulative reported deaths as a function of the time since the 10th death was reported. Dashed lines show the expected trajectory for different doubling times of the epidemic. For example, with a doubling time of 3 days, if there are currently a total of 20 deaths reported, we would expect there to be 40 deaths in total reported in 3 days-time, 80 deaths in 6 days-time, 160 deaths in 9 days-time etc. For most epidemics, in the absence of interventions, we expect a doubling time of 3-4 days for this disease.

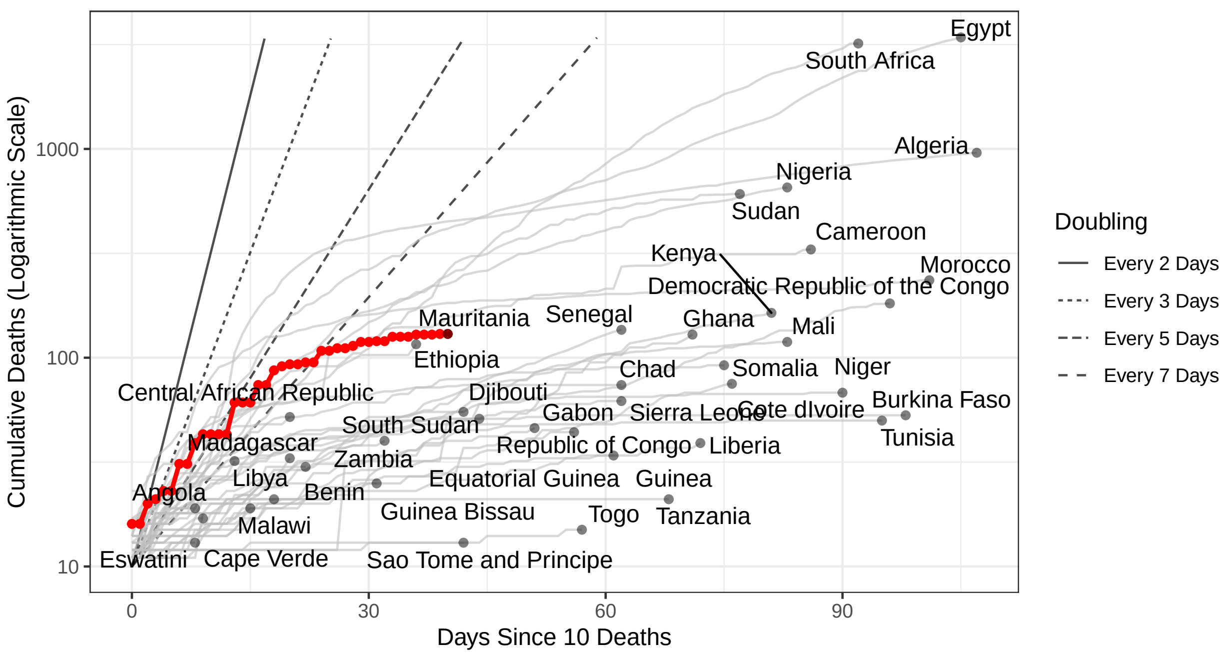

Figure 1: **Cumulative Deaths since 10 deaths.** Country not shown if fewer than 10 deaths.

COVID-19 Transmission Modelling

We assume that the deaths reported to date provide the best indication of the stage of the epidemic, as deaths are more consistently and accurately reported. Our current working estimate is that 1 death indicates that approximately 100 people will have been infected with the other 99 recovering (based on an infection fatality ratio of ~1%). These infections will have happened approximately 21 days previously – capturing a 5-day period from infection to onset of symptoms (the incubation period), 4 days from onset of symptoms to hospitalisation, and 12 days in hospital before death. With a 3-day doubling time, 100 infections that occurred 15 days ago will have generated 200 infections 12 days ago, 400 infections 9 days ago, 800 infections 6 days ago and 1,600 infections 3 days ago resulting in approximately 3,200 infections at the time the first death is observed.

To explore this, we fit our age-structured SEIR model (see Methods) to the time series of deaths in a country, in order to estimate the start date of the epidemic and the baseline R0. We assume that 100% of COVID-19 related deaths have been reported. We have also included the impact of interventions that have been put in place and their effect on human mobility and transmission based on the Google COVID-19 Community Mobility Reports. Using our mathematical model that formalises this approach, we estimate that there has been a total of 30,323 (95% CI: 27,491-33,155) infections over the past 4 weeks.

The figure below shows the estimated number of people infected over the past 4 weeks. The bar charts show, for comparison, the number of reported cases. The right-hand plot shows these data on a different scale as the estimated infections are likely to be much larger than the reported cases. **Importantly**, the estimated infections includes both asymptomatic and mild cases that would not necessarily be identified through surveillance. Consequently, the estimated infections are likely to be significantly higher than the reported cases (see our FAQ for further explanation of these differences and why the reported cases and estimated infections are unlikely to match).

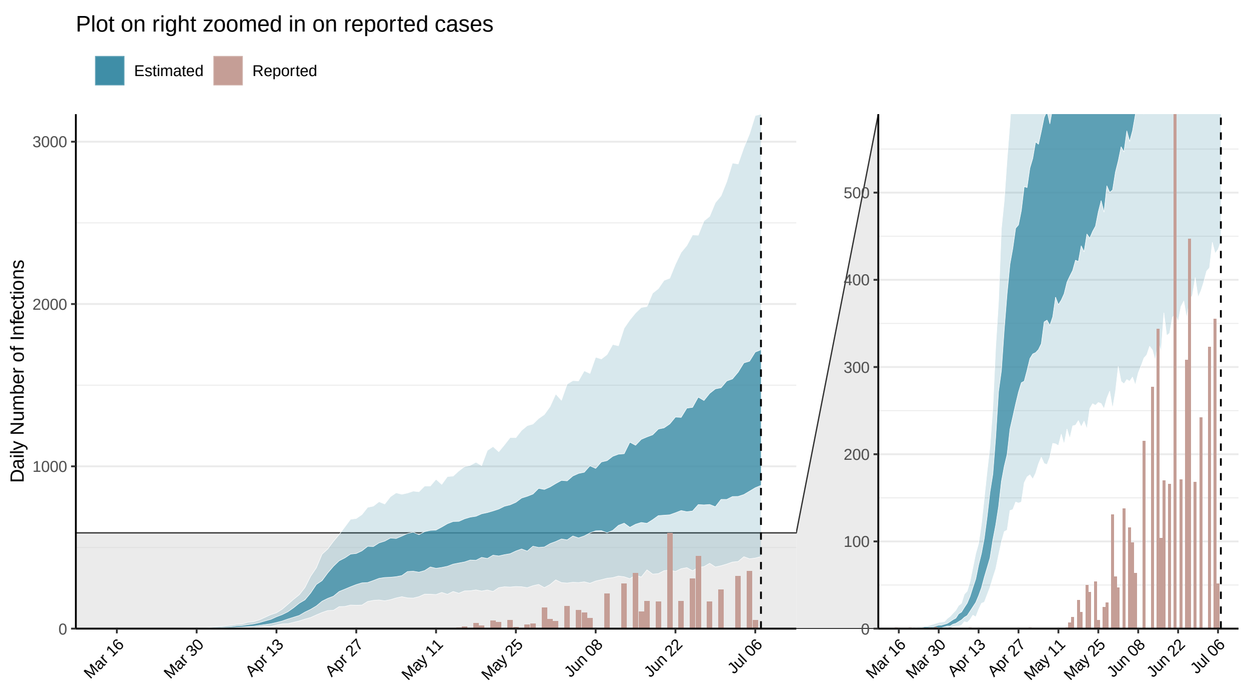

Figure 2: **Daily number of infections estimated by fitting to the current total of deaths.** Reported cases are shown in red. Model estimated infections are shown in blue (dark blue 50% interquartile range, light blue 95% quantile). The dashed line shows the current day.

By fitting to the time series of deaths, we are able to estimate a time-varying reproduction number, R_t. R_t is the the average number of secondary infections caused by a single infected person at a given time. If R_t is above 1, the rate of transmission is increasing and the number of new infections is increasing. R_t is assumed to change in relation to mobility fall in proportion. When fitting our model we assume that 100% of COVID-19 related deaths have been reported (please see our FAQ section for more information about this assumption). We also assume a fixed date at which the impact of mobility on transmission changes from pre-lockdown levels to post-lockdown levels, which may cause large changes in Rt. We are working to refine how this switch occurs and to formally calculate its shape.

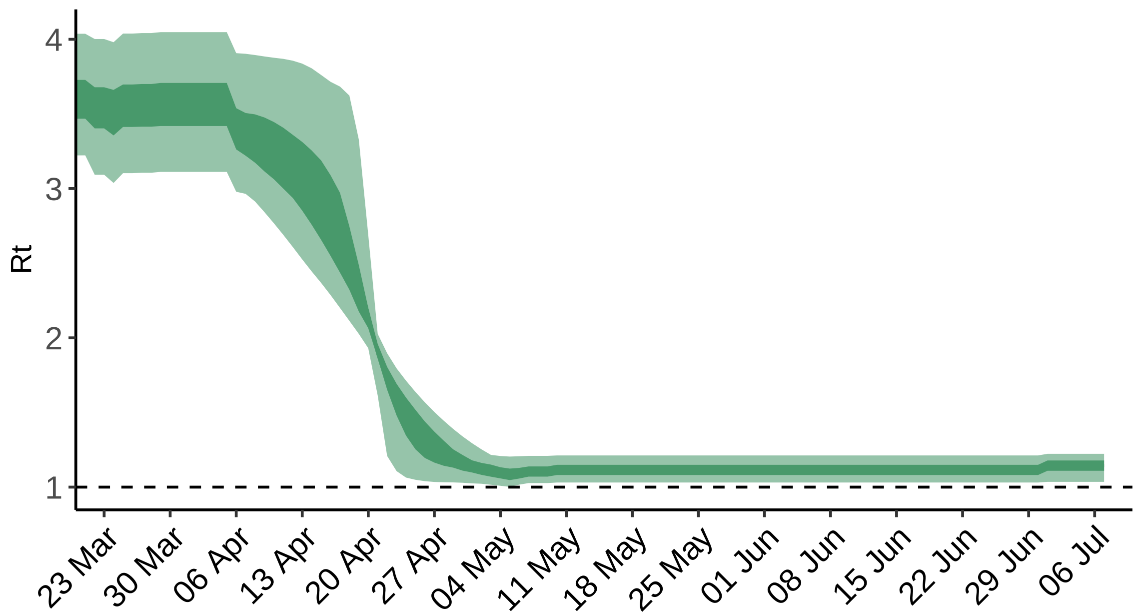

Figure 3: **Time-varying reproduction number, R_t.** R_t is the average number of secondary infections caused by a single infected person at time equal to t. $R_t < 1$ indicates a slowing epidemic in which new infections are not increasing. $R_t > 1$ indicates a growing epidemic in which new infections are increasing over time. Dark green shows the 50% CI and light green shows the 95% CI.

Using the model fit, we can forecast the expected trajectory for cumulative deaths, which is shown in the figure below. This assumes a severity pattern by age that is consistent with that observed in China, Europe and the U.S to date. This projection assumes that transmission is maintained at the current level of transmission as estimated by the final R_t value.

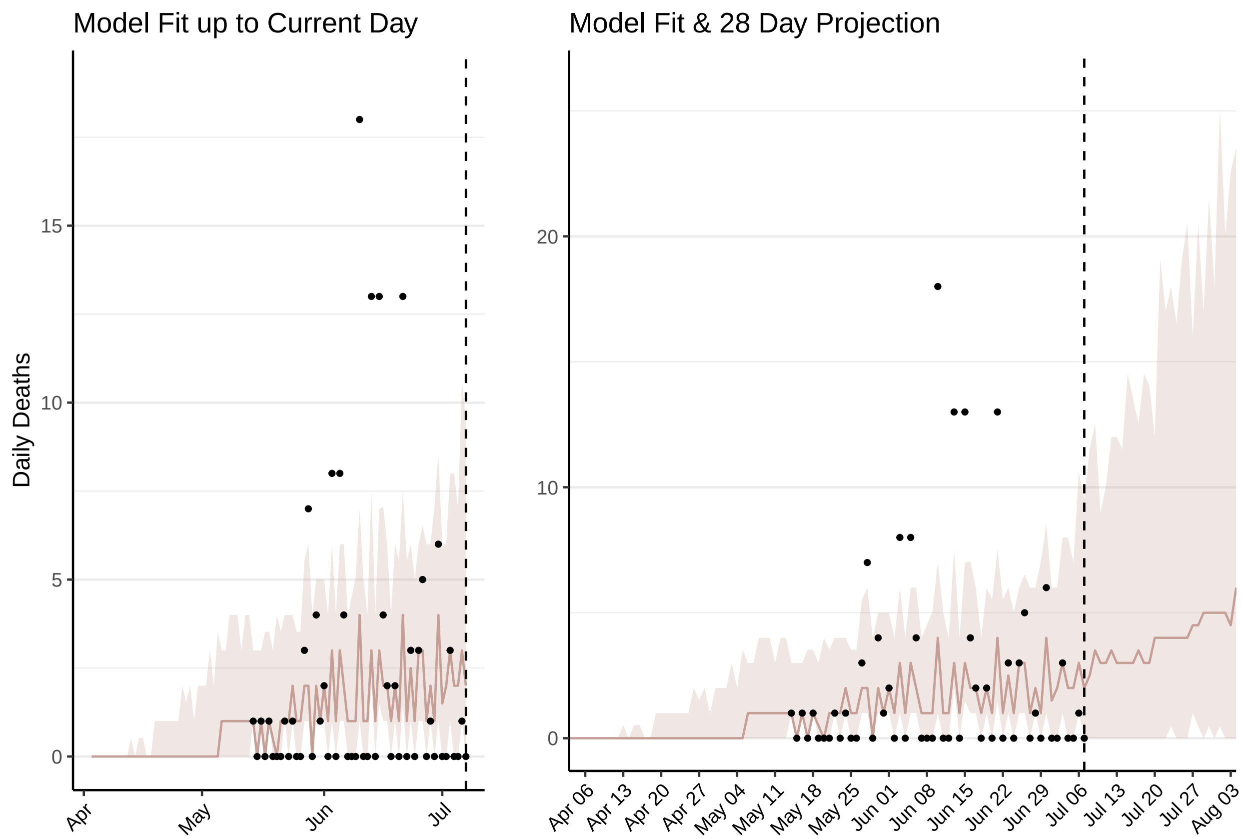

Figure 4: **Estimated daily deaths.** Projected deaths assuming the current level of interventions are maintained are shown in red (median and 95% quantile). Reported deaths are plotted in black. The plot on the left is focussed on the model fit prior to today, while the plot on the right forecasts the next 28 days.

Short-term Epidemic Scenarios

We make the following short-term projections of healthcare demand and new infections under the following three scenarios:

- **Scenario 1.** The epidemic continues to grow at the current rate.
- **Scenario 2.** Countries will further scale up interventions (either increasing current strategies or implementing new interventions) leading to a further 50% reduction in transmission.
- **Scenario 3.** Countries will relax current interventions by 50%

N.B. These scenarios currently assume that the impact of mobility on transmission will remain the same in the future as it has in the past. We are working to extend methods to estimate the impact of increases in mobility on transmission as lockdown and interventions are reversed. Consequently, projection are likely to represent an upper estimate of the healthcare demand and case load for each scenario

We estimate that over the next 4 weeks demand for hospital beds will change from 172 (95% CI: 155-188) patients requiring treatment with high-pressure oxygen at the current date to 301 (95% CI: 268-334) hospital beds being required on 2020-08-04 if no further interventions are introduced (Scenario 1). Similarly, we estimate that over the next 4 weeks demand for critical care (ICU) beds will change from 46 (95% CI: 41-50) patients requiring treatment with mechanical ventilation at the current date to 67 (95% CI: 63-72) by 2020-08-04. These projections assume that approximately 5% of all infections will require treatment with high-pressure oxygen and that approximately 30% of hospitalised cases will require treatment with mechanical ventilation (based on analysis of ongoing epidemics in Europe). **N.B. These scenarios are unlikely to show significant differences for the first week since there is a delay of approximately 10 days between infection and hospital admission. Consequently, the effectiveness of a change in policy is likely to be better captured by hospital admission data approximately 2 weeks after the policy change is implemented.**

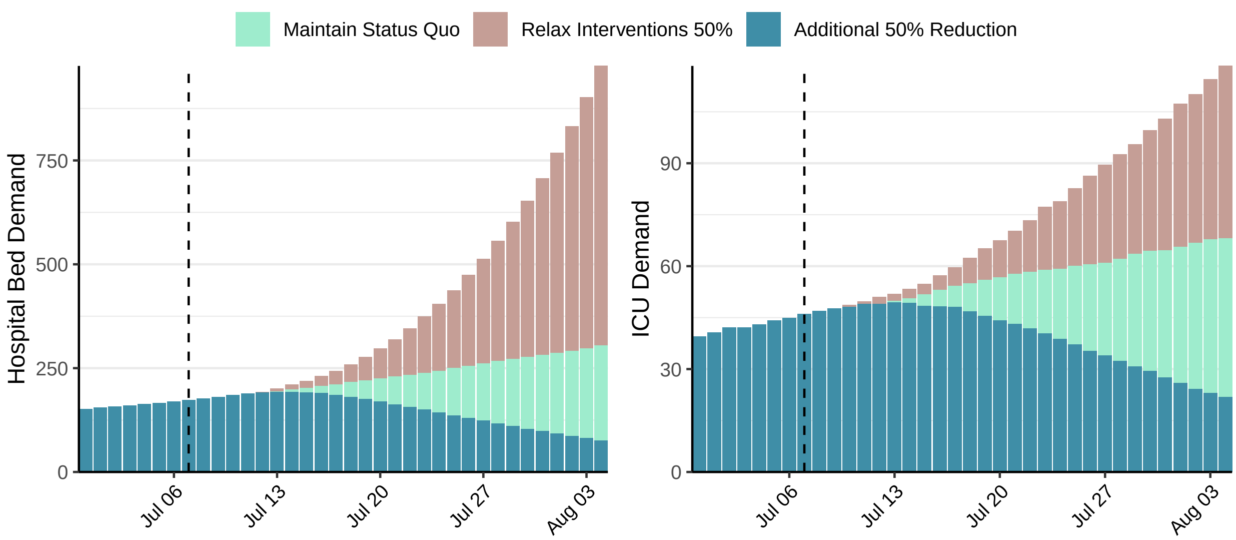

Figure 5: **Healthcare demands in the next 28 days.** Individuals needing an ICU bed are assumed to need mechanical ventilation. Projected demand for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

The impact of each scenario has a more immediate effect on the daily number of infections. The figure below shows the impact of each scenario on the estimated daily incidence of new infections. If interventions are scaled up (Scenario 2), the daily number of infections will change from 1,384 (95% CI: 1,243-1,525) at the current date to 189 (95% CI: 167-212) by 2020-08-04. If current interventions were relaxed by 50%, we estimate the daily number of infections will change from 1,384 (95% CI: 1,243-1,525) at the current date to 14,171 (95% CI: 12,573-15,770) by 2020-08-04.

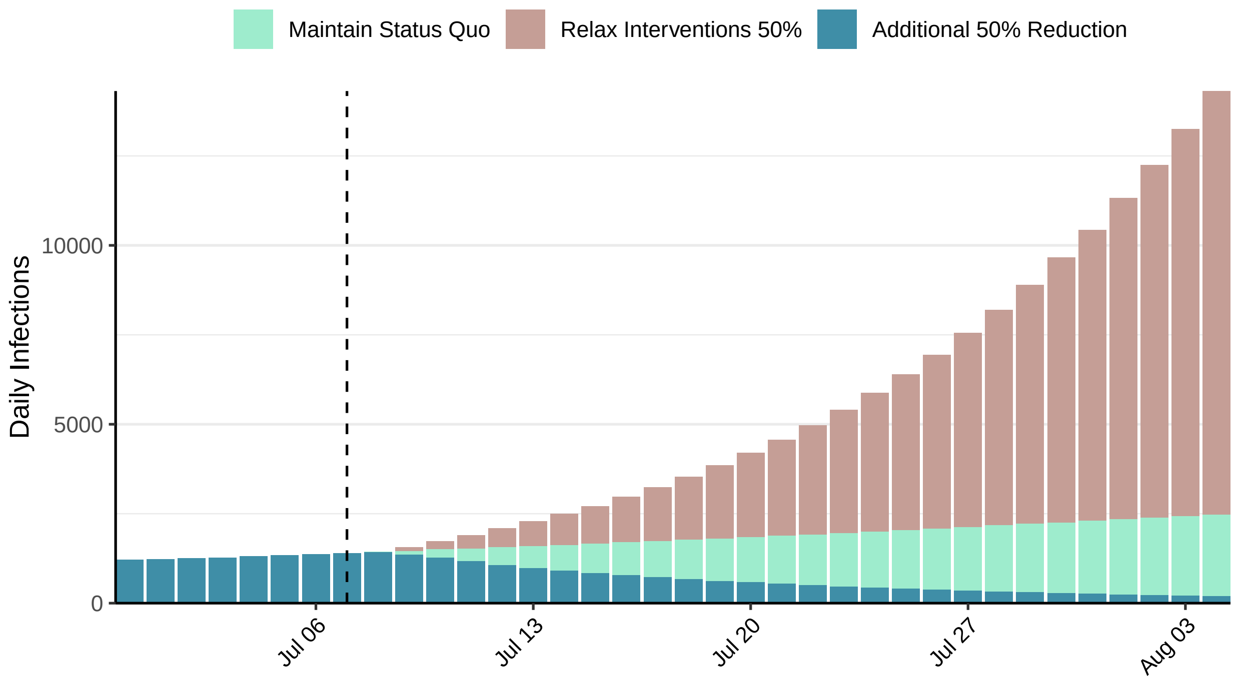

Figure 6: **Daily number of infections estimated by fitting to deaths.** Projected infections for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

To explore different scenarios, we recommend using our COVID-19 Scenario Analysis Tool - https://covidsim.org/, which can be used to simulate different intervention scenarios and explore the long term impact on healthcare demand.

Situation Report for COVID-19: Mauritius, 2020-07-07

Download the report for Mauritius, 2020-07-07 here. This report uses data from the European Centre for Disease Control. These data are updated daily and whilst there may be a short delay, they are generally consistent with Ministry reports. These data are then used to back-calculate an 'inferred number of COVID-19 infections' using mathematical modelling techniques (see Report 12 for further details) to estimate the number of people that have been infected and to make short-term projections for future healthcare needs.

Epidemiological Situation

Total Reported Cases	New Reported Cases	Total Reported Deaths	New Reported Deaths	Estimated R_t
342	1	10	0	0.53 (95% CI: 0.02-1.45)

The figure below shows the cumulative reported deaths as a function of the time since the 10th death was reported. Dashed lines show the expected trajectory for different doubling times of the epidemic. For example, with a doubling time of 3 days, if there are currently a total of 20 deaths reported, we would expect there to be 40 deaths in total reported in 3 days-time, 80 deaths in 6 days-time, 160 deaths in 9 days-time etc. For most epidemics, in the absence of interventions, we expect a doubling time of 3-4 days for this disease.

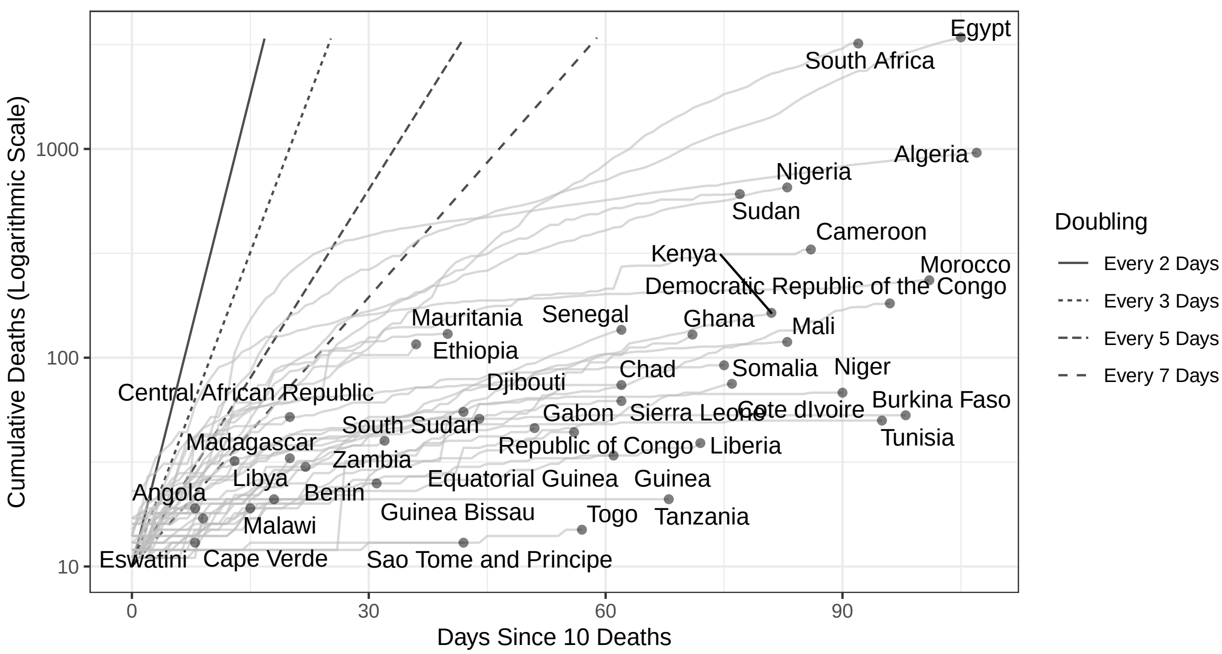

Figure 1: **Cumulative Deaths since 10 deaths.** Country not shown if fewer than 10 deaths.

COVID-19 Transmission Modelling

We assume that the deaths reported to date provide the best indication of the stage of the epidemic, as deaths are more consistently and accurately reported. Our current working estimate is that 1 death indicates that approximately 100 people will have been infected with the other 99 recovering (based on an infection fatality ratio of ~1%). These infections will have happened approximately 21 days previously – capturing a 5-day period from infection to onset of symptoms (the incubation period), 4 days from onset of symptoms to hospitalisation, and 12 days in hospital before death. With a 3-day doubling time, 100 infections that occurred 15 days ago will have generated 200 infections 12 days ago, 400 infections 9 days ago, 800 infections 6 days ago and 1,600 infections 3 days ago resulting in approximately 3,200 infections at the time the first death is observed.

To explore this, we fit our age-structured SEIR model (see Methods) to the time series of deaths in a country, in order to estimate the start date of the epidemic and the baseline R0. We assume that 100% of COVID-19 related deaths have been reported. We have also included the impact of interventions that have been put in place and their effect on human mobility and transmission based on the Google COVID-19 Community Mobility Reports. Using our mathematical model that formalises this approach, we estimate that there has been a total of 0 (95% CI: 0-0) infections over the past 4 weeks.

The figure below shows the estimated number of people infected over the past 4 weeks. The bar charts show, for comparison, the number of reported cases. The right-hand plot shows these data on a different scale as the estimated infections are likely to be much larger than the reported cases. **Importantly**, the estimated infections includes both asymptomatic and mild cases that would not necessarily be identified through surveillance. Consequently, the estimated infections are likely to be significantly higher than the reported cases (see our FAQ for further explanation of these differences and why the reported cases and estimated infections are unlikely to match).

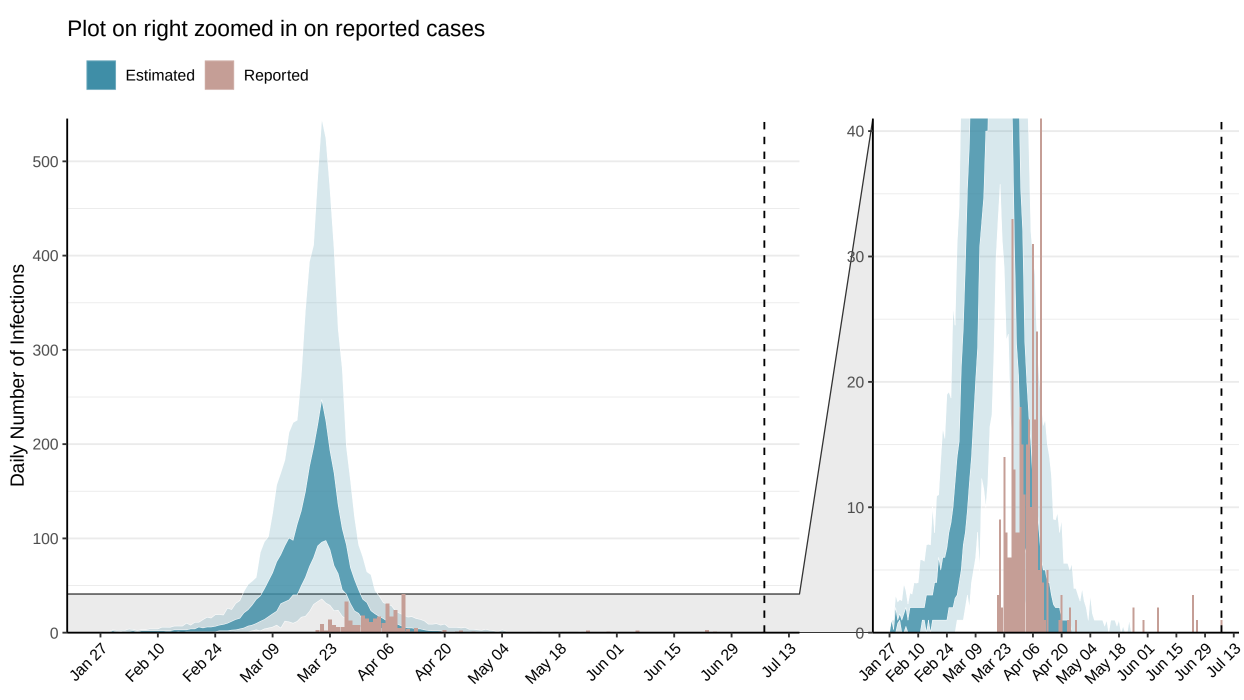

Figure 2: **Daily number of infections estimated by fitting to the current total of deaths.** Reported cases are shown in red. Model estimated infections are shown in blue (dark blue 50% interquartile range, light blue 95% quantile). The dashed line shows the current day.

By fitting to the time series of deaths, we are able to estimate a time-varying reproduction number, R_t. R_t is the the average number of secondary infections caused by a single infected person at a given time. If R_t is above 1, the rate of transmission is increasing and the number of new infections is increasing. R_t is assumed to change in relation to mobility fall in proportion. When fitting our model we assume that 100% of COVID-19 related deaths have been reported (please see our FAQ section for more information about this assumption). We also assume a fixed date at which the impact of mobility on transmission changes from pre-lockdown levels to post-lockdown levels, which may cause large changes in Rt. We are working to refine how this switch occurs and to formally calculate its shape.

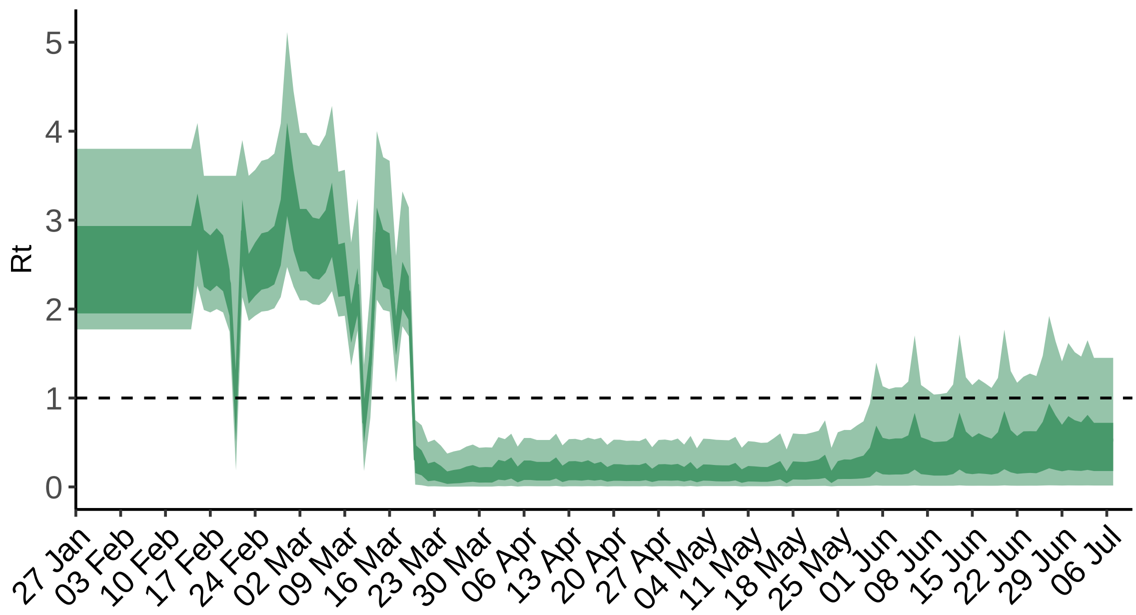

Figure 3: **Time-varying reproduction number, R_t.** R_t is the average number of secondary infections caused by a single infected person at time equal to t. $R_t < 1$ indicates a slowing epidemic in which new infections are not increasing. $R_t > 1$ indicates a growing epidemic in which new infections are increasing over time. Dark green shows the 50% CI and light green shows the 95% CI.

Using the model fit, we can forecast the expected trajectory for cumulative deaths, which is shown in the figure below. This assumes a severity pattern by age that is consistent with that observed in China, Europe and the U.S to date. This projection assumes that transmission is maintained at the current level of transmission as estimated by the final R_t value.

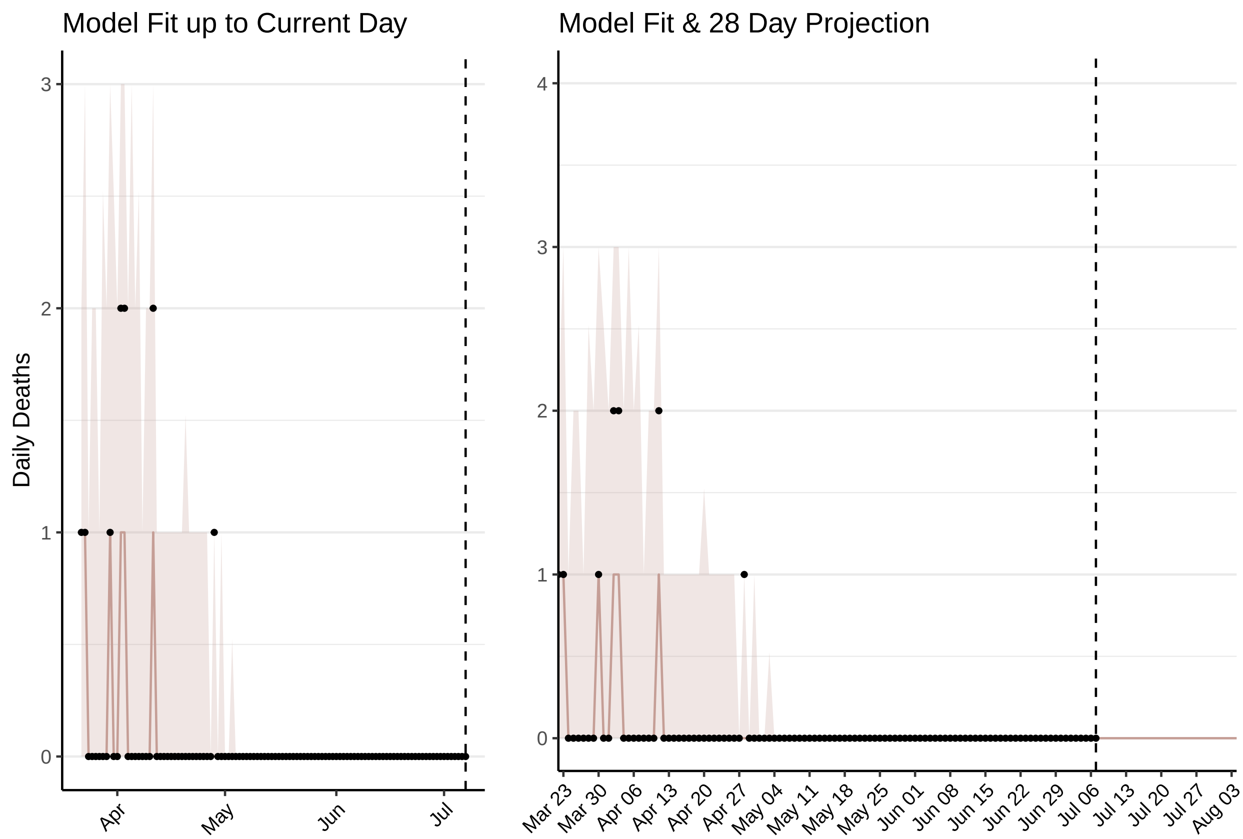

Figure 4: **Estimated daily deaths.** Projected deaths assuming the current level of interventions are maintained are shown in red (median and 95% quantile). Reported deaths are plotted in black. The plot on the left is focussed on the model fit prior to today, while the plot on the right forecasts the next 28 days.

Short-term Epidemic Scenarios

We make the following short-term projections of healthcare demand and new infections under the following three scenarios:

- **Scenario 1.** The epidemic continues to grow at the current rate.
- **Scenario 2.** Countries will further scale up interventions (either increasing current strategies or implementing new interventions) leading to a further 50% reduction in transmission.
- **Scenario 3.** Countries will relax current interventions by 50%

N.B. These scenarios currently assume that the impact of mobility on transmission will remain the same in the future as it has in the past. We are working to extend methods to estimate the impact of increases in mobility on transmission as lockdown and interventions are reversed. Consequently, projection are likely to represent an upper estimate of the healthcare demand and case load for each scenario

We estimate that over the next 4 weeks demand for hospital beds will change from 0 (95% CI: NaN-NaN) patients requiring treatment with high-pressure oxygen at the current date to 0 (95% CI: NaN-NaN) hospital beds being required on 2020-08-04 if no further interventions are introduced (Scenario 1). Similarly, we estimate that over the next 4 weeks demand for critical care (ICU) beds will change from 0 (95% CI: NaN-NaN) patients requiring treatment with mechanical ventilation at the current date to 0 (95% CI: NaN-NaN) by 2020-08-04. These projections assume that approximately 5% of all infections will require treatment with high-pressure oxygen and that approximately 30% of hospitalised cases will require treatment with mechanical ventilation (based on analysis of ongoing epidemics in Europe). **N.B. These scenarios are unlikely to show significant differences for the first week since there is a delay of approximately 10 days between infection and hospital admission. Consequently, the effectiveness of a change in policy is likely to be better captured by hospital admission data approximately 2 weeks after the policy change is implemented.**

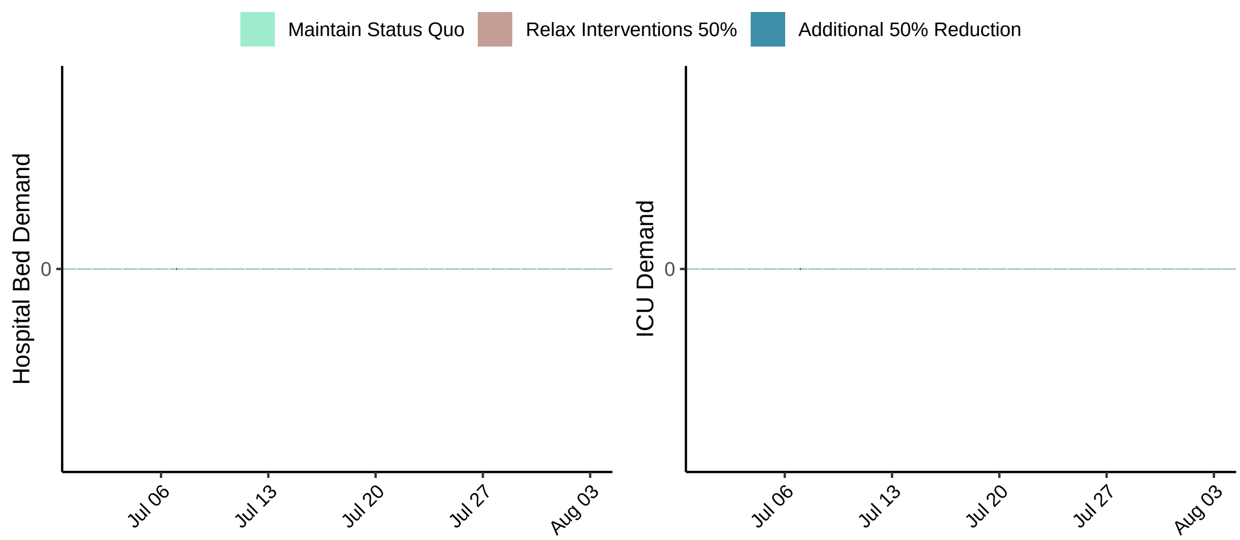

Figure 5: **Healthcare demands in the next 28 days.** Individuals needing an ICU bed are assumed to need mechanical ventilation. Projected demand for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

The impact of each scenario has a more immediate effect on the daily number of infections. The figure below shows the impact of each scenario on the estimated daily incidence of new infections. If interventions are scaled up (Scenario 2), the daily number of infections will change from 0 (95% CI: NaN-NaN) at the current date to 0 (95% CI: NaN-NaN) by 2020-08-04. If current interventions were relaxed by 50%, we estimate the daily number of infections will change from 0 (95% CI: NaN-NaN) at the current date to 0 (95% CI: NaN-NaN) by 2020-08-04.

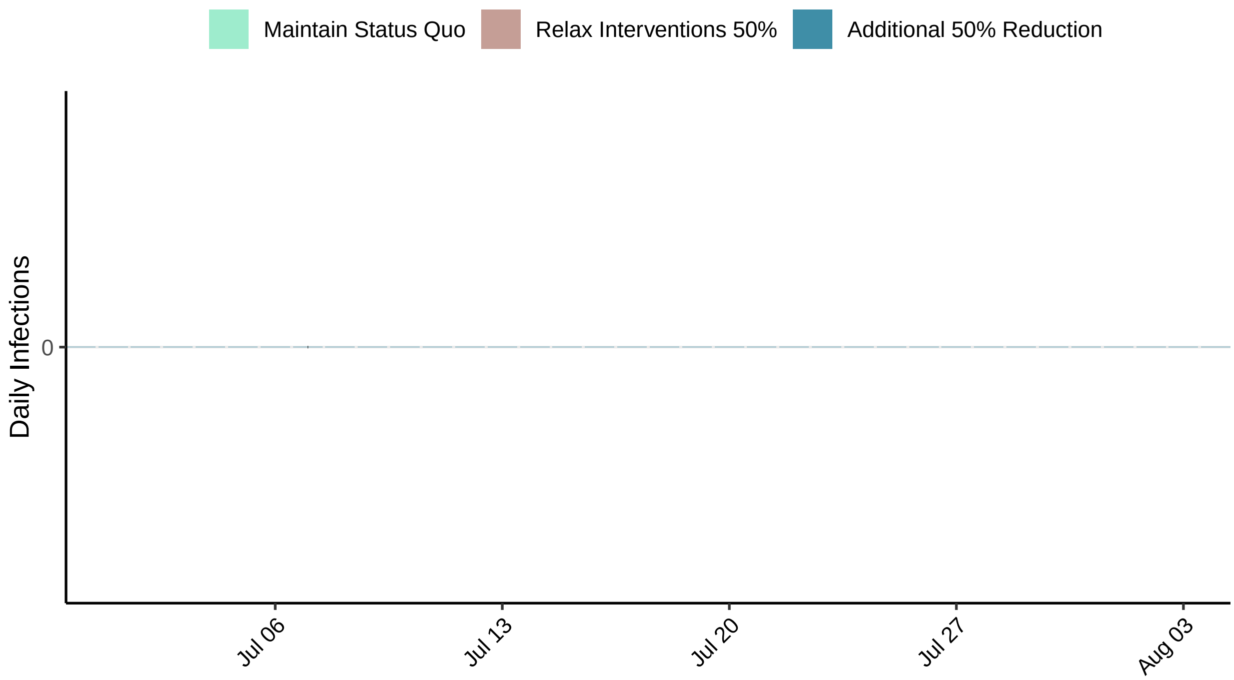

Figure 6: **Daily number of infections estimated by fitting to deaths.** Projected infections for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

To explore different scenarios, we recommend using our COVID-19 Scenario Analysis Tool - https://covidsim.org/, which can be used to simulate different intervention scenarios and explore the long term impact on healthcare demand.

Situation Report for COVID-19: Malawi, 2020-07-07

Download the report for Malawi, 2020-07-07 here. This report uses data from the European Centre for Disease Control. These data are updated daily and whilst there may be a short delay, they are generally consistent with Ministry reports. These data are then used to back-calculate an 'inferred number of COVID-19 infections' using mathematical modelling techniques (see Report 12 for further details) to estimate the number of people that have been infected and to make short-term projections for future healthcare needs.

Epidemiological Situation

Total Reported Cases	New Reported Cases	Total Reported Deaths	New Reported Deaths	Estimated R_t
1,818	76	19	0	1.24 (95% CI: 1.12-1.36)

The figure below shows the cumulative reported deaths as a function of the time since the 10th death was reported. Dashed lines show the expected trajectory for different doubling times of the epidemic. For example, with a doubling time of 3 days, if there are currently a total of 20 deaths reported, we would expect there to be 40 deaths in total reported in 3 days-time, 80 deaths in 6 days-time, 160 deaths in 9 days-time etc. For most epidemics, in the absence of interventions, we expect a doubling time of 3-4 days for this disease.

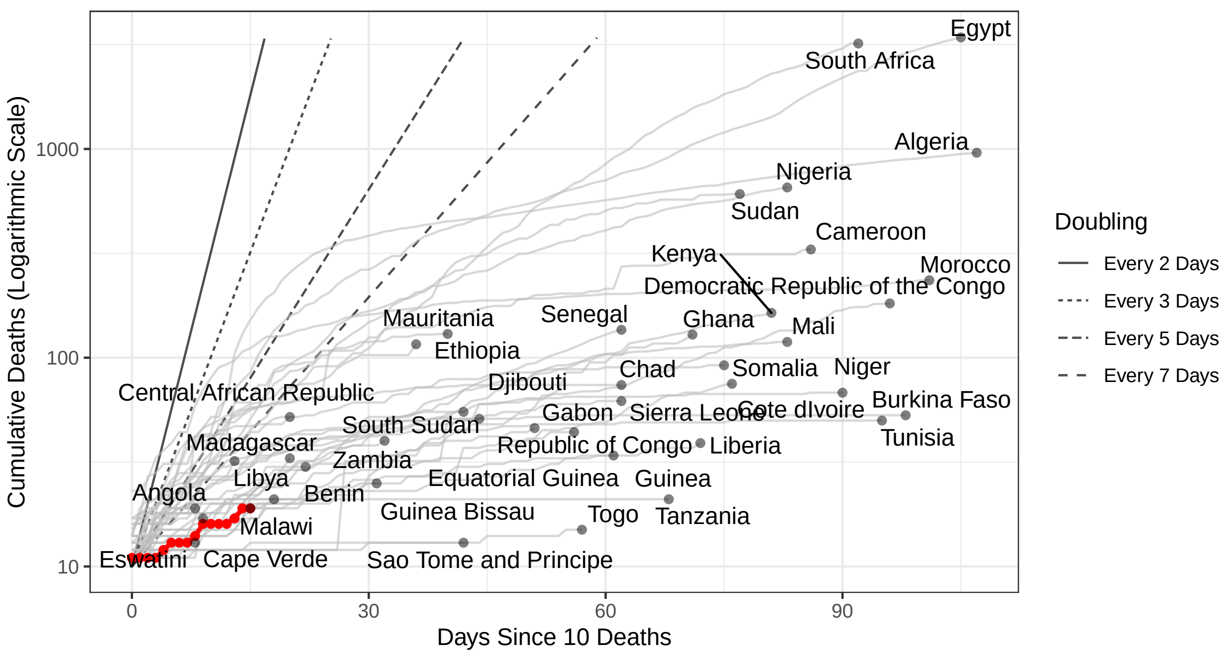

Figure 1: **Cumulative Deaths since 10 deaths.** Country not shown if fewer than 10 deaths.

COVID-19 Transmission Modelling

We assume that the deaths reported to date provide the best indication of the stage of the epidemic, as deaths are more consistently and accurately reported. Our current working estimate is that 1 death indicates that approximately 100 people will have been infected with the other 99 recovering (based on an infection fatality ratio of ~1%). These infections will have happened approximately 21 days previously – capturing a 5-day period from infection to onset of symptoms (the incubation period), 4 days from onset of symptoms to hospitalisation, and 12 days in hospital before death. With a 3-day doubling time, 100 infections that occurred 15 days ago will have generated 200 infections 12 days ago, 400 infections 9 days ago, 800 infections 6 days ago and 1,600 infections 3 days ago resulting in approximately 3,200 infections at the time the first death is observed.

To explore this, we fit our age-structured SEIR model (see Methods) to the time series of deaths in a country, in order to estimate the start date of the epidemic and the baseline R0. We assume that 100% of COVID-19 related deaths have been reported. We have also included the impact of interventions that have been put in place and their effect on human mobility and transmission based on the Google COVID-19 Community Mobility Reports. Using our mathematical model that formalises this approach, we estimate that there has been a total of 10,049 (95% CI: 8,119-11,979) infections over the past 4 weeks.

The figure below shows the estimated number of people infected over the past 4 weeks. The bar charts show, for comparison, the number of reported cases. The right-hand plot shows these data on a different scale as the estimated infections are likely to be much larger than the reported cases. **Importantly**, the estimated infections includes both asymptomatic and mild cases that would not necessarily be identified through surveillance. Consequently, the estimated infections are likely to be significantly higher than the reported cases (see our FAQ for further explanation of these differences and why the reported cases and estimated infections are unlikely to match).

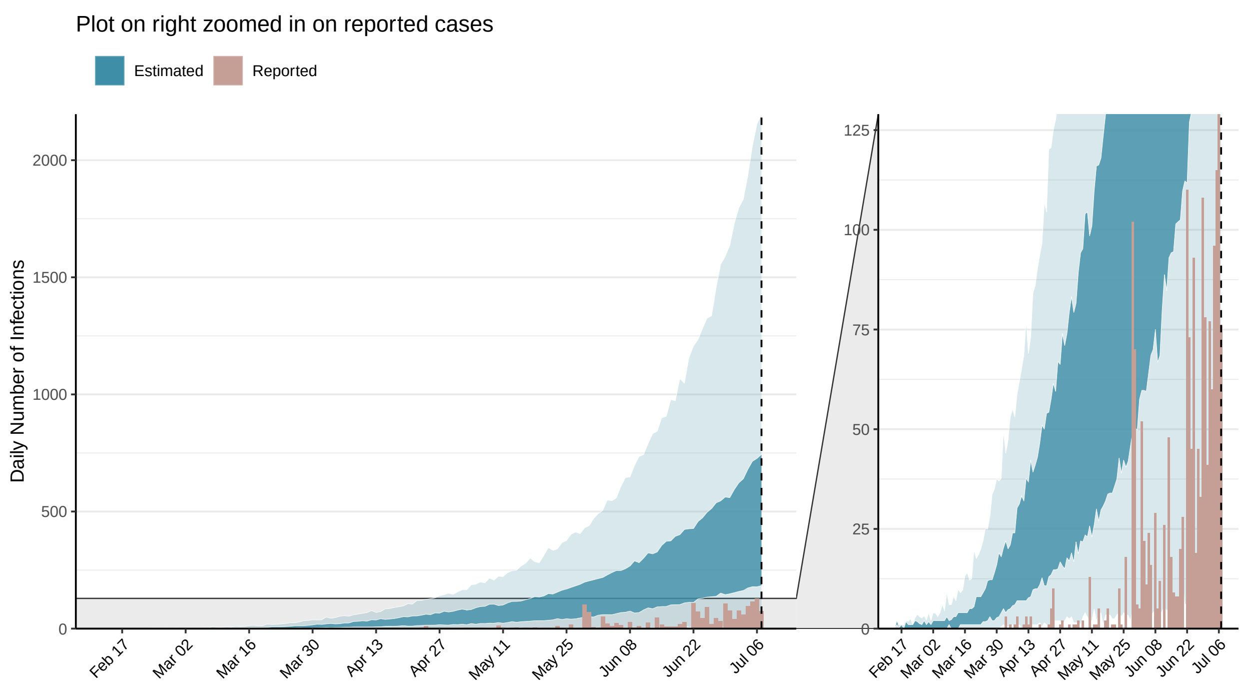

Figure 2: **Daily number of infections estimated by fitting to the current total of deaths.** Reported cases are shown in red. Model estimated infections are shown in blue (dark blue 50% interquartile range, light blue 95% quantile). The dashed line shows the current day.

By fitting to the time series of deaths, we are able to estimate a time-varying reproduction number, R_t. R_t is the the average number of secondary infections caused by a single infected person at a given time. If R_t is above 1, the rate of transmission is increasing and the number of new infections is increasing. R_t is assumed to change in relation to mobility fall in proportion. When fitting our model we assume that 100% of COVID-19 related deaths have been reported (please see our FAQ section for more information about this assumption). We also assume a fixed date at which the impact of mobility on transmission changes from pre-lockdown levels to post-lockdown levels, which may cause large changes in Rt. We are working to refine how this switch occurs and to formally calculate its shape.

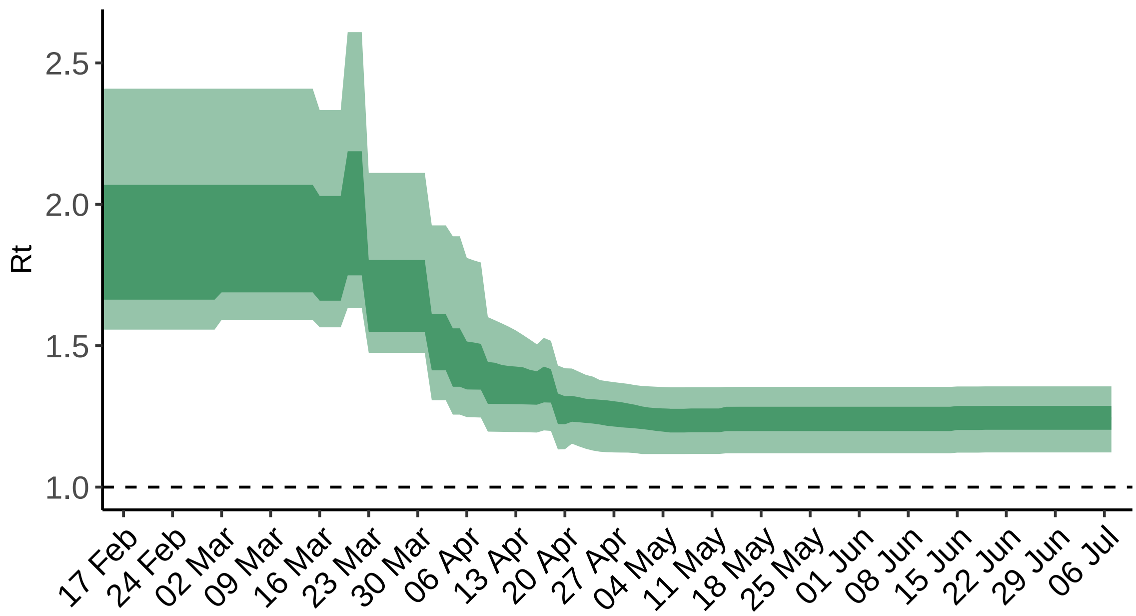

Figure 3: **Time-varying reproduction number, R_t.** R_t is the average number of secondary infections caused by a single infected person at time equal to t. $R_t < 1$ indicates a slowing epidemic in which new infections are not increasing. $R_t > 1$ indicates a growing epidemic in which new infections are increasing over time. Dark green shows the 50% CI and light green shows the 95% CI.

Using the model fit, we can forecast the expected trajectory for cumulative deaths, which is shown in the figure below. This assumes a severity pattern by age that is consistent with that observed in China, Europe and the U.S to date. This projection assumes that transmission is maintained at the current level of transmission as estimated by the final R_t value.

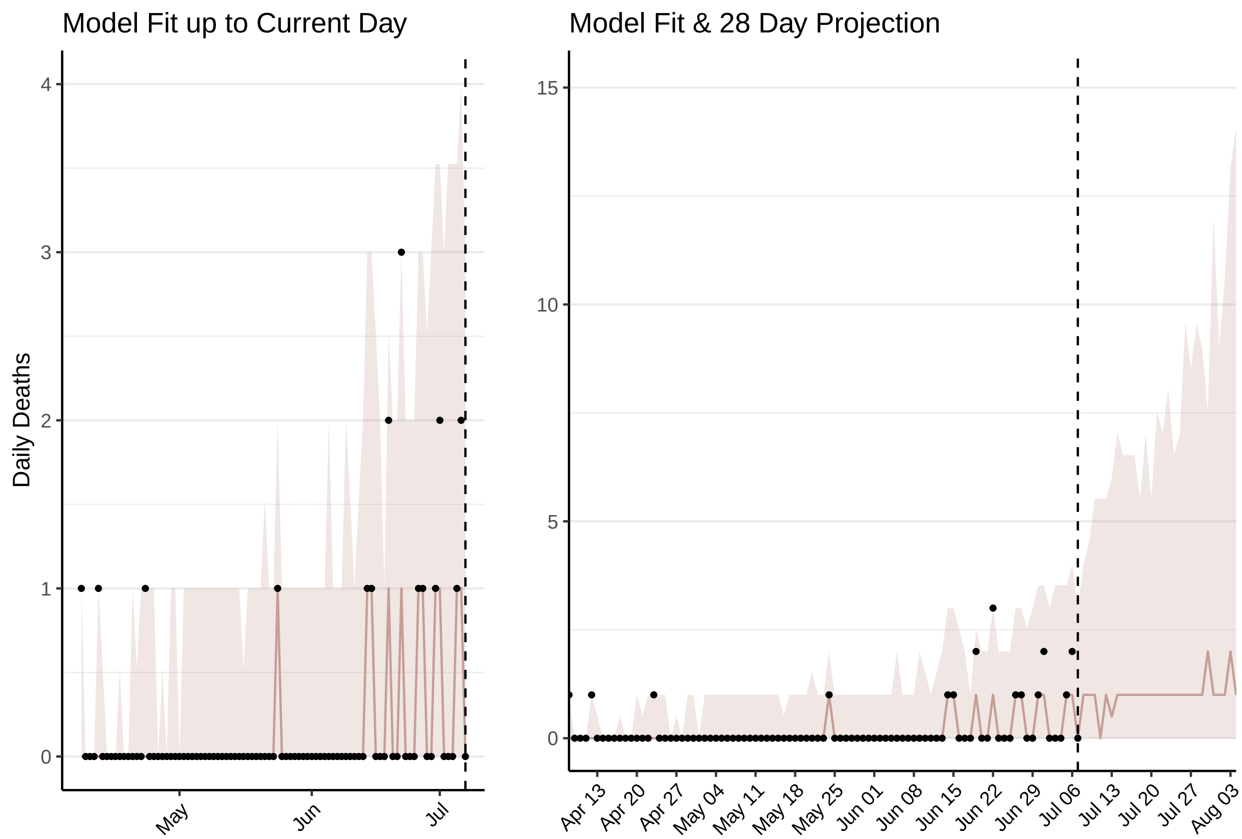

Figure 4: **Estimated daily deaths.** Projected deaths assuming the current level of interventions are maintained are shown in red (median and 95% quantile). Reported deaths are plotted in black. The plot on the left is focussed on the model fit prior to today, while the plot on the right forecasts the next 28 days.

Short-term Epidemic Scenarios

We make the following short-term projections of healthcare demand and new infections under the following three scenarios:

- **Scenario 1.** The epidemic continues to grow at the current rate.
- **Scenario 2.** Countries will further scale up interventions (either increasing current strategies or implementing new interventions) leading to a further 50% reduction in transmission.
- **Scenario 3.** Countries will relax current interventions by 50%

N.B. These scenarios currently assume that the impact of mobility on transmission will remain the same in the future as it has in the past. We are working to extend methods to estimate the impact of increases in mobility on transmission as lockdown and interventions are reversed. Consequently, projection are likely to represent an upper estimate of the healthcare demand and case load for each scenario

We estimate that over the next 4 weeks demand for hospital beds will change from 53 (95% CI: 43-64) patients requiring treatment with high-pressure oxygen at the current date to 157 (95% CI: 120-194) hospital beds being required on 2020-08-04 if no further interventions are introduced (Scenario 1). Similarly, we estimate that over the next 4 weeks demand for critical care (ICU) beds will change from 14 (95% CI: 11-17) patients requiring treatment with mechanical ventilation at the current date to 41 (95% CI: 31-50) by 2020-08-04. These projections assume that approximately 5% of all infections will require treatment with high-pressure oxygen and that approximately 30% of hospitalised cases will require treatment with mechanical ventilation (based on analysis of ongoing epidemics in Europe). **N.B. These scenarios are unlikely to show significant differences for the first week since there is a delay of approximately 10 days between infection and hospital admission. Consequently, the effectiveness of a change in policy is likely to be better captured by hospital admission data approximately 2 weeks after the policy change is implemented.**

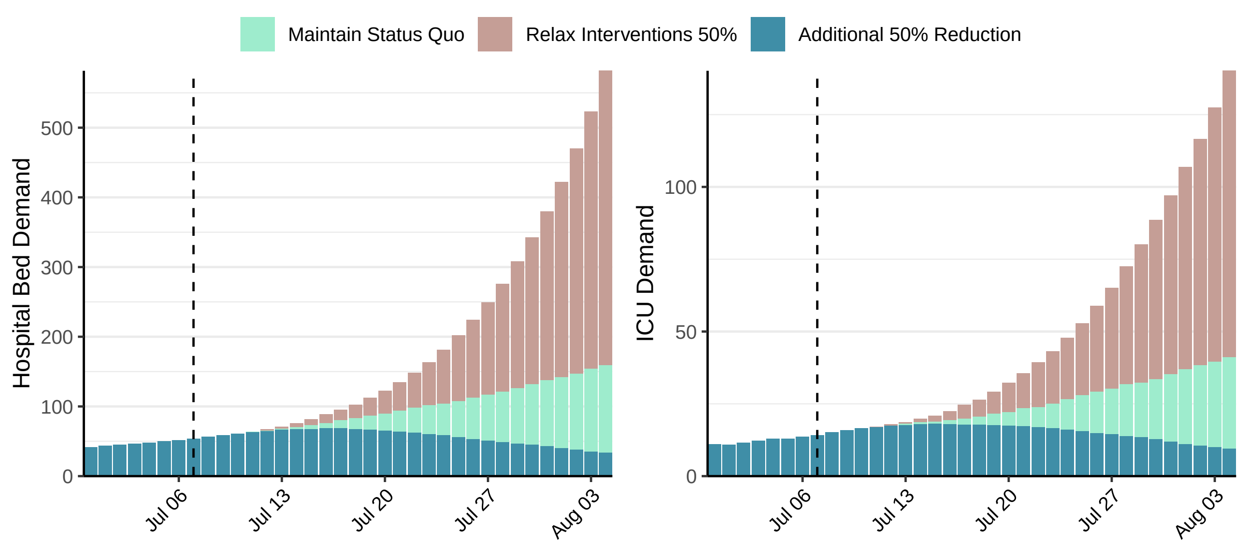

Figure 5: **Healthcare demands in the next 28 days.** Individuals needing an ICU bed are assumed to need mechanical ventilation. Projected demand for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

The impact of each scenario has a more immediate effect on the daily number of infections. The figure below shows the impact of each scenario on the estimated daily incidence of new infections. If interventions are scaled up (Scenario 2), the daily number of infections will change from 568 (95% CI: 450-686) at the current date to 114 (95% CI: 85-143) by 2020-08-04. If current interventions were relaxed by 50%, we estimate the daily number of infections will change from 568 (95% CI: 450-686) at the current date to 11,006 (95% CI: 8,104-13,908) by 2020-08-04.

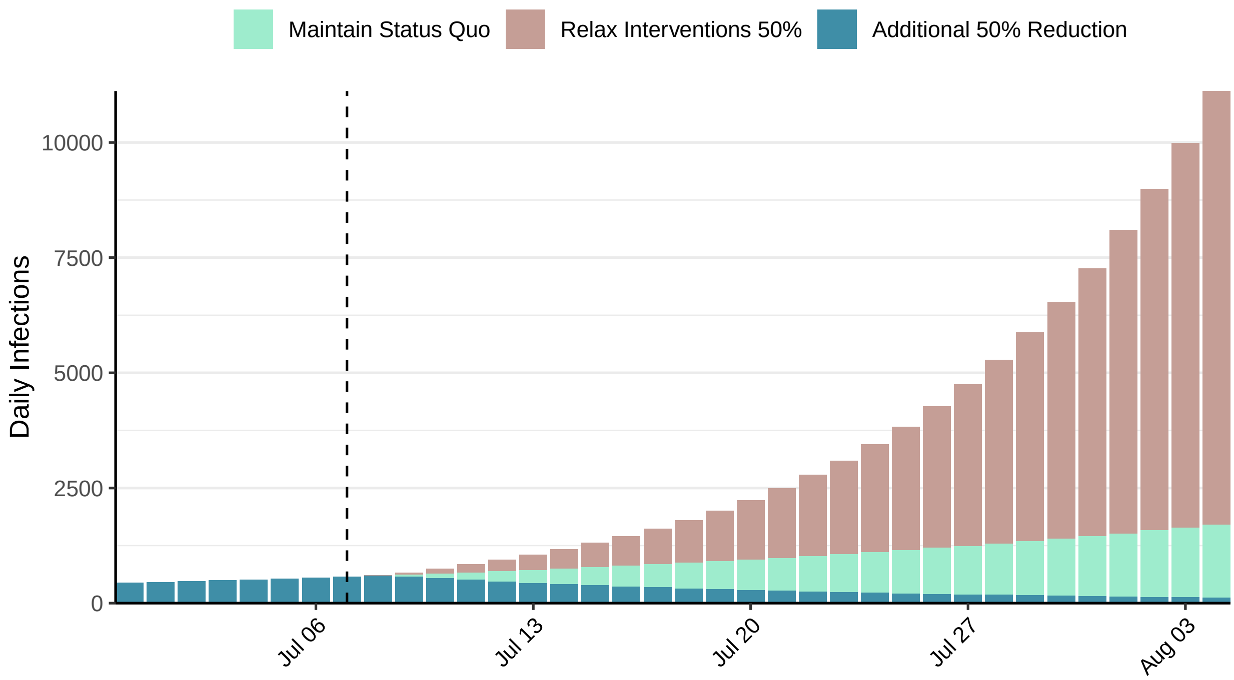

Figure 6: **Daily number of infections estimated by fitting to deaths.** Projected infections for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

To explore different scenarios, we recommend using our COVID-19 Scenario Analysis Tool - https://covidsim.org/, which can be used to simulate different intervention scenarios and explore the long term impact on healthcare demand.

Situation Report for COVID-19: Malaysia, 2020-07-07

Download the report for Malaysia, 2020-07-07 here. This report uses data from the European Centre for Disease Control. These data are updated daily and whilst there may be a short delay, they are generally consistent with Ministry reports. These data are then used to back-calculate an 'inferred number of COVID-19 infections' using mathematical modelling techniques (see Report 12 for further details) to estimate the number of people that have been infected and to make short-term projections for future healthcare needs.

Epidemiological Situation

Total Reported Cases	New Reported Cases	Total Reported Deaths	New Reported Deaths	Estimated R_t
8,668	10	121	0	0.93 (95% CI: 0.63-1.34)

The figure below shows the cumulative reported deaths as a function of the time since the 10th death was reported. Dashed lines show the expected trajectory for different doubling times of the epidemic. For example, with a doubling time of 3 days, if there are currently a total of 20 deaths reported, we would expect there to be 40 deaths in total reported in 3 days-time, 80 deaths in 6 days-time, 160 deaths in 9 days-time etc. For most epidemics, in the absence of interventions, we expect a doubling time of 3-4 days for this disease.

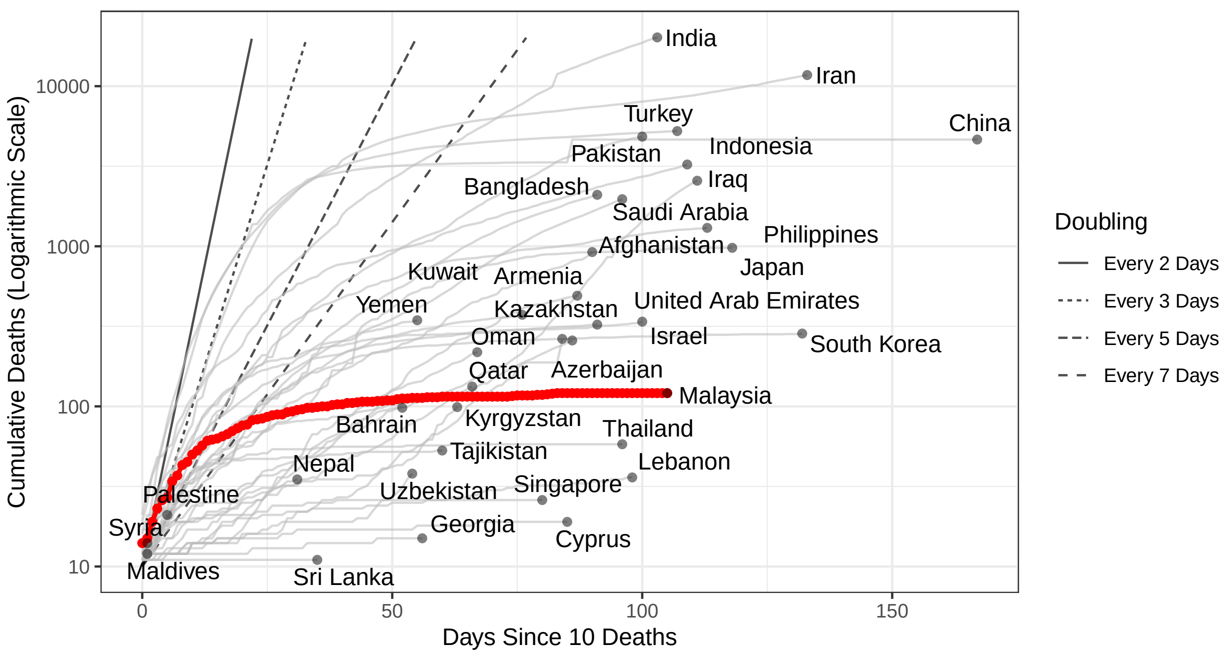

Figure 1: **Cumulative Deaths since 10 deaths.** Country not shown if fewer than 10 deaths.

COVID-19 Transmission Modelling

We assume that the deaths reported to date provide the best indication of the stage of the epidemic, as deaths are more consistently and accurately reported. Our current working estimate is that 1 death indicates that approximately 100 people will have been infected with the other 99 recovering (based on an infection fatality ratio of ~1%). These infections will have happened approximately 21 days previously – capturing a 5-day period from infection to onset of symptoms (the incubation period), 4 days from onset of symptoms to hospitalisation, and 12 days in hospital before death. With a 3-day doubling time, 100 infections that occurred 15 days ago will have generated 200 infections 12 days ago, 400 infections 9 days ago, 800 infections 6 days ago and 1,600 infections 3 days ago resulting in approximately 3,200 infections at the time the first death is observed.

To explore this, we fit our age-structured SEIR model (see Methods) to the time series of deaths in a country, in order to estimate the start date of the epidemic and the baseline R0. We assume that 100% of COVID-19 related deaths have been reported. We have also included the impact of interventions that have been put in place and their effect on human mobility and transmission based on the Google COVID-19 Community Mobility Reports. Using our mathematical model that formalises this approach, we estimate that there has been a total of 717 (95% CI: 568-866) infections over the past 4 weeks.

The figure below shows the estimated number of people infected over the past 4 weeks. The bar charts show, for comparison, the number of reported cases. The right-hand plot shows these data on a different scale as the estimated infections are likely to be much larger than the reported cases. **Importantly**, the estimated infections includes both asymptomatic and mild cases that would not necessarily be identified through surveillance. Consequently, the estimated infections are likely to be significantly higher than the reported cases (see our FAQ for further explanation of these differences and why the reported cases and estimated infections are unlikely to match).

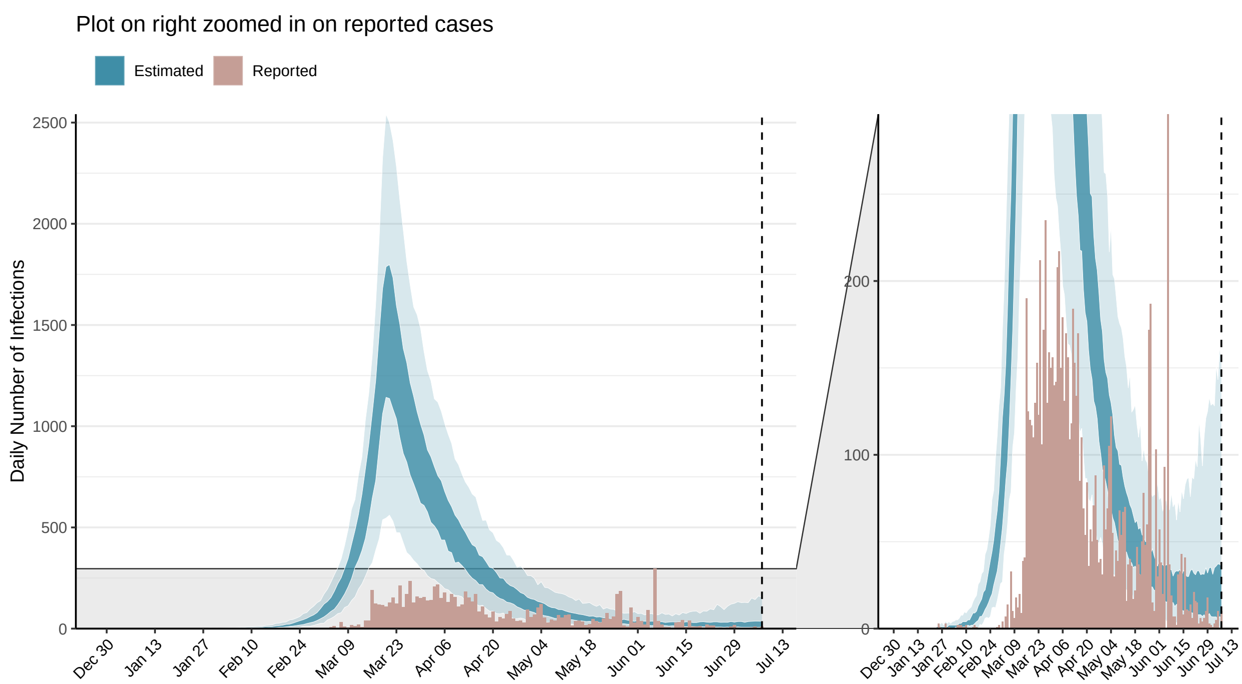

Figure 2: **Daily number of infections estimated by fitting to the current total of deaths.** Reported cases are shown in red. Model estimated infections are shown in blue (dark blue 50% interquartile range, light blue 95% quantile). The dashed line shows the current day.

By fitting to the time series of deaths, we are able to estimate a time-varying reproduction number, R_t. R_t is the the average number of secondary infections caused by a single infected person at a given time. If R_t is above 1, the rate of transmission is increasing and the number of new infections is increasing. R_t is assumed to change in relation to mobility fall in proportion. When fitting our model we assume that 100% of COVID-19 related deaths have been reported (please see our FAQ section for more information about this assumption). We also assume a fixed date at which the impact of mobility on transmission changes from pre-lockdown levels to post-lockdown levels, which may cause large changes in Rt. We are working to refine how this switch occurs and to formally calculate its shape.

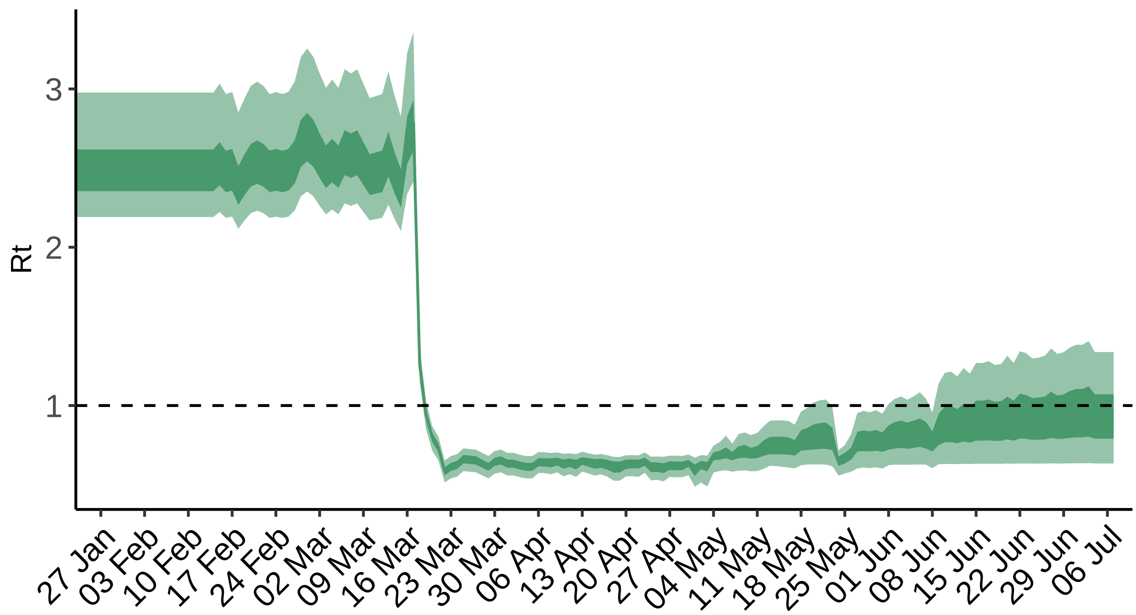

Figure 3: **Time-varying reproduction number, R_t.** R_t is the average number of secondary infections caused by a single infected person at time equal to t. $R_t < 1$ indicates a slowing epidemic in which new infections are not increasing. $R_t > 1$ indicates a growing epidemic in which new infections are increasing over time. Dark green shows the 50% CI and light green shows the 95% CI.

Using the model fit, we can forecast the expected trajectory for cumulative deaths, which is shown in the figure below. This assumes a severity pattern by age that is consistent with that observed in China, Europe and the U.S to date. This projection assumes that transmission is maintained at the current level of transmission as estimated by the final R_t value.

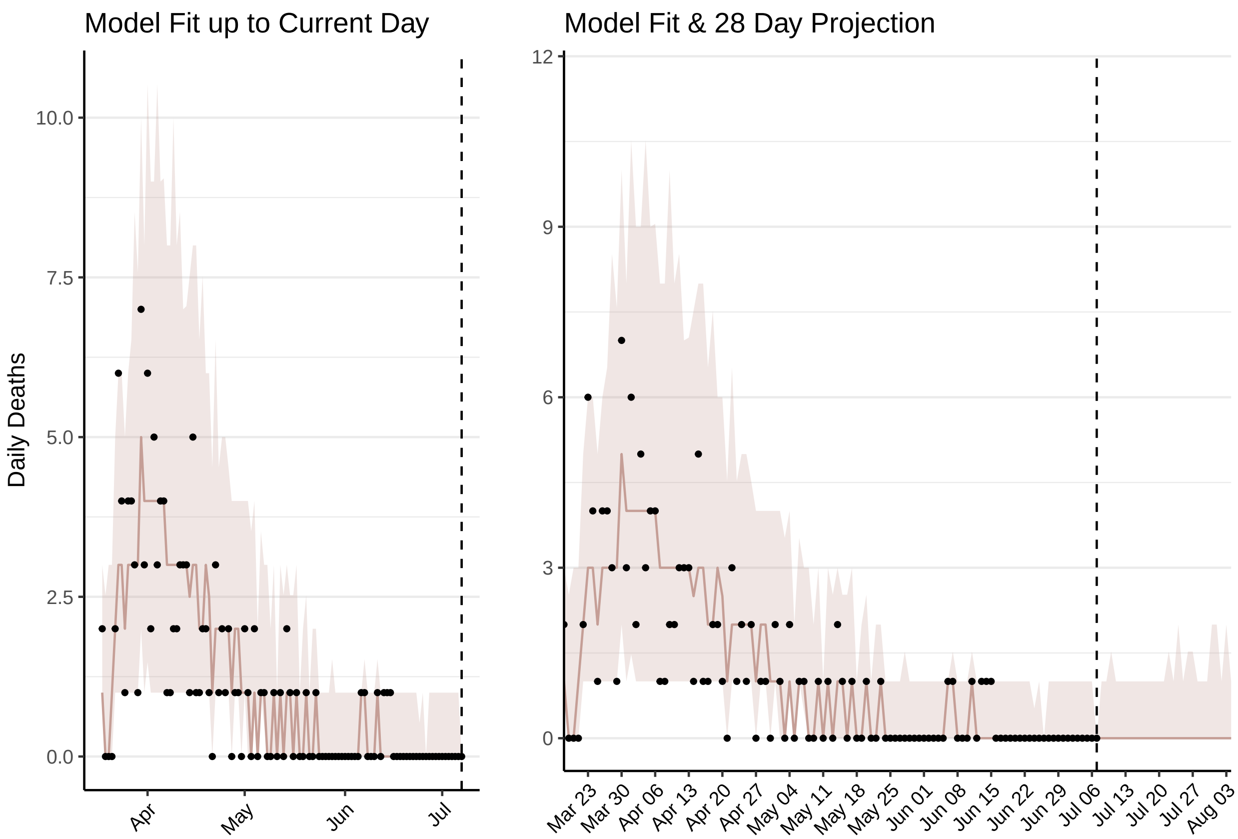

Figure 4: **Estimated daily deaths.** Projected deaths assuming the current level of interventions are maintained are shown in red (median and 95% quantile). Reported deaths are plotted in black. The plot on the left is focussed on the model fit prior to today, while the plot on the right forecasts the next 28 days.

Short-term Epidemic Scenarios

We make the following short-term projections of healthcare demand and new infections under the following three scenarios:

- **Scenario 1.** The epidemic continues to grow at the current rate.
- **Scenario 2.** Countries will further scale up interventions (either increasing current strategies or implementing new interventions) leading to a further 50% reduction in transmission.
- **Scenario 3.** Countries will relax current interventions by 50%

N.B. These scenarios currently assume that the impact of mobility on transmission will remain the same in the future as it has in the past. We are working to extend methods to estimate the impact of increases in mobility on transmission as lockdown and interventions are reversed. Consequently, projection are likely to represent an upper estimate of the healthcare demand and case load for each scenario

We estimate that over the next 4 weeks demand for hospital beds will change from 6 (95% CI: 5-8) patients requiring treatment with high-pressure oxygen at the current date to 11 (95% CI: 6-15) hospital beds being required on 2020-08-04 if no further interventions are introduced (Scenario 1). Similarly, we estimate that over the next 4 weeks demand for critical care (ICU) beds will change from 2 (95% CI: 1-2) patients requiring treatment with mechanical ventilation at the current date to 3 (95% CI: 1-4) by 2020-08-04. These projections assume that approximately 5% of all infections will require treatment with high-pressure oxygen and that approximately 30% of hospitalised cases will require treatment with mechanical ventilation (based on analysis of ongoing epidemics in Europe). **N.B. These scenarios are unlikely to show significant differences for the first week since there is a delay of approximately 10 days between infection and hospital admission. Consequently, the effectiveness of a change in policy is likely to be better captured by hospital admission data approximately 2 weeks after the policy change is implemented.**

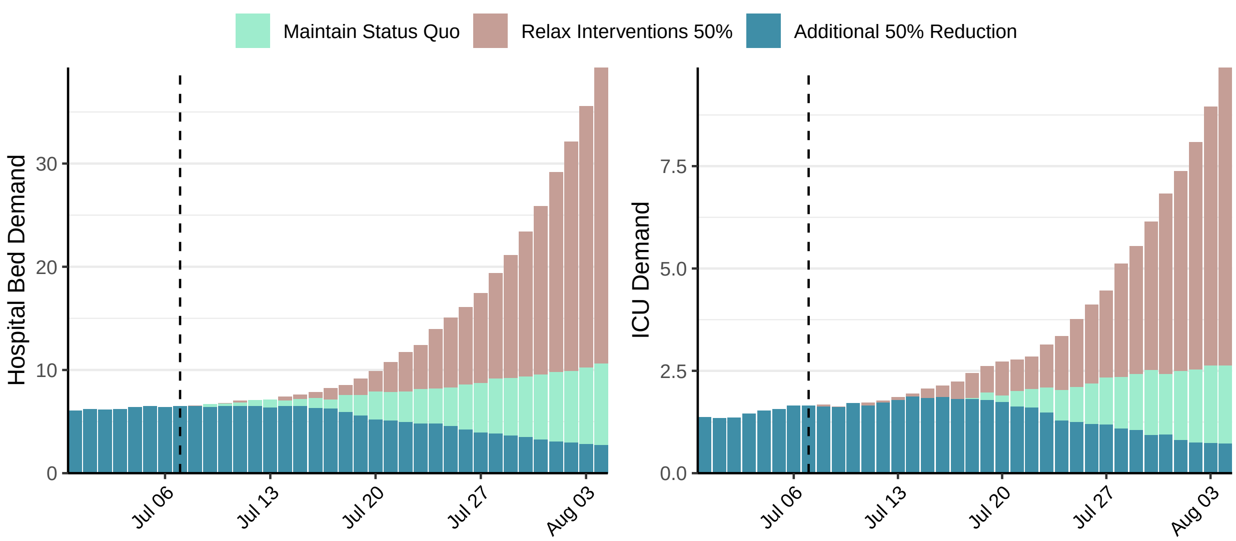

Figure 5: **Healthcare demands in the next 28 days.** Individuals needing an ICU bed are assumed to need mechanical ventilation. Projected demand for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

The impact of each scenario has a more immediate effect on the daily number of infections. The figure below shows the impact of each scenario on the estimated daily incidence of new infections. If interventions are scaled up (Scenario 2), the daily number of infections will change from 31 (95% CI: 21-40) at the current date to 5 (95% CI: 2-7) by 2020-08-04. If current interventions were relaxed by 50%, we estimate the daily number of infections will change from 31 (95% CI: 21-40) at the current date to 425 (95% CI: 177-674) by 2020-08-04.

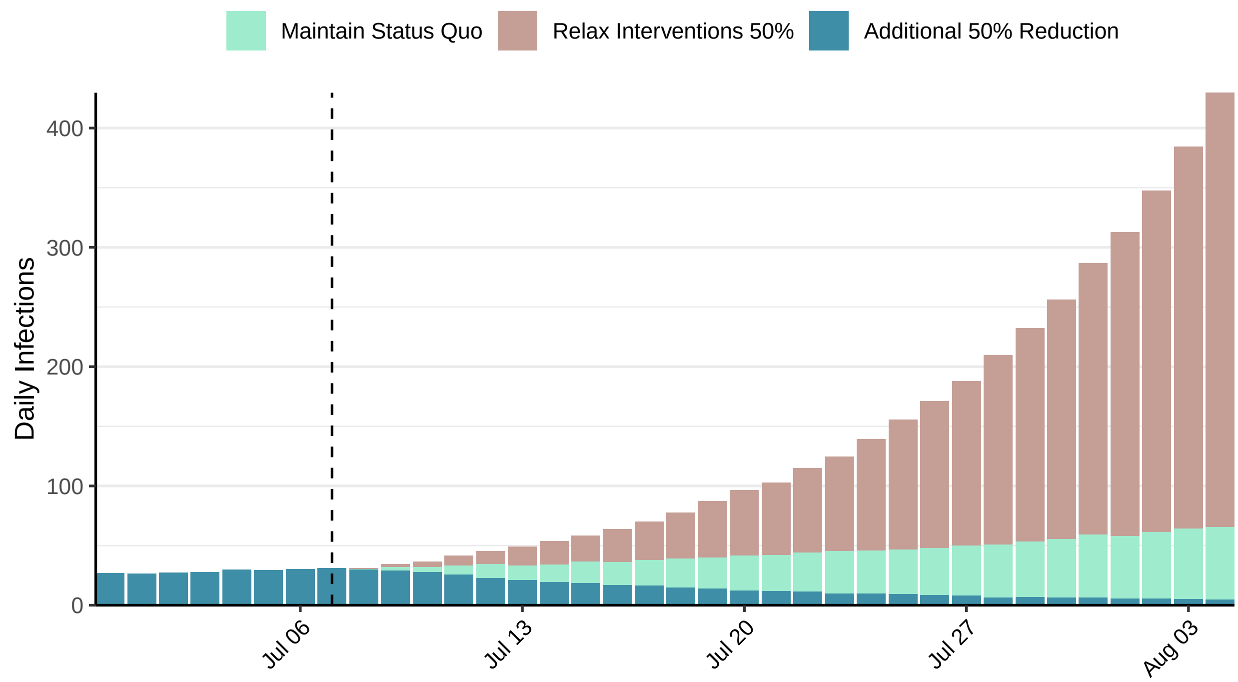

Figure 6: **Daily number of infections estimated by fitting to deaths.** Projected infections for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

To explore different scenarios, we recommend using our COVID-19 Scenario Analysis Tool - https://covidsim.org/, which can be used to simulate different intervention scenarios and explore the long term impact on healthcare demand.

Situation Report for COVID-19: Niger, 2020-07-07

Download the report for Niger, 2020-07-07 here. This report uses data from the European Centre for Disease Control. These data are updated daily and whilst there may be a short delay, they are generally consistent with Ministry reports. These data are then used to back-calculate an 'inferred number of COVID-19 infections' using mathematical modelling techniques (see Report 12 for further details) to estimate the number of people that have been infected and to make short-term projections for future healthcare needs.

Epidemiological Situation

Total Reported Cases	New Reported Cases	Total Reported Deaths	New Reported Deaths	Estimated R_t
1,093	0	68	0	0.73 (95% CI: 0.56-0.91)

The figure below shows the cumulative reported deaths as a function of the time since the 10th death was reported. Dashed lines show the expected trajectory for different doubling times of the epidemic. For example, with a doubling time of 3 days, if there are currently a total of 20 deaths reported, we would expect there to be 40 deaths in total reported in 3 days-time, 80 deaths in 6 days-time, 160 deaths in 9 days-time etc. For most epidemics, in the absence of interventions, we expect a doubling time of 3-4 days for this disease.

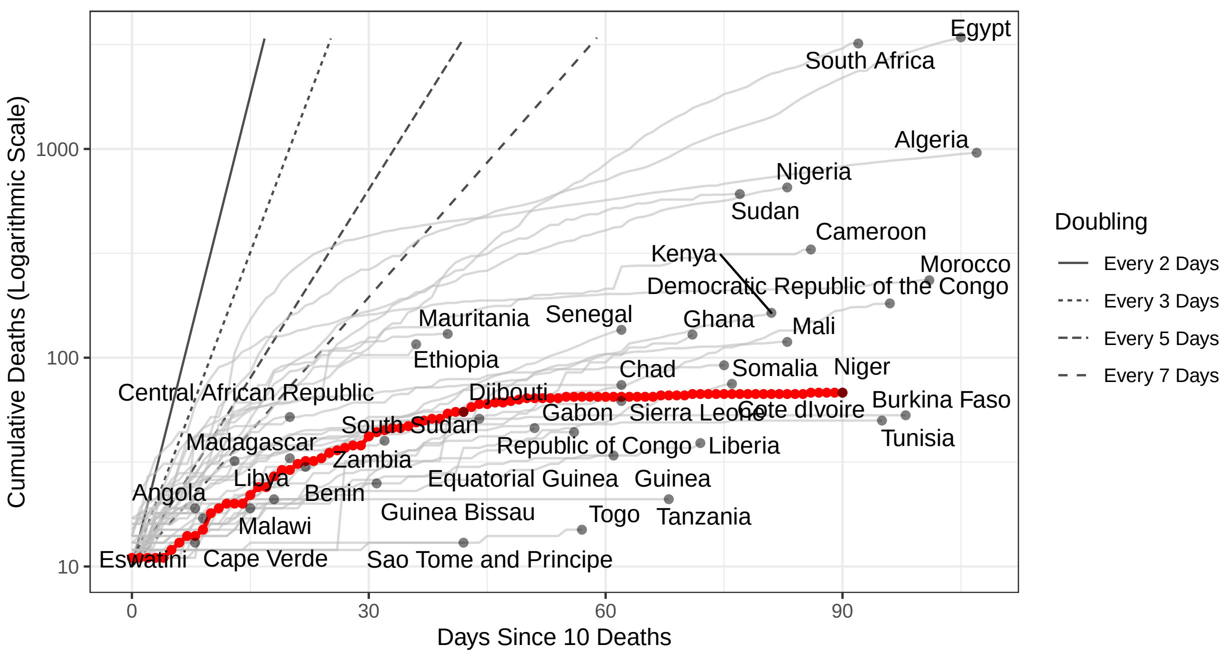

Figure 1: **Cumulative Deaths since 10 deaths.** Country not shown if fewer than 10 deaths.

COVID-19 Transmission Modelling

We assume that the deaths reported to date provide the best indication of the stage of the epidemic, as deaths are more consistently and accurately reported. Our current working estimate is that 1 death indicates that approximately 100 people will have been infected with the other 99 recovering (based on an infection fatality ratio of ~1%). These infections will have happened approximately 21 days previously – capturing a 5-day period from infection to onset of symptoms (the incubation period), 4 days from onset of symptoms to hospitalisation, and 12 days in hospital before death. With a 3-day doubling time, 100 infections that occurred 15 days ago will have generated 200 infections 12 days ago, 400 infections 9 days ago, 800 infections 6 days ago and 1,600 infections 3 days ago resulting in approximately 3,200 infections at the time the first death is observed.

To explore this, we fit our age-structured SEIR model (see Methods) to the time series of deaths in a country, in order to estimate the start date of the epidemic and the baseline R0. We assume that 100% of COVID-19 related deaths have been reported. We have also included the impact of interventions that have been put in place and their effect on human mobility and transmission based on the Google COVID-19 Community Mobility Reports. Using our mathematical model that formalises this approach, we estimate that there has been a total of 1,049 (95% CI: 910-1,189) infections over the past 4 weeks.

The figure below shows the estimated number of people infected over the past 4 weeks. The bar charts show, for comparison, the number of reported cases. The right-hand plot shows these data on a different scale as the estimated infections are likely to be much larger than the reported cases. **Importantly**, the estimated infections includes both asymptomatic and mild cases that would not necessarily be identified through surveillance. Consequently, the estimated infections are likely to be significantly higher than the reported cases (see our FAQ for further explanation of these differences and why the reported cases and estimated infections are unlikely to match).

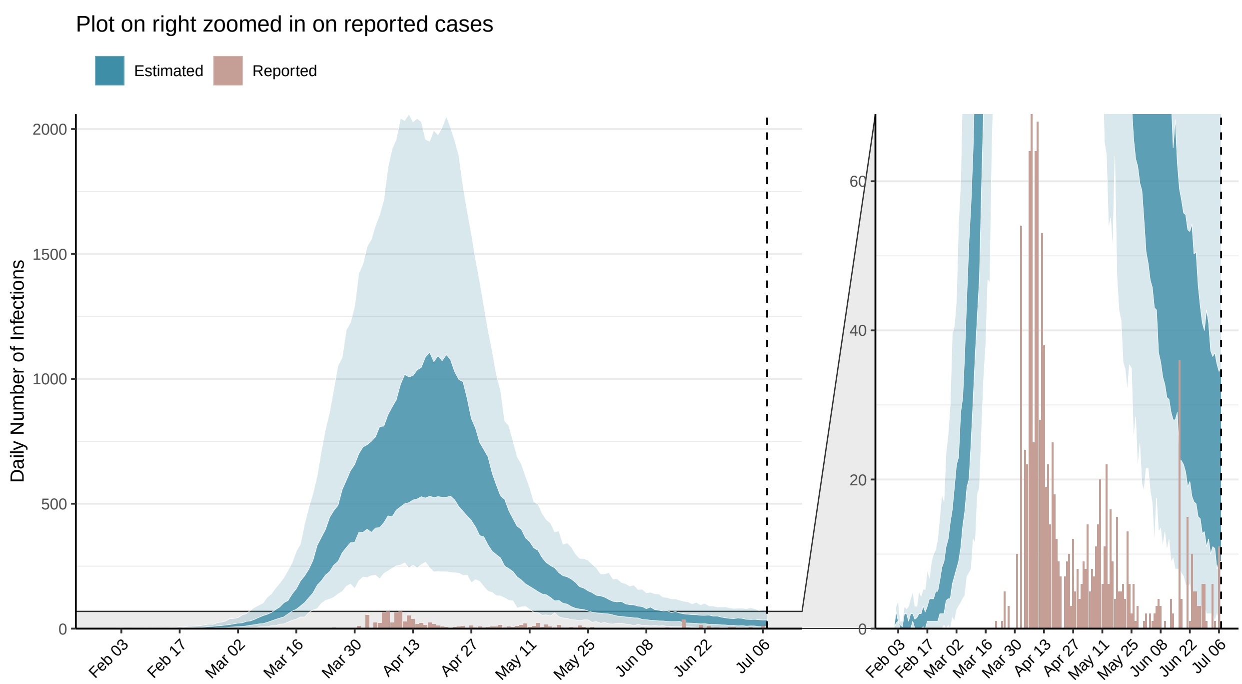

Figure 2: **Daily number of infections estimated by fitting to the current total of deaths.** Reported cases are shown in red. Model estimated infections are shown in blue (dark blue 50% interquartile range, light blue 95% quantile). The dashed line shows the current day.

By fitting to the time series of deaths, we are able to estimate a time-varying reproduction number, R_t. R_t is the the average number of secondary infections caused by a single infected person at a given time. If R_t is above 1, the rate of transmission is increasing and the number of new infections is increasing. R_t is assumed to change in relation to mobility fall in proportion. When fitting our model we assume that 100% of COVID-19 related deaths have been reported (please see our FAQ section for more information about this assumption). We also assume a fixed date at which the impact of mobility on transmission changes from pre-lockdown levels to post-lockdown levels, which may cause large changes in Rt. We are working to refine how this switch occurs and to formally calculate its shape.

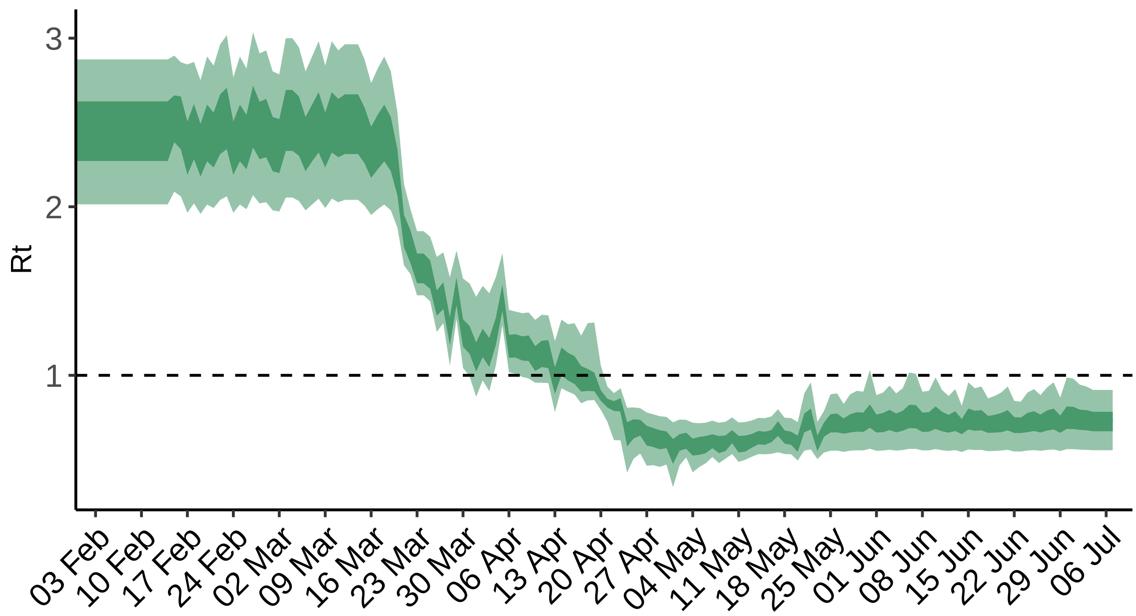

Figure 3: **Time-varying reproduction number, R_t.** R_t is the average number of secondary infections caused by a single infected person at time equal to t. $R_t < 1$ indicates a slowing epidemic in which new infections are not increasing. $R_t > 1$ indicates a growing epidemic in which new infections are increasing over time. Dark green shows the 50% CI and light green shows the 95% CI.

Using the model fit, we can forecast the expected trajectory for cumulative deaths, which is shown in the figure below. This assumes a severity pattern by age that is consistent with that observed in China, Europe and the U.S to date. This projection assumes that transmission is maintained at the current level of transmission as estimated by the final R_t value.

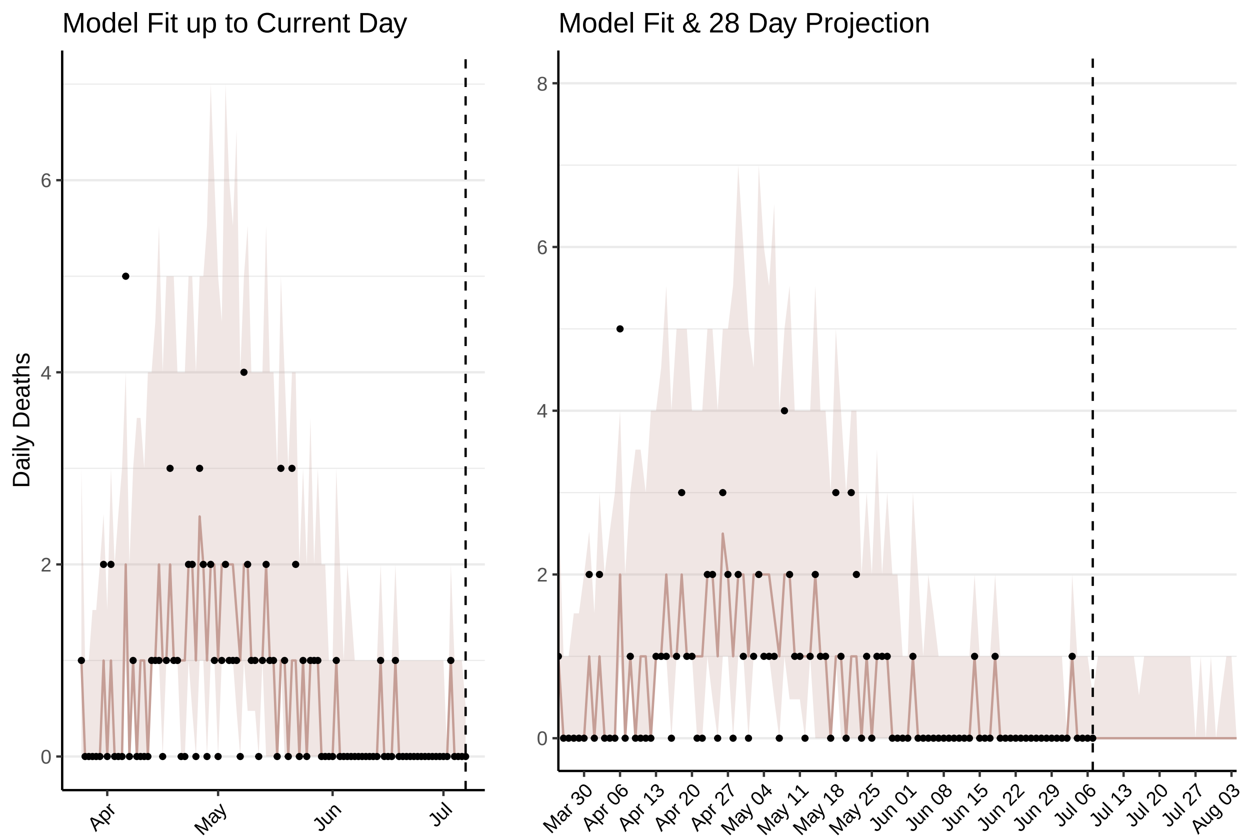

Figure 4: **Estimated daily deaths.** Projected deaths assuming the current level of interventions are maintained are shown in red (median and 95% quantile). Reported deaths are plotted in black. The plot on the left is focussed on the model fit prior to today, while the plot on the right forecasts the next 28 days.

Short-term Epidemic Scenarios

We make the following short-term projections of healthcare demand and new infections under the following three scenarios:

- **Scenario 1.** The epidemic continues to grow at the current rate.
- **Scenario 2.** Countries will further scale up interventions (either increasing current strategies or implementing new interventions) leading to a further 50% reduction in transmission.
- **Scenario 3.** Countries will relax current interventions by 50%

N.B. These scenarios currently assume that the impact of mobility on transmission will remain the same in the future as it has in the past. We are working to extend methods to estimate the impact of increases in mobility on transmission as lockdown and interventions are reversed. Consequently, projection are likely to represent an upper estimate of the healthcare demand and case load for each scenario

We estimate that over the next 4 weeks demand for hospital beds will change from 4 (95% CI: 4-5) patients requiring treatment with high-pressure oxygen at the current date to 2 (95% CI: 1-2) hospital beds being required on 2020-08-04 if no further interventions are introduced (Scenario 1). Similarly, we estimate that over the next 4 weeks demand for critical care (ICU) beds will change from 1 (95% CI: 1-2) patients requiring treatment with mechanical ventilation at the current date to 1 (95% CI: 0-1) by 2020-08-04. These projections assume that approximately 5% of all infections will require treatment with high-pressure oxygen and that approximately 30% of hospitalised cases will require treatment with mechanical ventilation (based on analysis of ongoing epidemics in Europe). **N.B. These scenarios are unlikely to show significant differences for the first week since there is a delay of approximately 10 days between infection and hospital admission. Consequently, the effectiveness of a change in policy is likely to be better captured by hospital admission data approximately 2 weeks after the policy change is implemented.**

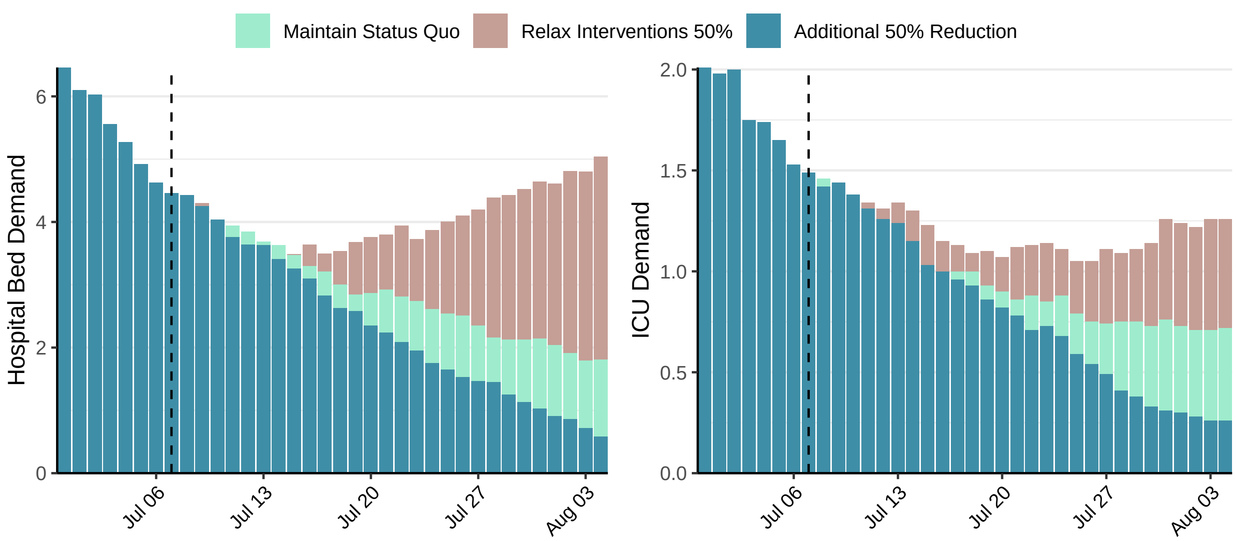

Figure 5: **Healthcare demands in the next 28 days.** Individuals needing an ICU bed are assumed to need mechanical ventilation. Projected demand for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

The impact of each scenario has a more immediate effect on the daily number of infections. The figure below shows the impact of each scenario on the estimated daily incidence of new infections. If interventions are scaled up (Scenario 2), the daily number of infections will change from 23 (95% CI: 19-26) at the current date to 1 (95% CI: 1-1) by 2020-08-04. If current interventions were relaxed by 50%, we estimate the daily number of infections will change from 23 (95% CI: 19-26) at the current date to 51 (95% CI: 37-65) by 2020-08-04.

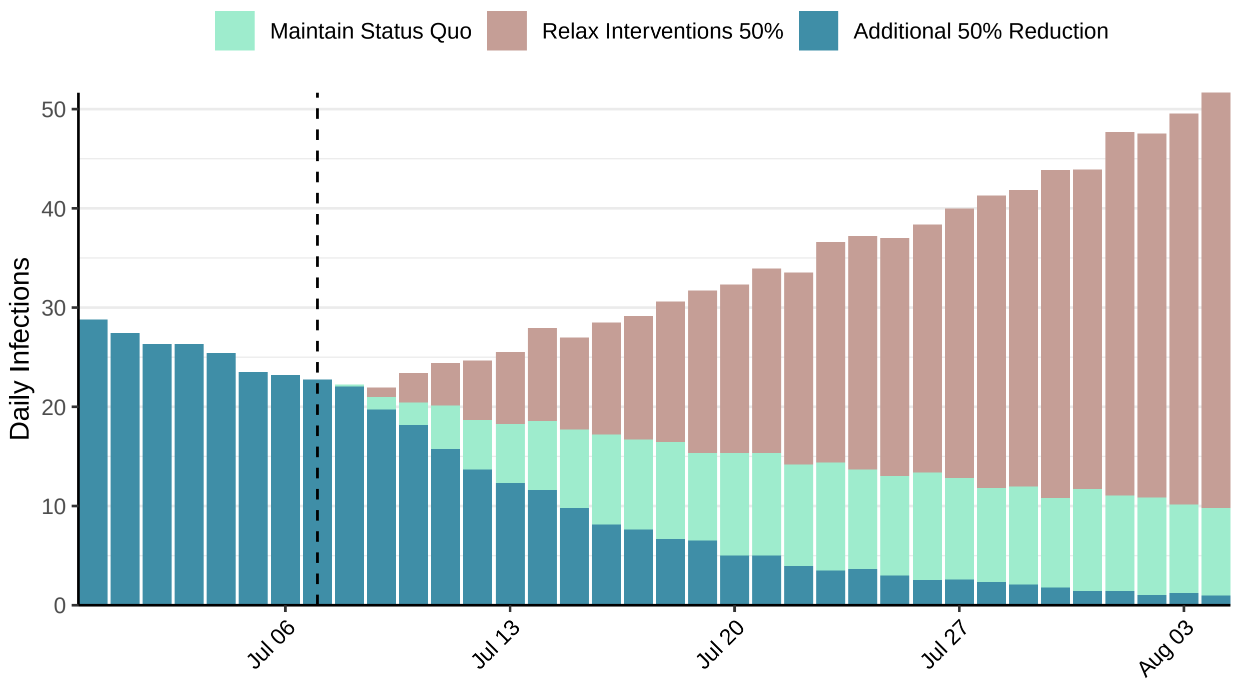

Figure 6: **Daily number of infections estimated by fitting to deaths.** Projected infections for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

To explore different scenarios, we recommend using our COVID-19 Scenario Analysis Tool - https://covidsim.org/, which can be used to simulate different intervention scenarios and explore the long term impact on healthcare demand.

Situation Report for COVID-19: Nigeria, 2020-07-07

Download the report for Nigeria, 2020-07-07 here. This report uses data from the European Centre for Disease Control. These data are updated daily and whilst there may be a short delay, they are generally consistent with Ministry reports. These data are then used to back-calculate an 'inferred number of COVID-19 infections' using mathematical modelling techniques (see Report 12 for further details) to estimate the number of people that have been infected and to make short-term projections for future healthcare needs.

Epidemiological Situation

Total Reported Cases	New Reported Cases	Total Reported Deaths	New Reported Deaths	Estimated R_t
29,286	575	654	9	1.05 (95% CI: 0.95-1.18)

The figure below shows the cumulative reported deaths as a function of the time since the 10th death was reported. Dashed lines show the expected trajectory for different doubling times of the epidemic. For example, with a doubling time of 3 days, if there are currently a total of 20 deaths reported, we would expect there to be 40 deaths in total reported in 3 days-time, 80 deaths in 6 days-time, 160 deaths in 9 days-time etc. For most epidemics, in the absence of interventions, we expect a doubling time of 3-4 days for this disease.

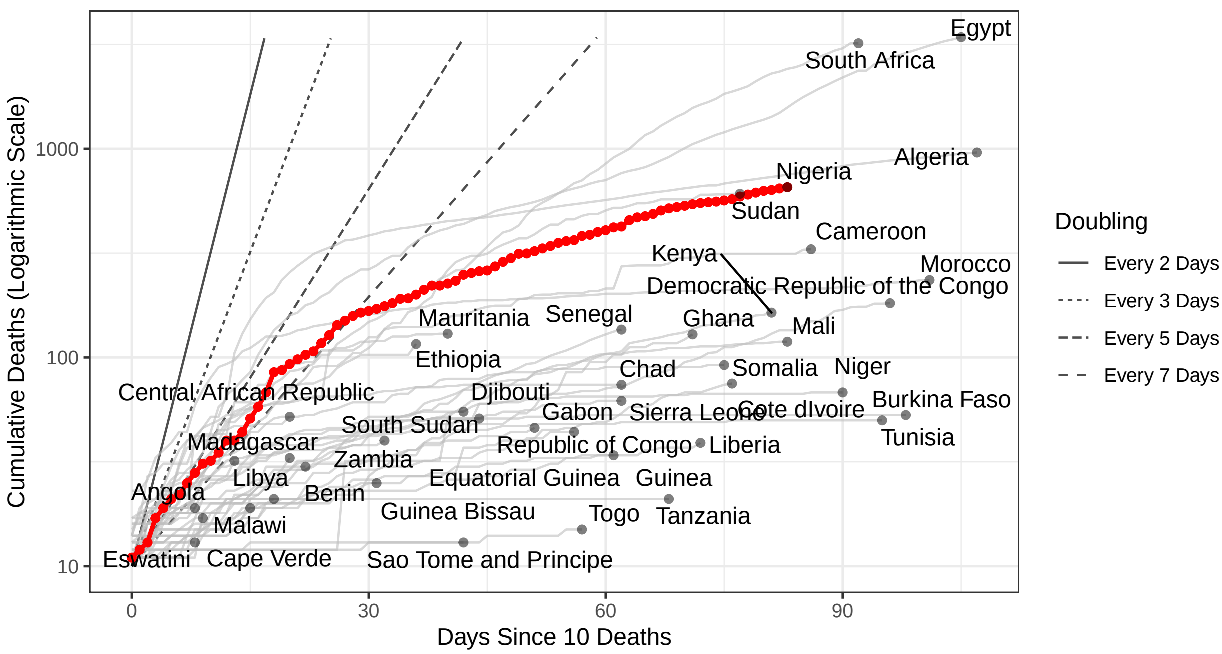

Figure 1: **Cumulative Deaths since 10 deaths.** Country not shown if fewer than 10 deaths.

COVID-19 Transmission Modelling

We assume that the deaths reported to date provide the best indication of the stage of the epidemic, as deaths are more consistently and accurately reported. Our current working estimate is that 1 death indicates that approximately 100 people will have been infected with the other 99 recovering (based on an infection fatality ratio of ~1%). These infections will have happened approximately 21 days previously – capturing a 5-day period from infection to onset of symptoms (the incubation period), 4 days from onset of symptoms to hospitalisation, and 12 days in hospital before death. With a 3-day doubling time, 100 infections that occurred 15 days ago will have generated 200 infections 12 days ago, 400 infections 9 days ago, 800 infections 6 days ago and 1,600 infections 3 days ago resulting in approximately 3,200 infections at the time the first death is observed.

To explore this, we fit our age-structured SEIR model (see Methods) to the time series of deaths in a country, in order to estimate the start date of the epidemic and the baseline R0. We assume that 100% of COVID-19 related deaths have been reported. We have also included the impact of interventions that have been put in place and their effect on human mobility and transmission based on the Google COVID-19 Community Mobility Reports. Using our mathematical model that formalises this approach, we estimate that there has been a total of 157,731 (95% CI: 143,803-171,659) infections over the past 4 weeks.

The figure below shows the estimated number of people infected over the past 4 weeks. The bar charts show, for comparison, the number of reported cases. The right-hand plot shows these data on a different scale as the estimated infections are likely to be much larger than the reported cases. **Importantly**, the estimated infections includes both asymptomatic and mild cases that would not necessarily be identified through surveillance. Consequently, the estimated infections are likely to be significantly higher than the reported cases (see our FAQ for further explanation of these differences and why the reported cases and estimated infections are unlikely to match).

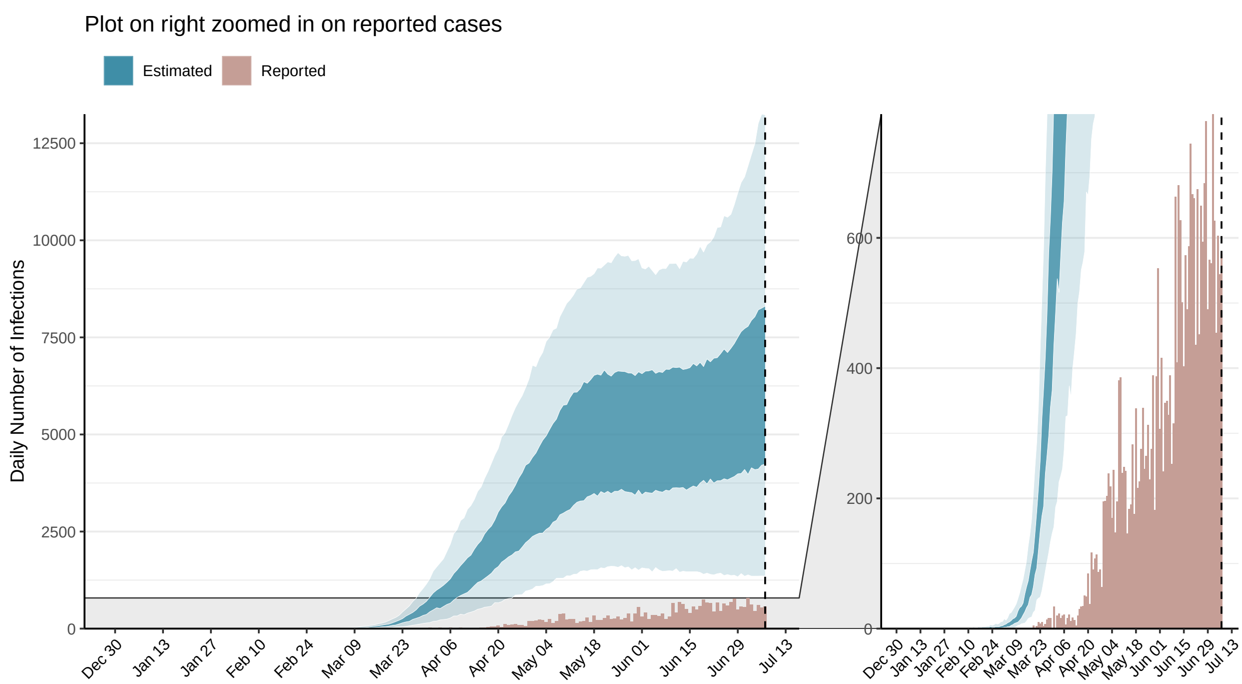

Figure 2: **Daily number of infections estimated by fitting to the current total of deaths.** Reported cases are shown in red. Model estimated infections are shown in blue (dark blue 50% interquartile range, light blue 95% quantile). The dashed line shows the current day.

By fitting to the time series of deaths, we are able to estimate a time-varying reproduction number, R_t. R_t is the the average number of secondary infections caused by a single infected person at a given time. If R_t is above 1, the rate of transmission is increasing and the number of new infections is increasing. R_t is assumed to change in relation to mobility fall in proportion. When fitting our model we assume that 100% of COVID-19 related deaths have been reported (please see our FAQ section for more information about this assumption). We also assume a fixed date at which the impact of mobility on transmission changes from pre-lockdown levels to post-lockdown levels, which may cause large changes in Rt. We are working to refine how this switch occurs and to formally calculate its shape.

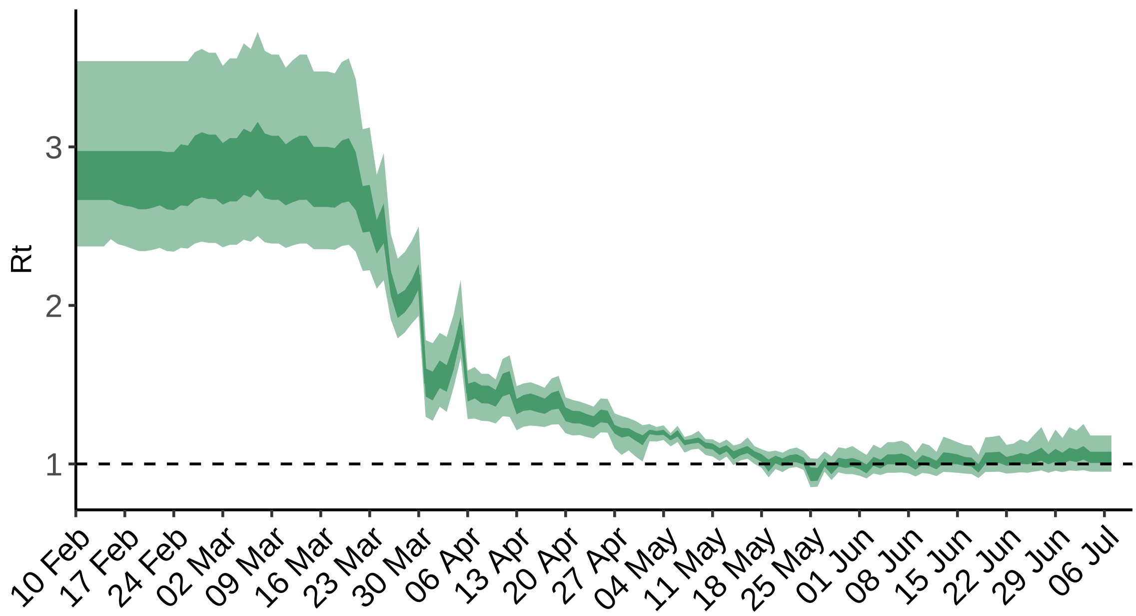

Figure 3: **Time-varying reproduction number, R_t.** R_t is the average number of secondary infections caused by a single infected person at time equal to t. $R_t < 1$ indicates a slowing epidemic in which new infections are not increasing. $R_t > 1$ indicates a growing epidemic in which new infections are increasing over time. Dark green shows the 50% CI and light green shows the 95% CI.

Using the model fit, we can forecast the expected trajectory for cumulative deaths, which is shown in the figure below. This assumes a severity pattern by age that is consistent with that observed in China, Europe and the U.S to date. This projection assumes that transmission is maintained at the current level of transmission as estimated by the final R_t value.

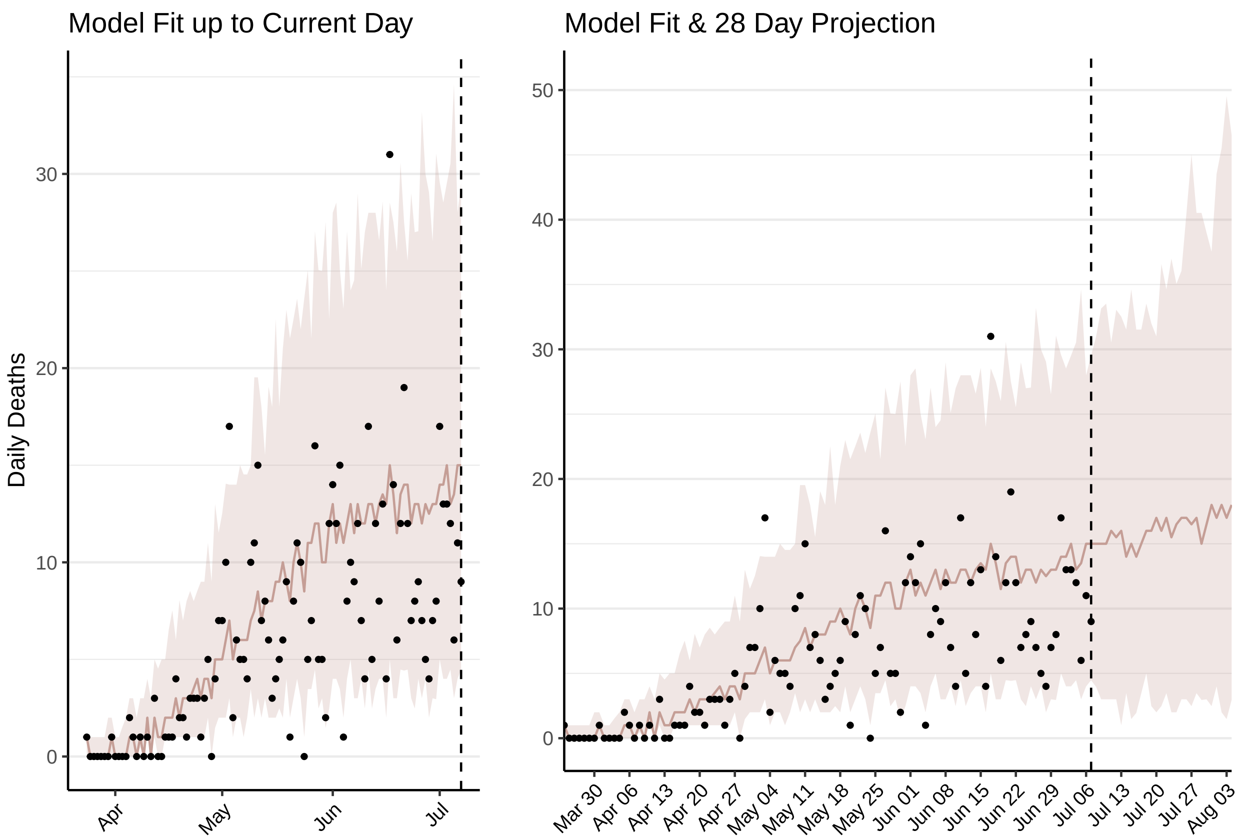

Figure 4: **Estimated daily deaths.** Projected deaths assuming the current level of interventions are maintained are shown in red (median and 95% quantile). Reported deaths are plotted in black. The plot on the left is focussed on the model fit prior to today, while the plot on the right forecasts the next 28 days.

Short-term Epidemic Scenarios

We make the following short-term projections of healthcare demand and new infections under the following three scenarios:

- **Scenario 1.** The epidemic continues to grow at the current rate.
- **Scenario 2.** Countries will further scale up interventions (either increasing current strategies or implementing new interventions) leading to a further 50% reduction in transmission.
- **Scenario 3.** Countries will relax current interventions by 50%

N.B. These scenarios currently assume that the impact of mobility on transmission will remain the same in the future as it has in the past. We are working to extend methods to estimate the impact of increases in mobility on transmission as lockdown and interventions are reversed. Consequently, projection are likely to represent an upper estimate of the healthcare demand and case load for each scenario

We estimate that over the next 4 weeks demand for hospital beds will change from 831 (95% CI: 758-905) patients requiring treatment with high-pressure oxygen at the current date to 1,103 (95% CI: 976-1,229) hospital beds being required on 2020-08-04 if no further interventions are introduced (Scenario 1). Similarly, we estimate that over the next 4 weeks demand for critical care (ICU) beds will change from 222 (95% CI: 202-242) patients requiring treatment with mechanical ventilation at the current date to 285 (95% CI: 253-318) by 2020-08-04. These projections assume that approximately 5% of all infections will require treatment with high-pressure oxygen and that approximately 30% of hospitalised cases will require treatment with mechanical ventilation (based on analysis of ongoing epidemics in Europe). **N.B. These scenarios are unlikely to show significant differences for the first week since there is a delay of approximately 10 days between infection and hospital admission. Consequently, the effectiveness of a change in policy is likely to be better captured by hospital admission data approximately 2 weeks after the policy change is implemented.**

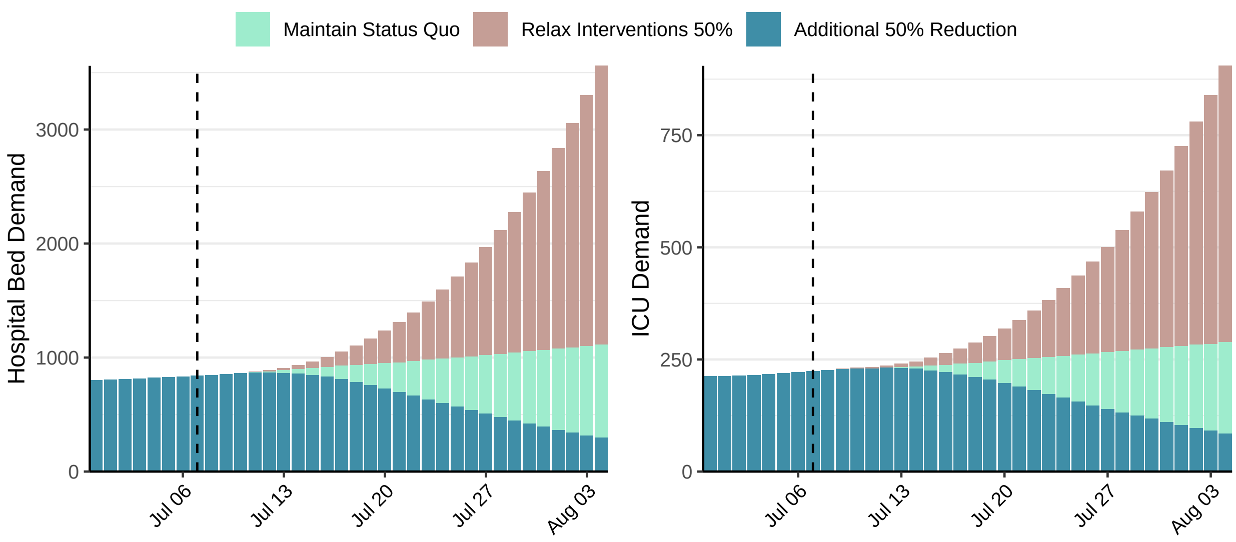

Figure 5: **Healthcare demands in the next 28 days.** Individuals needing an ICU bed are assumed to need mechanical ventilation. Projected demand for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

The impact of each scenario has a more immediate effect on the daily number of infections. The figure below shows the impact of each scenario on the estimated daily incidence of new infections. If interventions are scaled up (Scenario 2), the daily number of infections will change from 6,313 (95% CI: 5,717-6,910) at the current date to 680 (95% CI: 596-763) by 2020-08-04. If current interventions were relaxed by 50%, we estimate the daily number of infections will change from 6,313 (95% CI: 5,717-6,910) at the current date to 50,965 (95% CI: 44,073-57,856) by 2020-08-04.

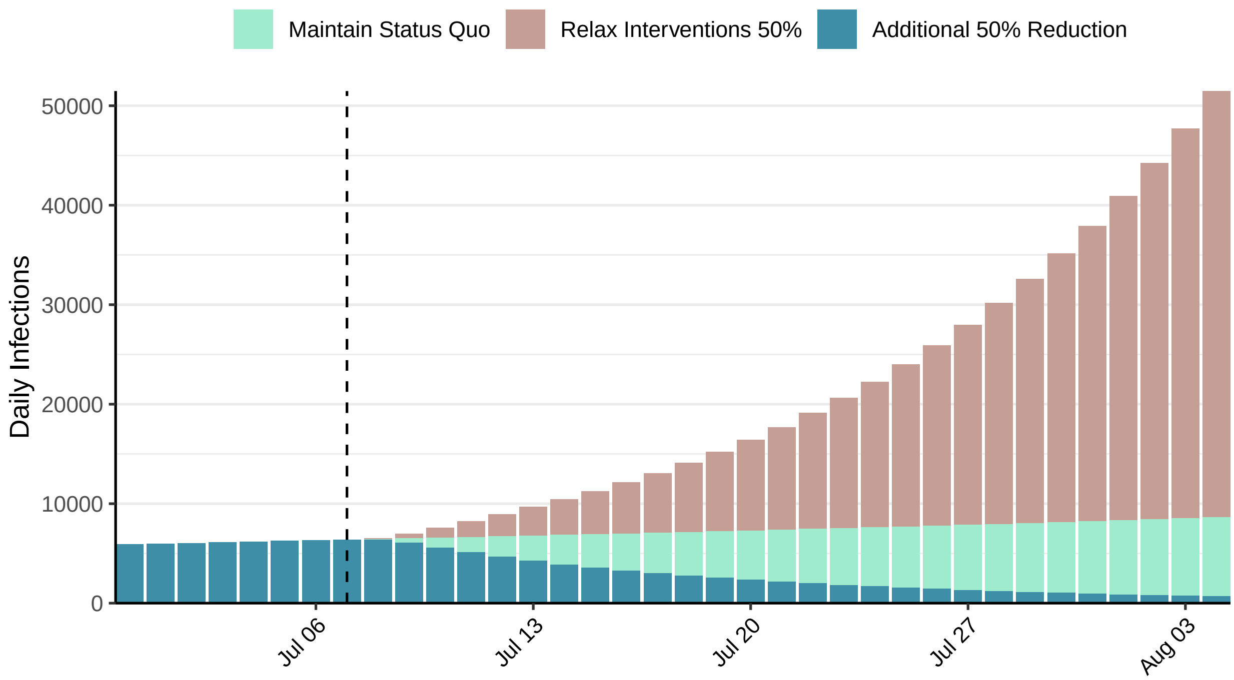

Figure 6: **Daily number of infections estimated by fitting to deaths.** Projected infections for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

To explore different scenarios, we recommend using our COVID-19 Scenario Analysis Tool - https://covidsim.org/, which can be used to simulate different intervention scenarios and explore the long term impact on healthcare demand.

Situation Report for COVID-19: Nicaragua, 2020-07-07

Download the report for Nicaragua, 2020-07-07 here. This report uses data from the European Centre for Disease Control. These data are updated daily and whilst there may be a short delay, they are generally consistent with Ministry reports. These data are then used to back-calculate an 'inferred number of COVID-19 infections' using mathematical modelling techniques (see Report 12 for further details) to estimate the number of people that have been infected and to make short-term projections for future healthcare needs.

Epidemiological Situation

Total Reported Cases	New Reported Cases	Total Reported Deaths	New Reported Deaths	Estimated R_t
2,519	0	83	0	1.13 (95% CI: 1.06-1.2)

The figure below shows the cumulative reported deaths as a function of the time since the 10th death was reported. Dashed lines show the expected trajectory for different doubling times of the epidemic. For example, with a doubling time of 3 days, if there are currently a total of 20 deaths reported, we would expect there to be 40 deaths in total reported in 3 days-time, 80 deaths in 6 days-time, 160 deaths in 9 days-time etc. For most epidemics, in the absence of interventions, we expect a doubling time of 3-4 days for this disease.

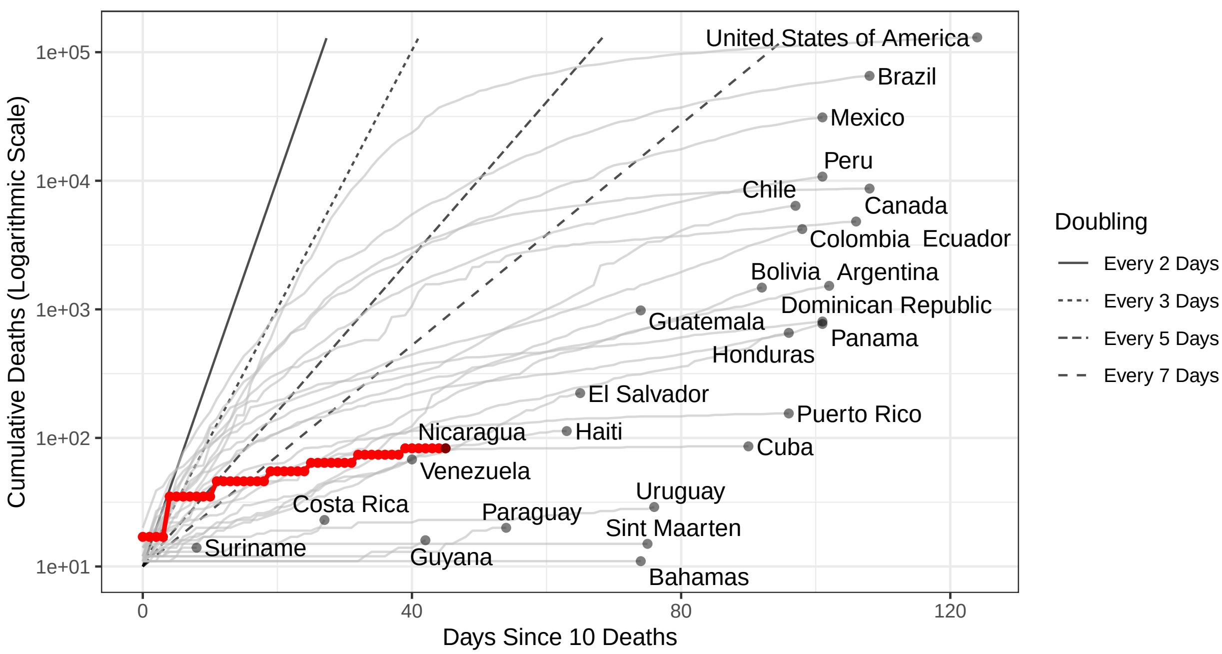

Figure 1: **Cumulative Deaths since 10 deaths.** Country not shown if fewer than 10 deaths.

COVID-19 Transmission Modelling

We assume that the deaths reported to date provide the best indication of the stage of the epidemic, as deaths are more consistently and accurately reported. Our current working estimate is that 1 death indicates that approximately 100 people will have been infected with the other 99 recovering (based on an infection fatality ratio of ~1%). These infections will have happened approximately 21 days previously – capturing a 5-day period from infection to onset of symptoms (the incubation period), 4 days from onset of symptoms to hospitalisation, and 12 days in hospital before death. With a 3-day doubling time, 100 infections that occurred 15 days ago will have generated 200 infections 12 days ago, 400 infections 9 days ago, 800 infections 6 days ago and 1,600 infections 3 days ago resulting in approximately 3,200 infections at the time the first death is observed.

To explore this, we fit our age-structured SEIR model (see Methods) to the time series of deaths in a country, in order to estimate the start date of the epidemic and the baseline R0. We assume that 100% of COVID-19 related deaths have been reported. We have also included the impact of interventions that have been put in place and their effect on human mobility and transmission based on the Google COVID-19 Community Mobility Reports. Using our mathematical model that formalises this approach, we estimate that there has been a total of 24,595 (95% CI: 21,528-27,662) infections over the past 4 weeks.

The figure below shows the estimated number of people infected over the past 4 weeks. The bar charts show, for comparison, the number of reported cases. The right-hand plot shows these data on a different scale as the estimated infections are likely to be much larger than the reported cases. **Importantly**, the estimated infections includes both asymptomatic and mild cases that would not necessarily be identified through surveillance. Consequently, the estimated infections are likely to be significantly higher than the reported cases (see our FAQ for further explanation of these differences and why the reported cases and estimated infections are unlikely to match).

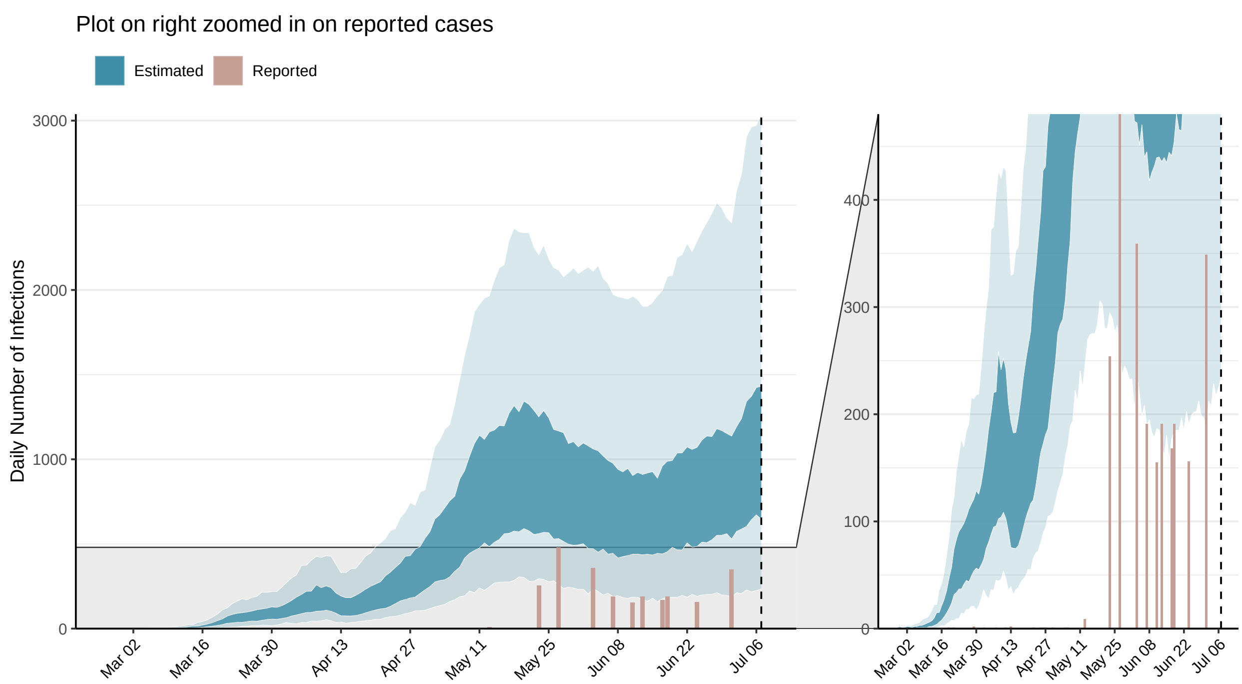

Figure 2: **Daily number of infections estimated by fitting to the current total of deaths.** Reported cases are shown in red. Model estimated infections are shown in blue (dark blue 50% interquartile range, light blue 95% quantile). The dashed line shows the current day.

By fitting to the time series of deaths, we are able to estimate a time-varying reproduction number, R_t. R_t is the the average number of secondary infections caused by a single infected person at a given time. If R_t is above 1, the rate of transmission is increasing and the number of new infections is increasing. R_t is assumed to change in relation to mobility fall in proportion. When fitting our model we assume that 100% of COVID-19 related deaths have been reported (please see our FAQ section for more information about this assumption). We also assume a fixed date at which the impact of mobility on transmission changes from pre-lockdown levels to post-lockdown levels, which may cause large changes in Rt. We are working to refine how this switch occurs and to formally calculate its shape.

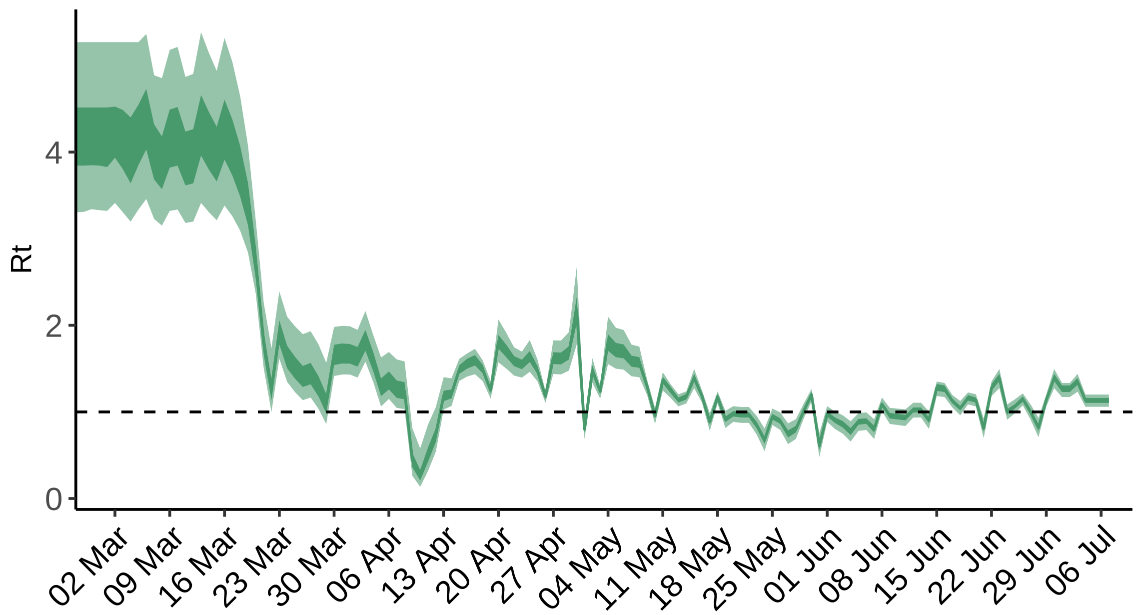

Figure 3: **Time-varying reproduction number, R_t.** R_t is the average number of secondary infections caused by a single infected person at time equal to t. $R_t < 1$ indicates a slowing epidemic in which new infections are not increasing. $R_t > 1$ indicates a growing epidemic in which new infections are increasing over time. Dark green shows the 50% CI and light green shows the 95% CI.

Using the model fit, we can forecast the expected trajectory for cumulative deaths, which is shown in the figure below. This assumes a severity pattern by age that is consistent with that observed in China, Europe and the U.S to date. This projection assumes that transmission is maintained at the current level of transmission as estimated by the final R_t value.

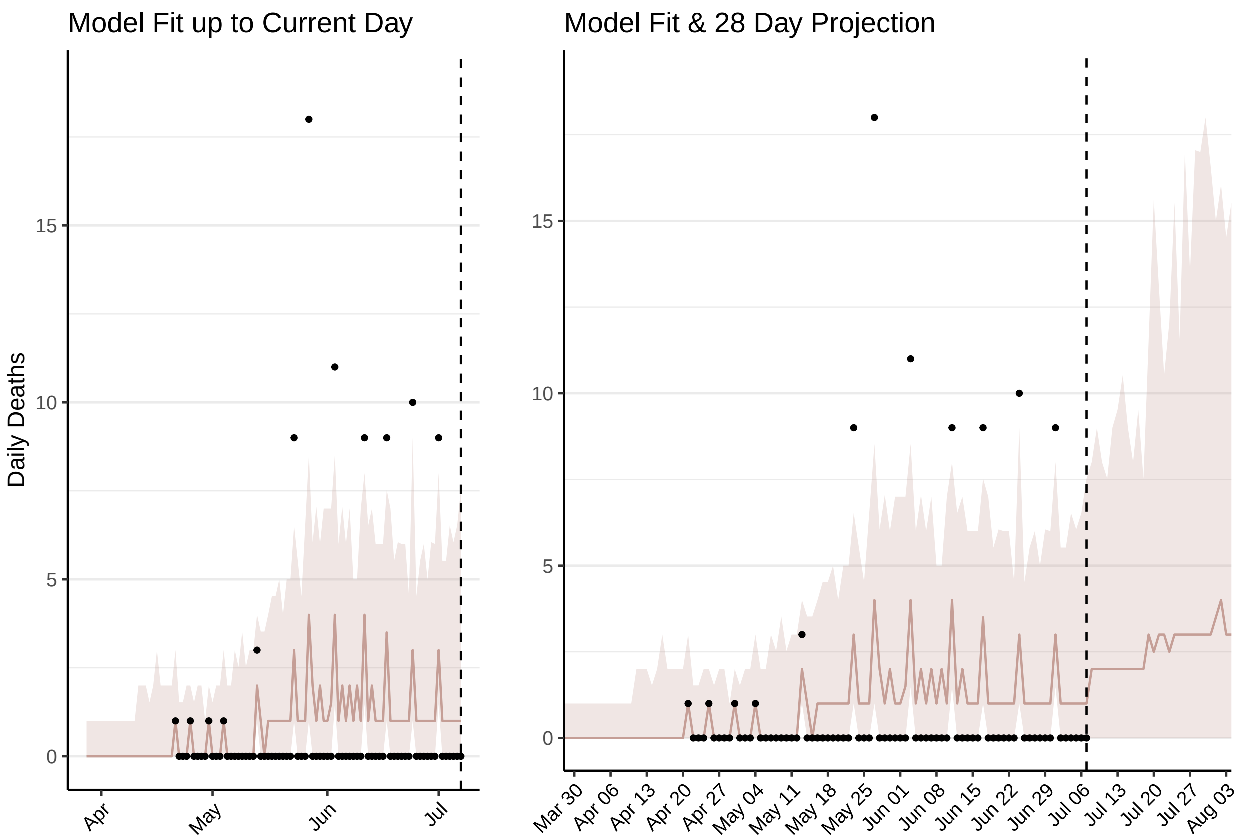

Figure 4: **Estimated daily deaths.** Projected deaths assuming the current level of interventions are maintained are shown in red (median and 95% quantile). Reported deaths are plotted in black. The plot on the left is focussed on the model fit prior to today, while the plot on the right forecasts the next 28 days.

Short-term Epidemic Scenarios

We make the following short-term projections of healthcare demand and new infections under the following three scenarios:

- **Scenario 1.** The epidemic continues to grow at the current rate.
- **Scenario 2.** Countries will further scale up interventions (either increasing current strategies or implementing new interventions) leading to a further 50% reduction in transmission.
- **Scenario 3.** Countries will relax current interventions by 50%

N.B. These scenarios currently assume that the impact of mobility on transmission will remain the same in the future as it has in the past. We are working to extend methods to estimate the impact of increases in mobility on transmission as lockdown and interventions are reversed. Consequently, projection are likely to represent an upper estimate of the healthcare demand and case load for each scenario

We estimate that over the next 4 weeks demand for hospital beds will change from 122 (95% CI: 107-138) patients requiring treatment with high-pressure oxygen at the current date to 217 (95% CI: 188-245) hospital beds being required on 2020-08-04 if no further interventions are introduced (Scenario 1). Similarly, we estimate that over the next 4 weeks demand for critical care (ICU) beds will change from 36 (95% CI: 31-40) patients requiring treatment with mechanical ventilation at the current date to 56 (95% CI: 50-62) by 2020-08-04. These projections assume that approximately 5% of all infections will require treatment with high-pressure oxygen and that approximately 30% of hospitalised cases will require treatment with mechanical ventilation (based on analysis of ongoing epidemics in Europe). **N.B. These scenarios are unlikely to show significant differences for the first week since there is a delay of approximately 10 days between infection and hospital admission. Consequently, the effectiveness of a change in policy is likely to be better captured by hospital admission data approximately 2 weeks after the policy change is implemented.**

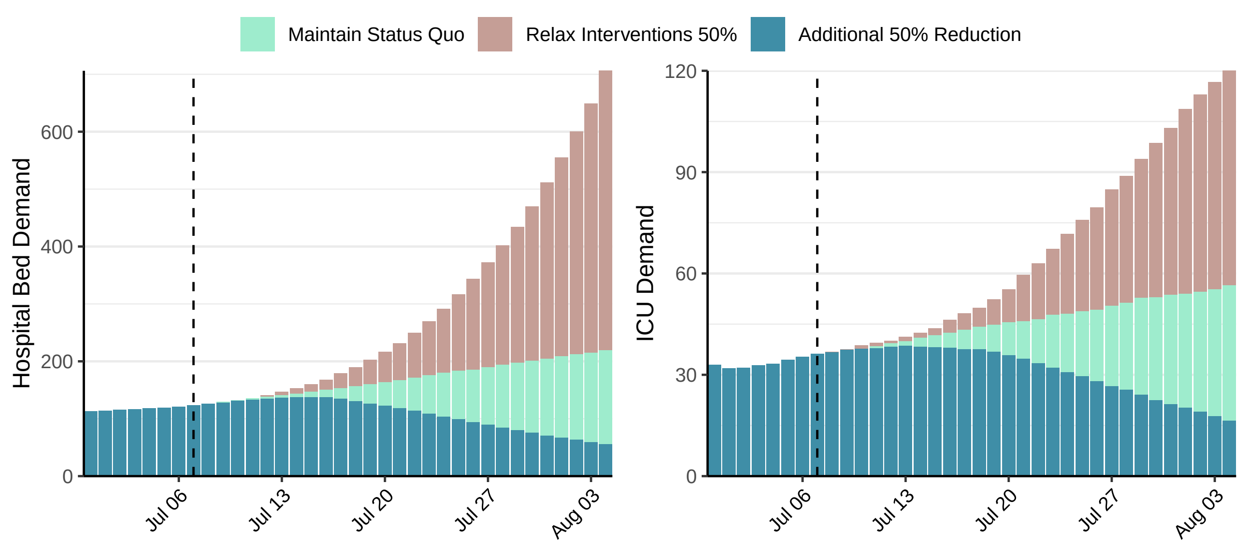

Figure 5: **Healthcare demands in the next 28 days.** Individuals needing an ICU bed are assumed to need mechanical ventilation. Projected demand for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

The impact of each scenario has a more immediate effect on the daily number of infections. The figure below shows the impact of each scenario on the estimated daily incidence of new infections. If interventions are scaled up (Scenario 2), the daily number of infections will change from 1,156 (95% CI: 1,006-1,306) at the current date to 150 (95% CI: 129-171) by 2020-08-04. If current interventions were relaxed by 50%, we estimate the daily number of infections will change from 1,156 (95% CI: 1,006-1,306) at the current date to 11,304 (95% CI: 9,810-12,798) by 2020-08-04.

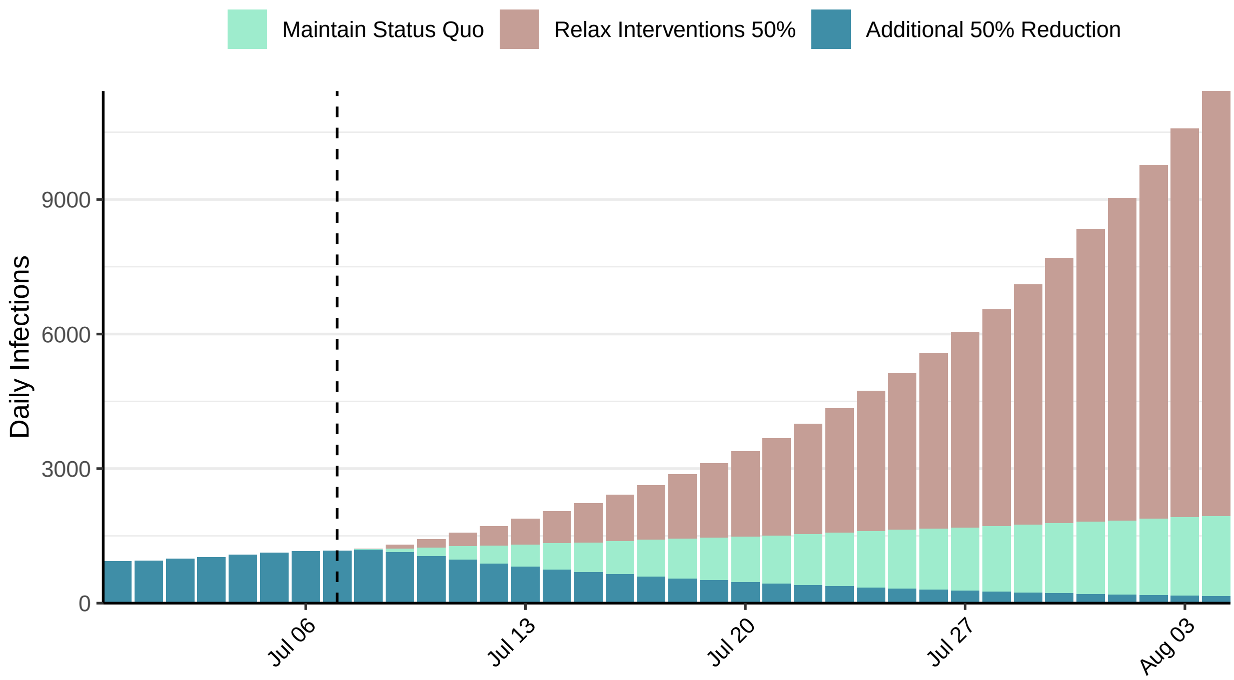

Figure 6: **Daily number of infections estimated by fitting to deaths.** Projected infections for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

To explore different scenarios, we recommend using our COVID-19 Scenario Analysis Tool - https://covidsim.org/, which can be used to simulate different intervention scenarios and explore the long term impact on healthcare demand.

Situation Report for COVID-19: Nepal, 2020-07-07

Download the report for Nepal, 2020-07-07 here. This report uses data from the European Centre for Disease Control. These data are updated daily and whilst there may be a short delay, they are generally consistent with Ministry reports. These data are then used to back-calculate an 'inferred number of COVID-19 infections' using mathematical modelling techniques (see Report 12 for further details) to estimate the number of people that have been infected and to make short-term projections for future healthcare needs.

Epidemiological Situation

Total Reported Cases	New Reported Cases	Total Reported Deaths	New Reported Deaths	Estimated R_t
15,964	180	35	1	1.13 (95% CI: 0.97-1.33)

The figure below shows the cumulative reported deaths as a function of the time since the 10th death was reported. Dashed lines show the expected trajectory for different doubling times of the epidemic. For example, with a doubling time of 3 days, if there are currently a total of 20 deaths reported, we would expect there to be 40 deaths in total reported in 3 days-time, 80 deaths in 6 days-time, 160 deaths in 9 days-time etc. For most epidemics, in the absence of interventions, we expect a doubling time of 3-4 days for this disease.

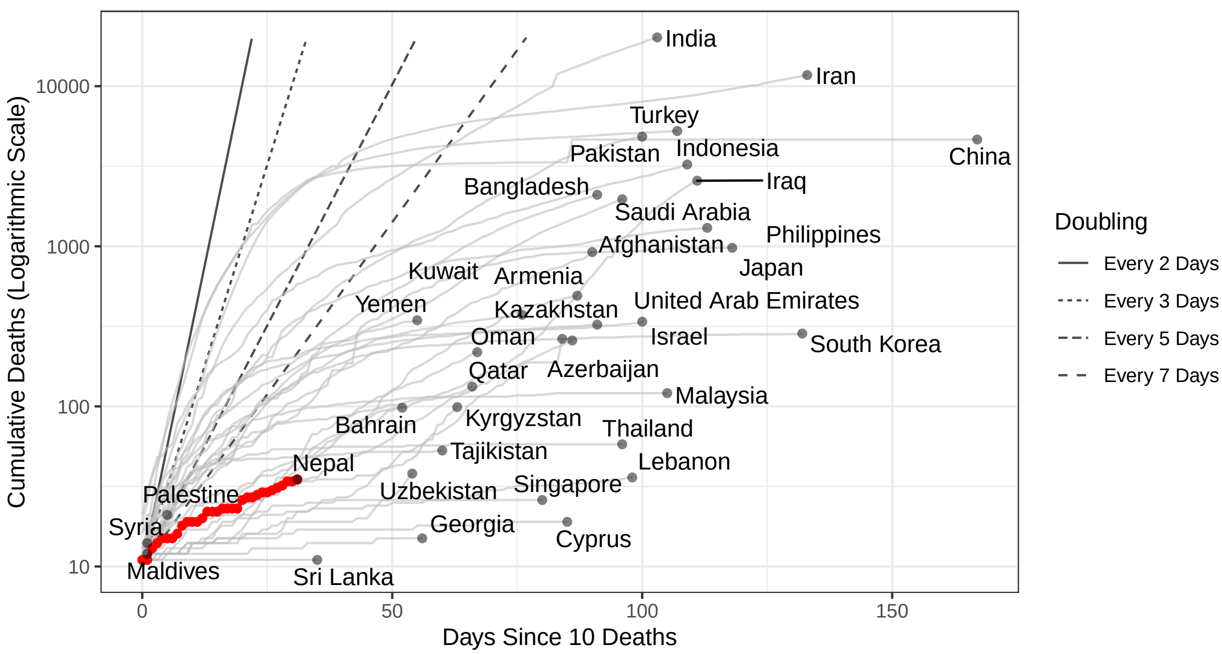

Figure 1: **Cumulative Deaths since 10 deaths.** Country not shown if fewer than 10 deaths.

COVID-19 Transmission Modelling

We assume that the deaths reported to date provide the best indication of the stage of the epidemic, as deaths are more consistently and accurately reported. Our current working estimate is that 1 death indicates that approximately 100 people will have been infected with the other 99 recovering (based on an infection fatality ratio of ~1%). These infections will have happened approximately 21 days previously – capturing a 5-day period from infection to onset of symptoms (the incubation period), 4 days from onset of symptoms to hospitalisation, and 12 days in hospital before death. With a 3-day doubling time, 100 infections that occurred 15 days ago will have generated 200 infections 12 days ago, 400 infections 9 days ago, 800 infections 6 days ago and 1,600 infections 3 days ago resulting in approximately 3,200 infections at the time the first death is observed.

To explore this, we fit our age-structured SEIR model (see Methods) to the time series of deaths in a country, in order to estimate the start date of the epidemic and the baseline R0. We assume that 100% of COVID-19 related deaths have been reported. We have also included the impact of interventions that have been put in place and their effect on human mobility and transmission based on the Google COVID-19 Community Mobility Reports. Using our mathematical model that formalises this approach, we estimate that there has been a total of 11,479 (95% CI: 9,741-13,217) infections over the past 4 weeks.

The figure below shows the estimated number of people infected over the past 4 weeks. The bar charts show, for comparison, the number of reported cases. The right-hand plot shows these data on a different scale as the estimated infections are likely to be much larger than the reported cases. **Importantly**, the estimated infections includes both asymptomatic and mild cases that would not necessarily be identified through surveillance. Consequently, the estimated infections are likely to be significantly higher than the reported cases (see our FAQ for further explanation of these differences and why the reported cases and estimated infections are unlikely to match).

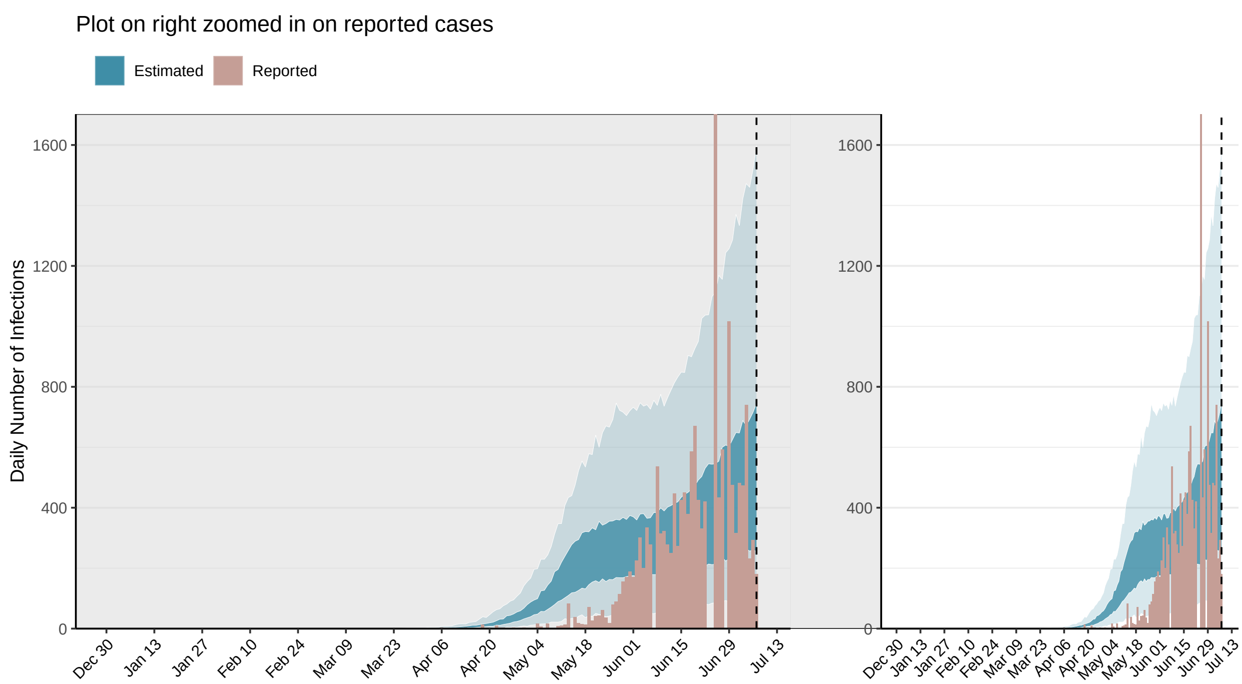

Figure 2: **Daily number of infections estimated by fitting to the current total of deaths.** Reported cases are shown in red. Model estimated infections are shown in blue (dark blue 50% interquartile range, light blue 95% quantile). The dashed line shows the current day.

By fitting to the time series of deaths, we are able to estimate a time-varying reproduction number, R_t. R_t is the the average number of secondary infections caused by a single infected person at a given time. If R_t is above 1, the rate of transmission is increasing and the number of new infections is increasing. R_t is assumed to change in relation to mobility fall in proportion. When fitting our model we assume that 100% of COVID-19 related deaths have been reported (please see our FAQ section for more information about this assumption). We also assume a fixed date at which the impact of mobility on transmission changes from pre-lockdown levels to post-lockdown levels, which may cause large changes in Rt. We are working to refine how this switch occurs and to formally calculate its shape.

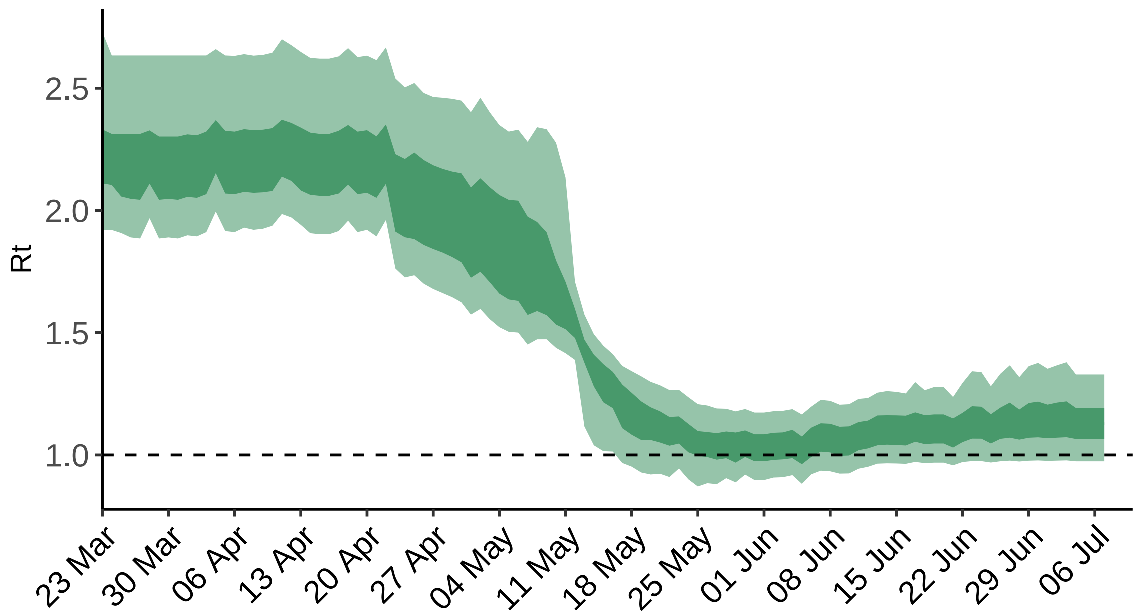

Figure 3: **Time-varying reproduction number, R_t.** R_t is the average number of secondary infections caused by a single infected person at time equal to t. $R_t < 1$ indicates a slowing epidemic in which new infections are not increasing. $R_t > 1$ indicates a growing epidemic in which new infections are increasing over time. Dark green shows the 50% CI and light green shows the 95% CI.

Using the model fit, we can forecast the expected trajectory for cumulative deaths, which is shown in the figure below. This assumes a severity pattern by age that is consistent with that observed in China, Europe and the U.S to date. This projection assumes that transmission is maintained at the current level of transmission as estimated by the final R_t value.

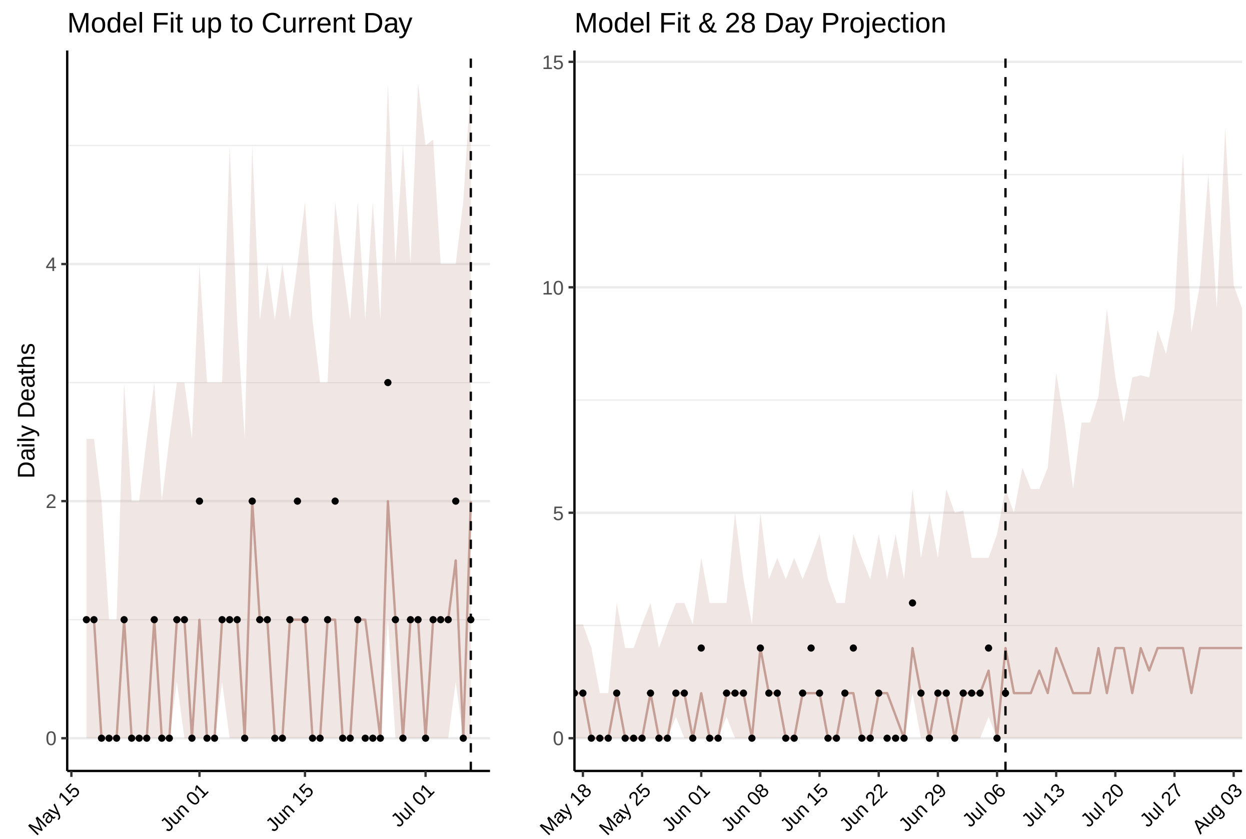

Figure 4: **Estimated daily deaths.** Projected deaths assuming the current level of interventions are maintained are shown in red (median and 95% quantile). Reported deaths are plotted in black. The plot on the left is focussed on the model fit prior to today, while the plot on the right forecasts the next 28 days.

Short-term Epidemic Scenarios

We make the following short-term projections of healthcare demand and new infections under the following three scenarios:

- **Scenario 1.** The epidemic continues to grow at the current rate.
- **Scenario 2.** Countries will further scale up interventions (either increasing current strategies or implementing new interventions) leading to a further 50% reduction in transmission.
- **Scenario 3.** Countries will relax current interventions by 50%

N.B. These scenarios currently assume that the impact of mobility on transmission will remain the same in the future as it has in the past. We are working to extend methods to estimate the impact of increases in mobility on transmission as lockdown and interventions are reversed. Consequently, projection are likely to represent an upper estimate of the healthcare demand and case load for each scenario

We estimate that over the next 4 weeks demand for hospital beds will change from 79 (95% CI: 67-91) patients requiring treatment with high-pressure oxygen at the current date to 162 (95% CI: 122-202) hospital beds being required on 2020-08-04 if no further interventions are introduced (Scenario 1). Similarly, we estimate that over the next 4 weeks demand for critical care (ICU) beds will change from 24 (95% CI: 20-28) patients requiring treatment with mechanical ventilation at the current date to 49 (95% CI: 37-61) by 2020-08-04. These projections assume that approximately 5% of all infections will require treatment with high-pressure oxygen and that approximately 30% of hospitalised cases will require treatment with mechanical ventilation (based on analysis of ongoing epidemics in Europe). **N.B. These scenarios are unlikely to show significant differences for the first week since there is a delay of approximately 10 days between infection and hospital admission. Consequently, the effectiveness of a change in policy is likely to be better captured by hospital admission data approximately 2 weeks after the policy change is implemented.**

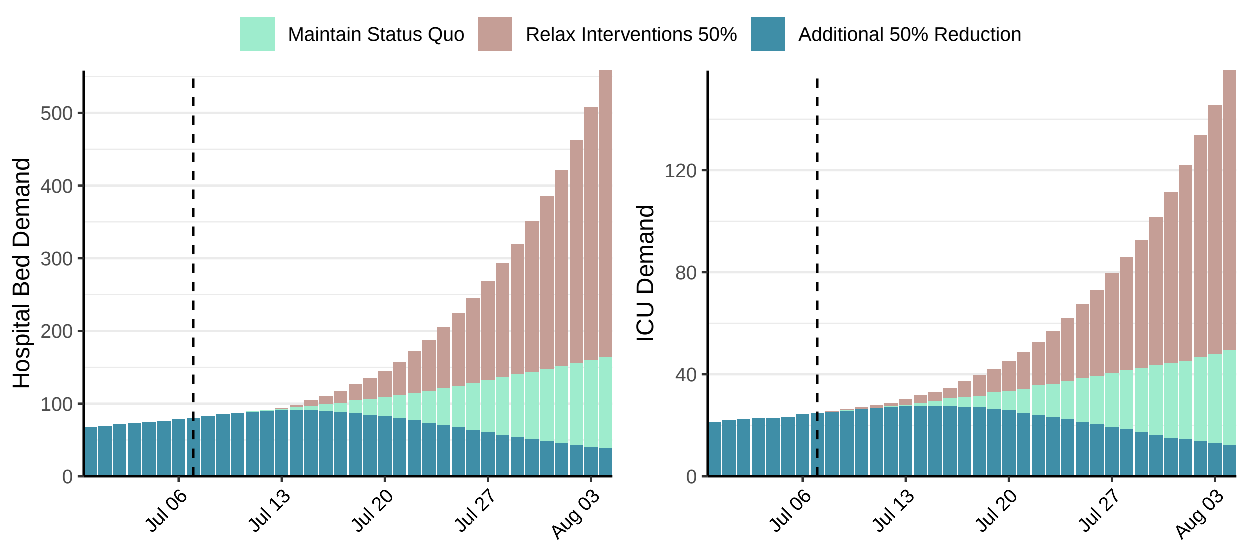

Figure 5: **Healthcare demands in the next 28 days.** Individuals needing an ICU bed are assumed to need mechanical ventilation. Projected demand for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

The impact of each scenario has a more immediate effect on the daily number of infections. The figure below shows the impact of each scenario on the estimated daily incidence of new infections. If interventions are scaled up (Scenario 2), the daily number of infections will change from 551 (95% CI: 449-652) at the current date to 84 (95% CI: 62-107) by 2020-08-04. If current interventions were relaxed by 50%, we estimate the daily number of infections will change from 551 (95% CI: 449-652) at the current date to 7,304 (95% CI: 5,123-9,485) by 2020-08-04.

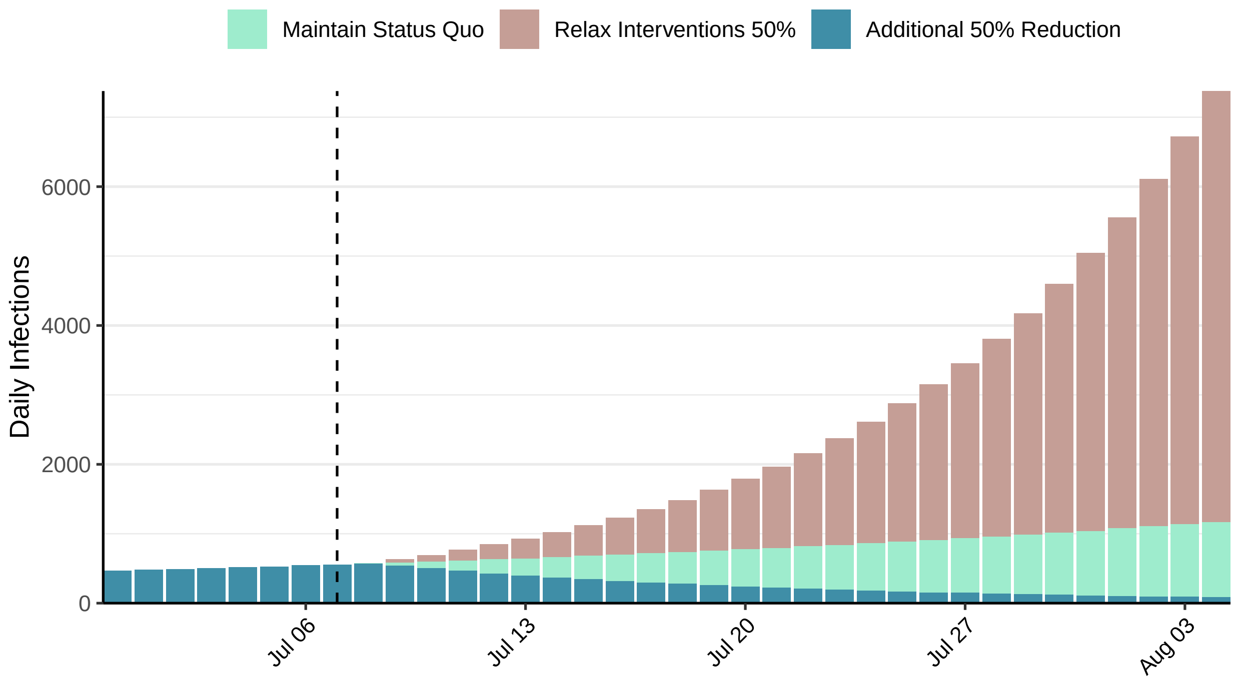

Figure 6: **Daily number of infections estimated by fitting to deaths.** Projected infections for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

To explore different scenarios, we recommend using our COVID-19 Scenario Analysis Tool - https://covidsim.org/, which can be used to simulate different intervention scenarios and explore the long term impact on healthcare demand.

Situation Report for COVID-19: Pakistan, 2020-07-07

Download the report for Pakistan, 2020-07-07 here. This report uses data from the European Centre for Disease Control. These data are updated daily and whilst there may be a short delay, they are generally consistent with Ministry reports. These data are then used to back-calculate an 'inferred number of COVID-19 infections' using mathematical modelling techniques (see Report 12 for further details) to estimate the number of people that have been infected and to make short-term projections for future healthcare needs.

Epidemiological Situation

Total Reported Cases	New Reported Cases	Total Reported Deaths	New Reported Deaths	Estimated R_t
234,509	2,691	4,839	77	1.07 (95% CI: 0.99-1.14)

The figure below shows the cumulative reported deaths as a function of the time since the 10th death was reported. Dashed lines show the expected trajectory for different doubling times of the epidemic. For example, with a doubling time of 3 days, if there are currently a total of 20 deaths reported, we would expect there to be 40 deaths in total reported in 3 days-time, 80 deaths in 6 days-time, 160 deaths in 9 days-time etc. For most epidemics, in the absence of interventions, we expect a doubling time of 3-4 days for this disease.

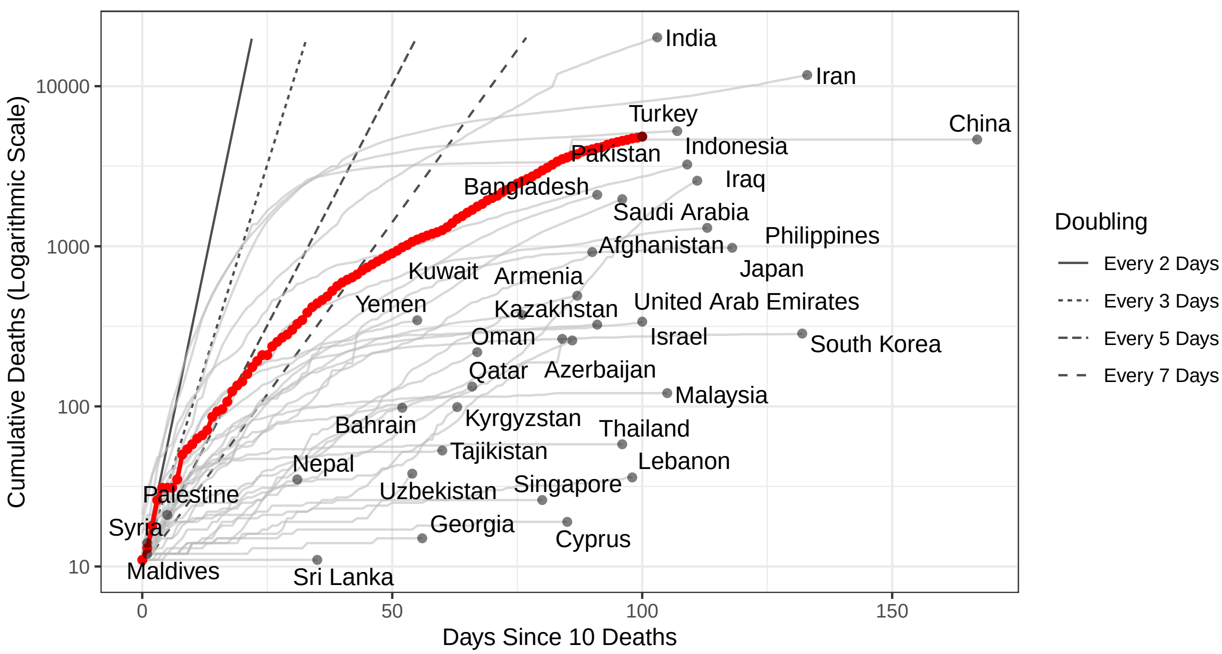

Figure 1: **Cumulative Deaths since 10 deaths.** Country not shown if fewer than 10 deaths.

COVID-19 Transmission Modelling

We assume that the deaths reported to date provide the best indication of the stage of the epidemic, as deaths are more consistently and accurately reported. Our current working estimate is that 1 death indicates that approximately 100 people will have been infected with the other 99 recovering (based on an infection fatality ratio of ~1%). These infections will have happened approximately 21 days previously – capturing a 5-day period from infection to onset of symptoms (the incubation period), 4 days from onset of symptoms to hospitalisation, and 12 days in hospital before death. With a 3-day doubling time, 100 infections that occurred 15 days ago will have generated 200 infections 12 days ago, 400 infections 9 days ago, 800 infections 6 days ago and 1,600 infections 3 days ago resulting in approximately 3,200 infections at the time the first death is observed.

To explore this, we fit our age-structured SEIR model (see Methods) to the time series of deaths in a country, in order to estimate the start date of the epidemic and the baseline R0. We assume that 100% of COVID-19 related deaths have been reported. We have also included the impact of interventions that have been put in place and their effect on human mobility and transmission based on the Google COVID-19 Community Mobility Reports. Using our mathematical model that formalises this approach, we estimate that there has been a total of 1,134,937 (95% CI: 1,045,779-1,224,095) infections over the past 4 weeks.

The figure below shows the estimated number of people infected over the past 4 weeks. The bar charts show, for comparison, the number of reported cases. The right-hand plot shows these data on a different scale as the estimated infections are likely to be much larger than the reported cases. **Importantly**, the estimated infections includes both asymptomatic and mild cases that would not necessarily be identified through surveillance. Consequently, the estimated infections are likely to be significantly higher than the reported cases (see our FAQ for further explanation of these differences and why the reported cases and estimated infections are unlikely to match).

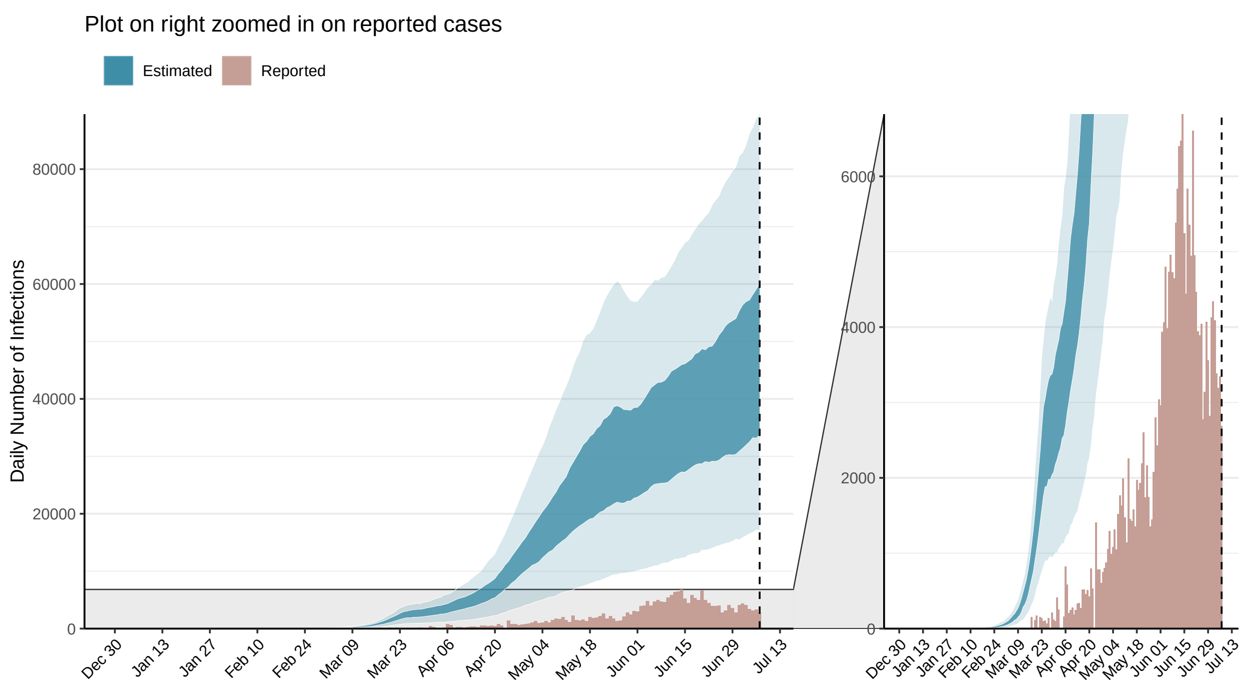

Figure 2: **Daily number of infections estimated by fitting to the current total of deaths.** Reported cases are shown in red. Model estimated infections are shown in blue (dark blue 50% interquartile range, light blue 95% quantile). The dashed line shows the current day.

By fitting to the time series of deaths, we are able to estimate a time-varying reproduction number, R_t. R_t is the the average number of secondary infections caused by a single infected person at a given time. If R_t is above 1, the rate of transmission is increasing and the number of new infections is increasing. R_t is assumed to change in relation to mobility fall in proportion. When fitting our model we assume that 100% of COVID-19 related deaths have been reported (please see our FAQ section for more information about this assumption). We also assume a fixed date at which the impact of mobility on transmission changes from pre-lockdown levels to post-lockdown levels, which may cause large changes in Rt. We are working to refine how this switch occurs and to formally calculate its shape.

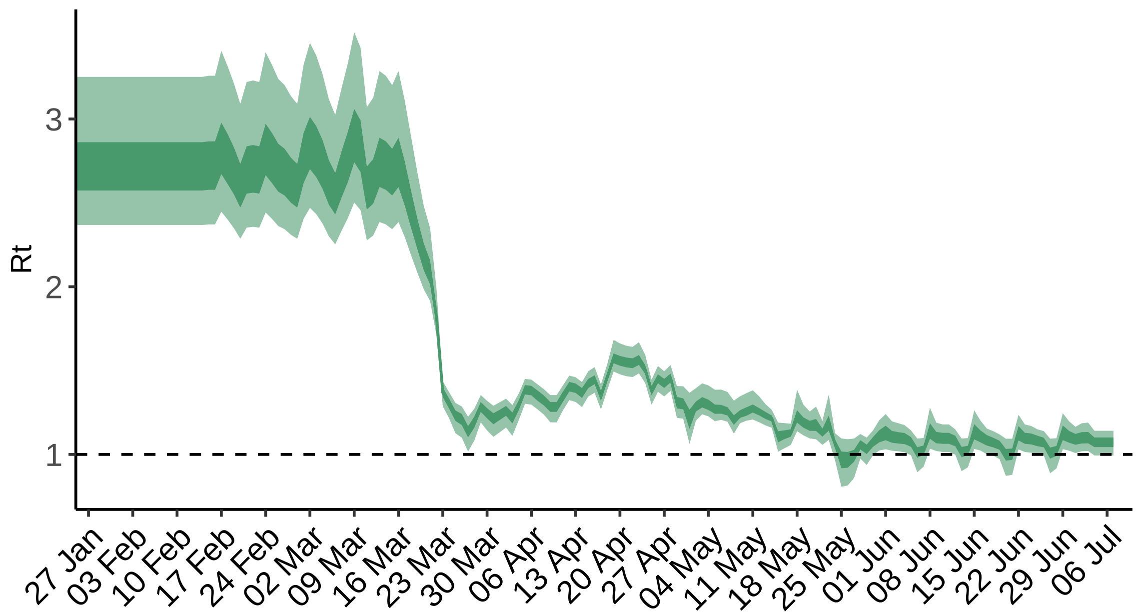

Figure 3: **Time-varying reproduction number, R_t.** R_t is the average number of secondary infections caused by a single infected person at time equal to t. $R_t < 1$ indicates a slowing epidemic in which new infections are not increasing. $R_t > 1$ indicates a growing epidemic in which new infections are increasing over time. Dark green shows the 50% CI and light green shows the 95% CI.

Using the model fit, we can forecast the expected trajectory for cumulative deaths, which is shown in the figure below. This assumes a severity pattern by age that is consistent with that observed in China, Europe and the U.S to date. This projection assumes that transmission is maintained at the current level of transmission as estimated by the final R_t value.

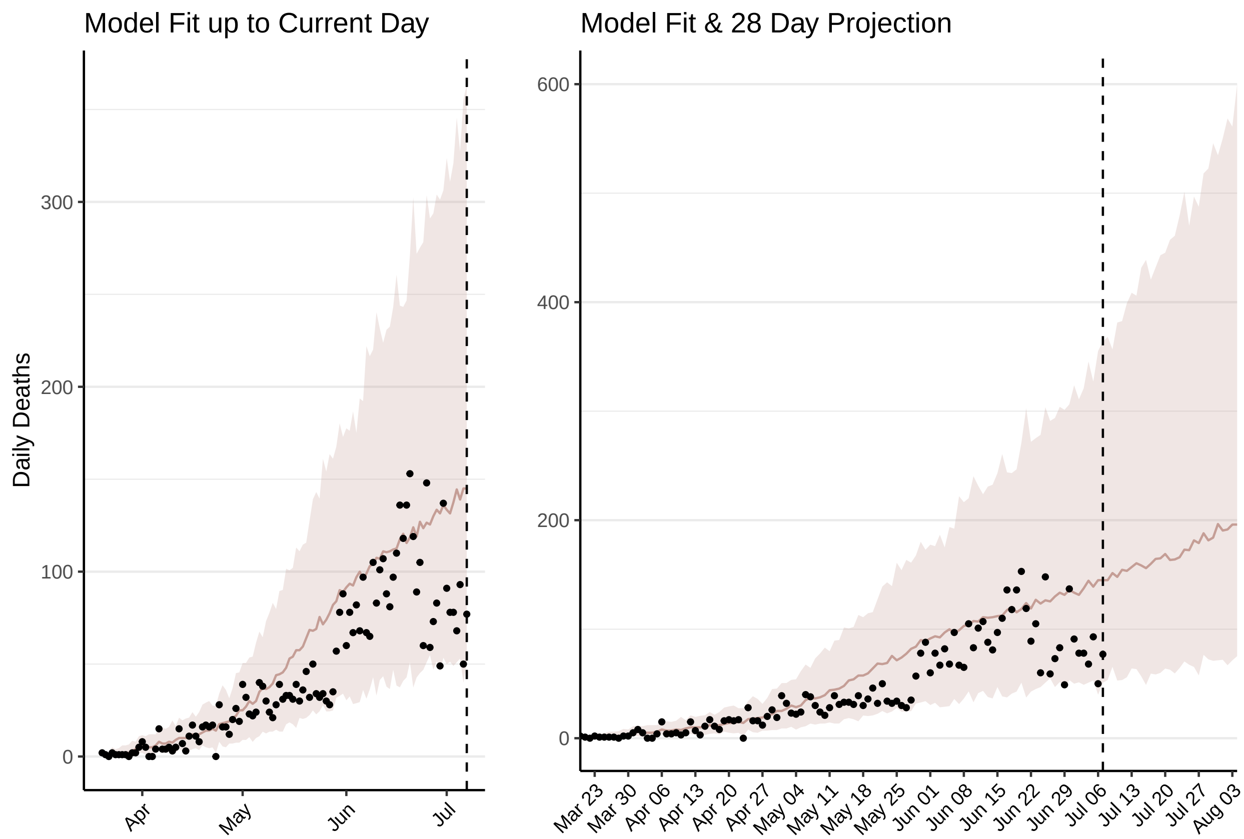

Figure 4: **Estimated daily deaths.** Projected deaths assuming the current level of interventions are maintained are shown in red (median and 95% quantile). Reported deaths are plotted in black. The plot on the left is focussed on the model fit prior to today, while the plot on the right forecasts the next 28 days.

Short-term Epidemic Scenarios

We make the following short-term projections of healthcare demand and new infections under the following three scenarios:

- **Scenario 1.** The epidemic continues to grow at the current rate.
- **Scenario 2.** Countries will further scale up interventions (either increasing current strategies or implementing new interventions) leading to a further 50% reduction in transmission.
- **Scenario 3.** Countries will relax current interventions by 50%

N.B. These scenarios currently assume that the impact of mobility on transmission will remain the same in the future as it has in the past. We are working to extend methods to estimate the impact of increases in mobility on transmission as lockdown and interventions are reversed. Consequently, projection are likely to represent an upper estimate of the healthcare demand and case load for each scenario

We estimate that over the next 4 weeks demand for hospital beds will change from 7,227 (95% CI: 6,660-7,795) patients requiring treatment with high-pressure oxygen at the current date to 9,753 (95% CI: 8,892-10,613) hospital beds being required on 2020-08-04 if no further interventions are introduced (Scenario 1). Similarly, we estimate that over the next 4 weeks demand for critical care (ICU) beds will change from 2,110 (95% CI: 1,964-2,256) patients requiring treatment with mechanical ventilation at the current date to 2,500 (95% CI: 2,348-2,652) by 2020-08-04. These projections assume that approximately 5% of all infections will require treatment with high-pressure oxygen and that approximately 30% of hospitalised cases will require treatment with mechanical ventilation (based on analysis of ongoing epidemics in Europe). **N.B. These scenarios are unlikely to show significant differences for the first week since there is a delay of approximately 10 days between infection and hospital admission. Consequently, the effectiveness of a change in policy is likely to be better captured by hospital admission data approximately 2 weeks after the policy change is implemented.**

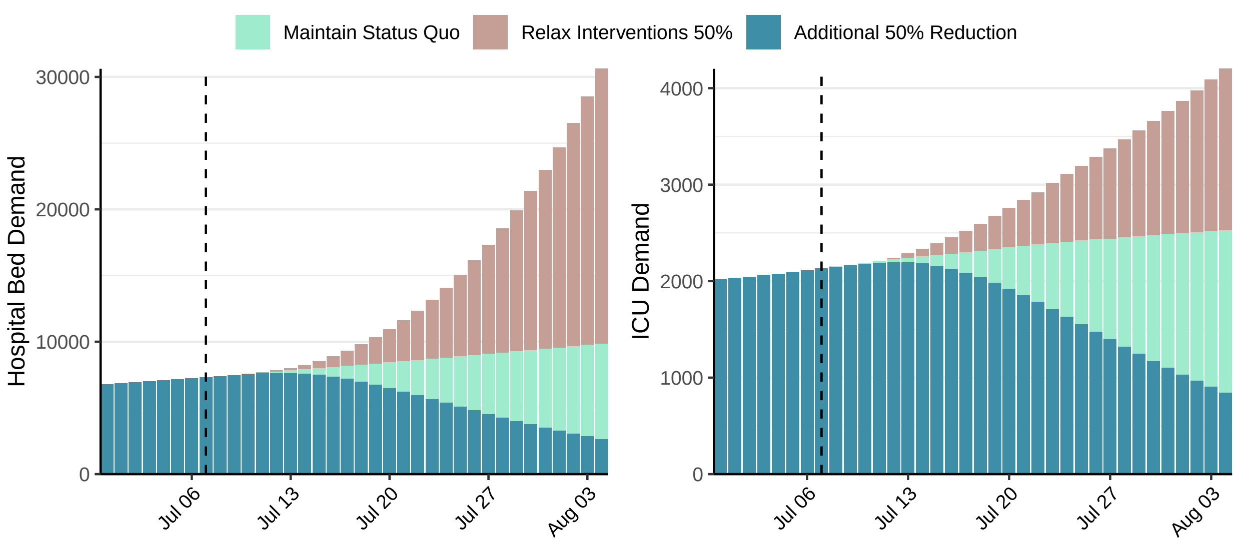

Figure 5: **Healthcare demands in the next 28 days.** Individuals needing an ICU bed are assumed to need mechanical ventilation. Projected demand for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

The impact of each scenario has a more immediate effect on the daily number of infections. The figure below shows the impact of each scenario on the estimated daily incidence of new infections. If interventions are scaled up (Scenario 2), the daily number of infections will change from 47,029 (95% CI: 43,156-50,902) at the current date to 5,069 (95% CI: 4,597-5,541) by 2020-08-04. If current interventions were relaxed by 50%, we estimate the daily number of infections will change from 47,029 (95% CI: 43,156-50,902) at the current date to 360,727 (95% CI: 326,339-395,116) by 2020-08-04.

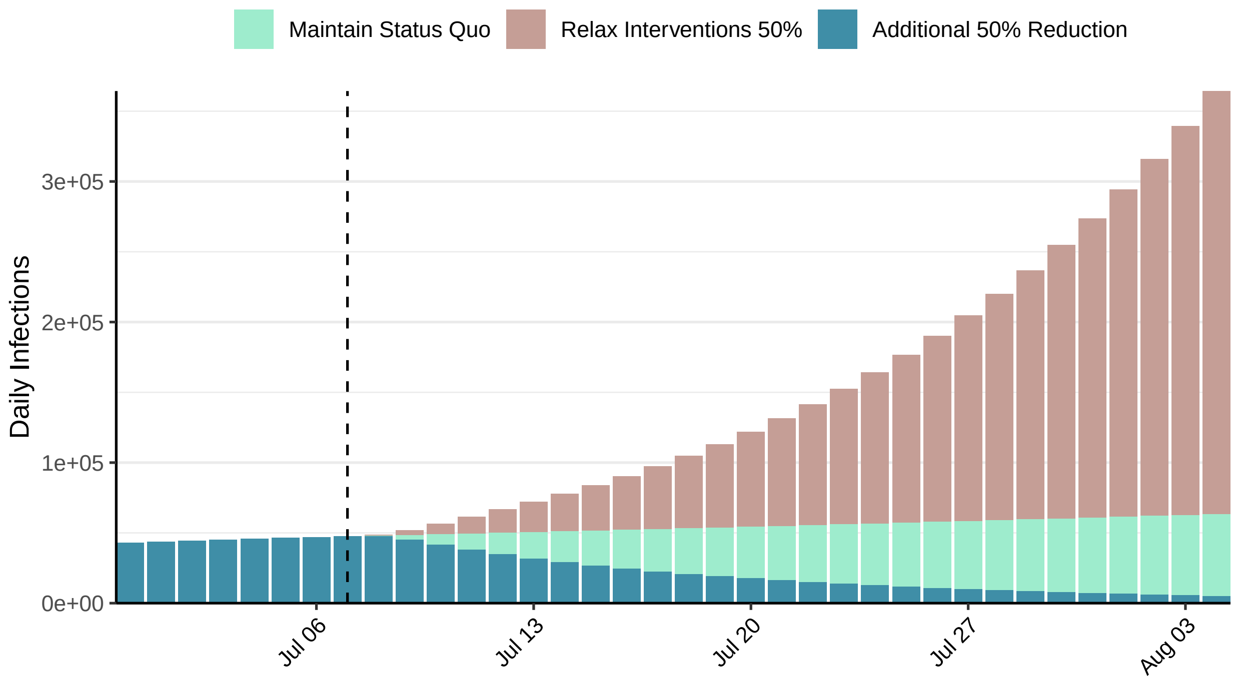

Figure 6: **Daily number of infections estimated by fitting to deaths.** Projected infections for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

To explore different scenarios, we recommend using our COVID-19 Scenario Analysis Tool - https://covidsim.org/, which can be used to simulate different intervention scenarios and explore the long term impact on healthcare demand.

Situation Report for COVID-19: Panama, 2020-07-07

Download the report for Panama, 2020-07-07 here. This report uses data from the European Centre for Disease Control. These data are updated daily and whilst there may be a short delay, they are generally consistent with Ministry reports. These data are then used to back-calculate an 'inferred number of COVID-19 infections' using mathematical modelling techniques (see Report 12 for further details) to estimate the number of people that have been infected and to make short-term projections for future healthcare needs.

Epidemiological Situation

Total Reported Cases	New Reported Cases	Total Reported Deaths	New Reported Deaths	Estimated R_t
39,334	1,185	770	23	1.37 (95% CI: 1.32-1.43)

The figure below shows the cumulative reported deaths as a function of the time since the 10th death was reported. Dashed lines show the expected trajectory for different doubling times of the epidemic. For example, with a doubling time of 3 days, if there are currently a total of 20 deaths reported, we would expect there to be 40 deaths in total reported in 3 days-time, 80 deaths in 6 days-time, 160 deaths in 9 days-time etc. For most epidemics, in the absence of interventions, we expect a doubling time of 3-4 days for this disease.

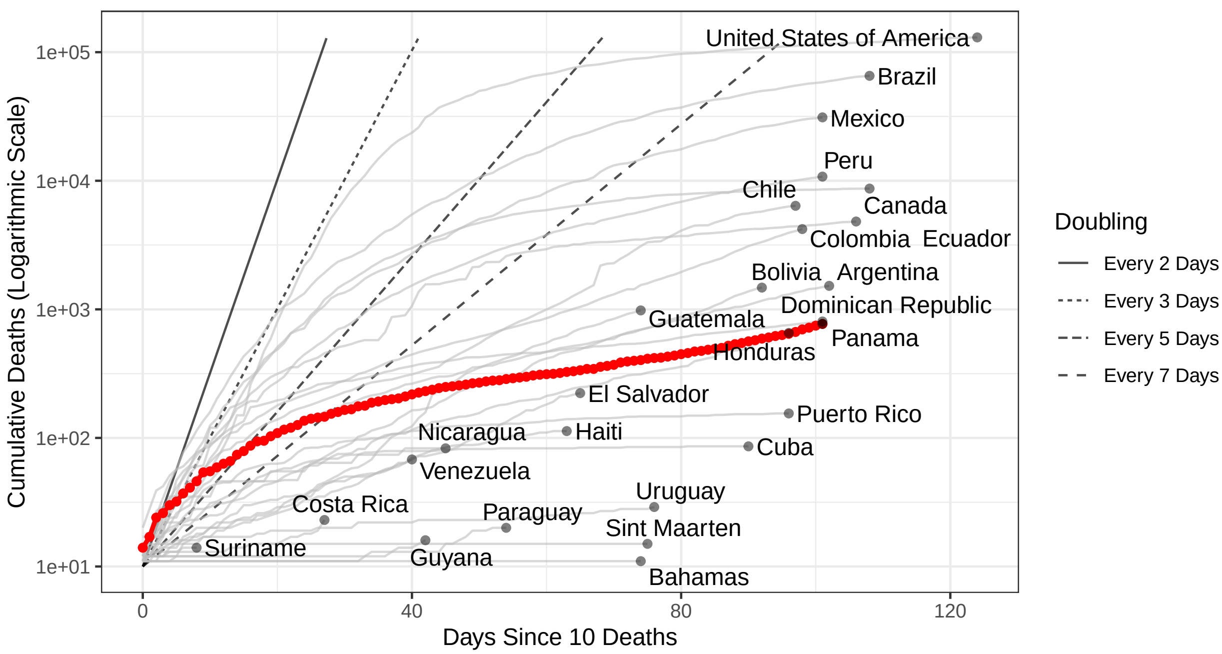

Figure 1: **Cumulative Deaths since 10 deaths.** Country not shown if fewer than 10 deaths.

COVID-19 Transmission Modelling

We assume that the deaths reported to date provide the best indication of the stage of the epidemic, as deaths are more consistently and accurately reported. Our current working estimate is that 1 death indicates that approximately 100 people will have been infected with the other 99 recovering (based on an infection fatality ratio of ~1%). These infections will have happened approximately 21 days previously – capturing a 5-day period from infection to onset of symptoms (the incubation period), 4 days from onset of symptoms to hospitalisation, and 12 days in hospital before death. With a 3-day doubling time, 100 infections that occurred 15 days ago will have generated 200 infections 12 days ago, 400 infections 9 days ago, 800 infections 6 days ago and 1,600 infections 3 days ago resulting in approximately 3,200 infections at the time the first death is observed.

To explore this, we fit our age-structured SEIR model (see Methods) to the time series of deaths in a country, in order to estimate the start date of the epidemic and the baseline R0. We assume that 100% of COVID-19 related deaths have been reported. We have also included the impact of interventions that have been put in place and their effect on human mobility and transmission based on the Google COVID-19 Community Mobility Reports. Using our mathematical model that formalises this approach, we estimate that there has been a total of 171,830 (95% CI: 160,548-183,111) infections over the past 4 weeks.

The figure below shows the estimated number of people infected over the past 4 weeks. The bar charts show, for comparison, the number of reported cases. The right-hand plot shows these data on a different scale as the estimated infections are likely to be much larger than the reported cases. **Importantly**, the estimated infections includes both asymptomatic and mild cases that would not necessarily be identified through surveillance. Consequently, the estimated infections are likely to be significantly higher than the reported cases (see our FAQ for further explanation of these differences and why the reported cases and estimated infections are unlikely to match).

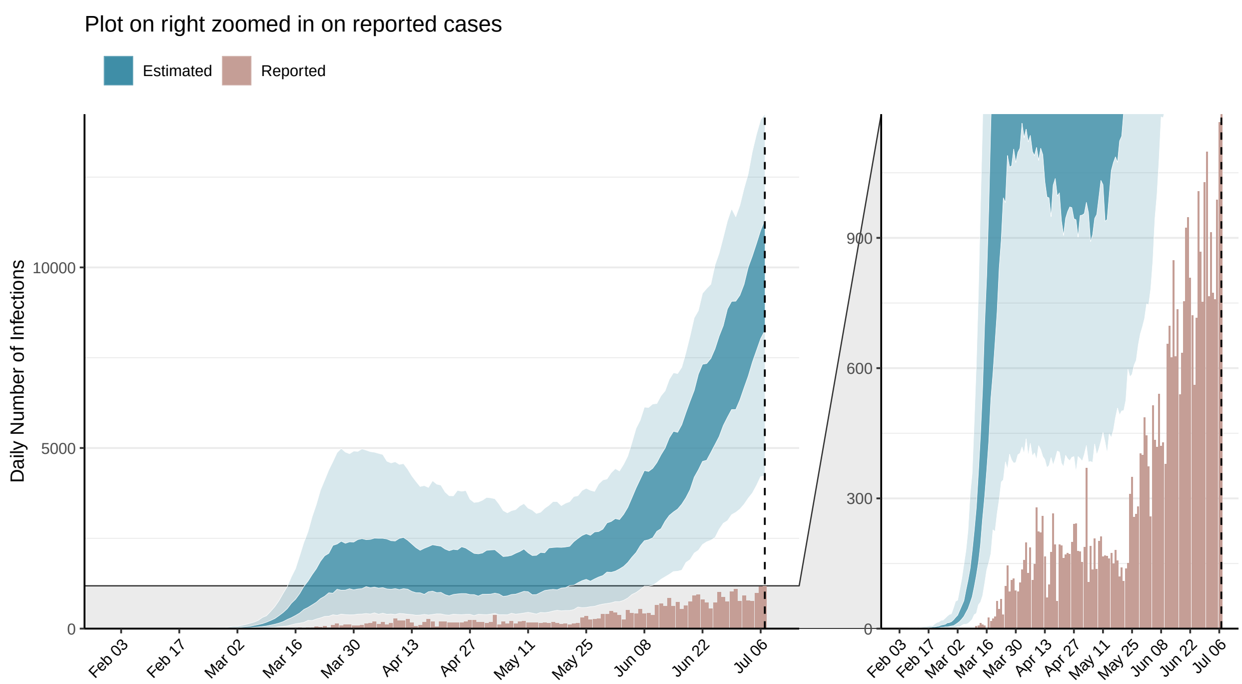

Figure 2: **Daily number of infections estimated by fitting to the current total of deaths.** Reported cases are shown in red. Model estimated infections are shown in blue (dark blue 50% interquartile range, light blue 95% quantile). The dashed line shows the current day.

By fitting to the time series of deaths, we are able to estimate a time-varying reproduction number, R_t. R_t is the the average number of secondary infections caused by a single infected person at a given time. If R_t is above 1, the rate of transmission is increasing and the number of new infections is increasing. R_t is assumed to change in relation to mobility fall in proportion. When fitting our model we assume that 100% of COVID-19 related deaths have been reported (please see our FAQ section for more information about this assumption). We also assume a fixed date at which the impact of mobility on transmission changes from pre-lockdown levels to post-lockdown levels, which may cause large changes in Rt. We are working to refine how this switch occurs and to formally calculate its shape.

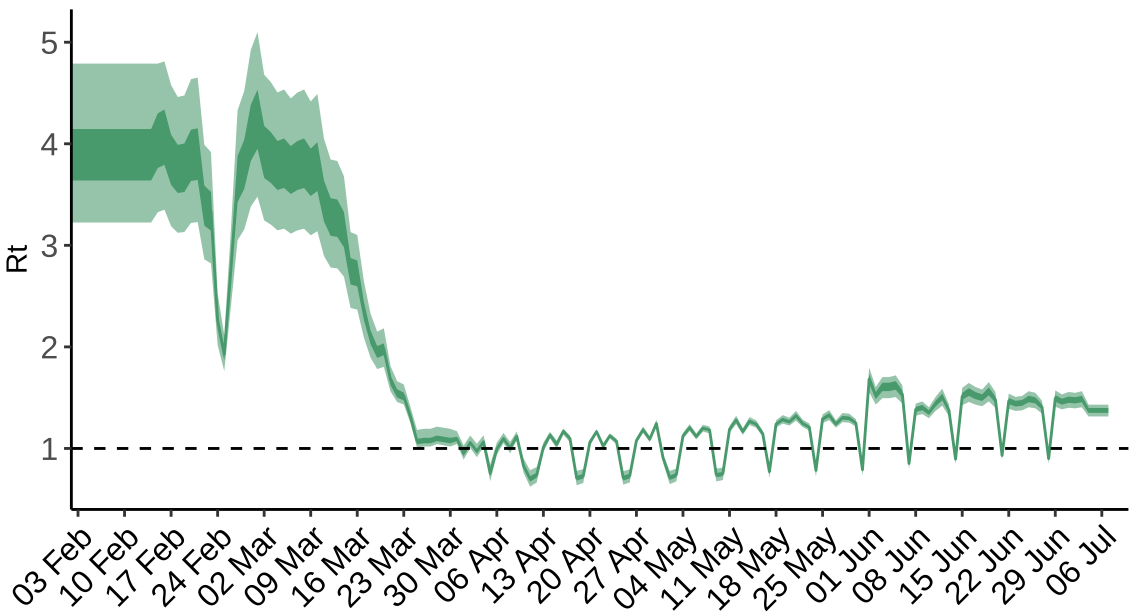

Figure 3: **Time-varying reproduction number, R_t.** R_t is the average number of secondary infections caused by a single infected person at time equal to t. $R_t < 1$ indicates a slowing epidemic in which new infections are not increasing. $R_t > 1$ indicates a growing epidemic in which new infections are increasing over time. Dark green shows the 50% CI and light green shows the 95% CI.

Using the model fit, we can forecast the expected trajectory for cumulative deaths, which is shown in the figure below. This assumes a severity pattern by age that is consistent with that observed in China, Europe and the U.S to date. This projection assumes that transmission is maintained at the current level of transmission as estimated by the final R_t value. **N.B. Panama is forecast to be close to or surpassing our best estimates for healthcare capacity in the next 28 days.** Estimates of deaths in the next 28 days may be inaccurate due to our working assumptions for mortality in individuals who do not receive appropriate treatment. See our methods for more information.

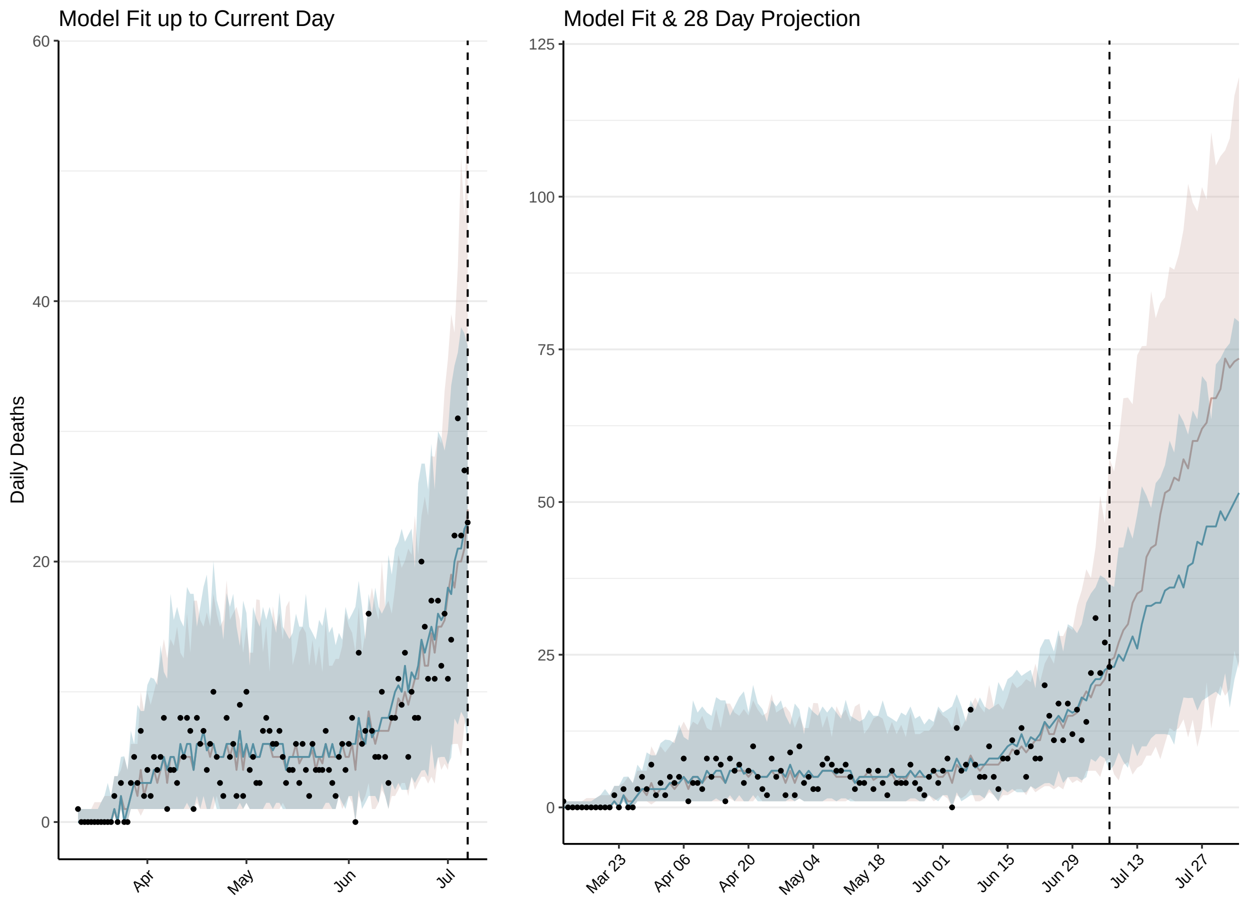

Figure 4: **Estimated daily deaths.** Projected deaths assuming the current level of interventions are maintained are shown in red (median and 95% quantile). Reported deaths are plotted in black. The plot on the left is focussed on the model fit prior to today, while the plot on the right forecasts the next 28 days. The forecasted deaths in blue assumes healthcare capacity has been surged to ensure sufficient supply of ICU and hospital beds. The red curve assumes no surging in healthcare capacity and subsequently projects increased deaths.

Short-term Epidemic Scenarios

We make the following short-term projections of healthcare demand and new infections under the following three scenarios:

- **Scenario 1.** The epidemic continues to grow at the current rate.
- **Scenario 2.** Countries will further scale up interventions (either increasing current strategies or implementing new interventions) leading to a further 50% reduction in transmission.
- **Scenario 3.** Countries will relax current interventions by 50%

N.B. These scenarios currently assume that the impact of mobility on transmission will remain the same in the future as it has in the past. We are working to extend methods to estimate the impact of increases in mobility on transmission as lockdown and interventions are reversed. Consequently, projection are likely to represent an upper estimate of the healthcare demand and case load for each scenario

We estimate that over the next 4 weeks demand for hospital beds will change from 1,047 (95% CI: 976-1,119) patients requiring treatment with high-pressure oxygen at the current date to 2,252 (95% CI: 2,135-2,368) hospital beds being required on 2020-08-04 if no further interventions are introduced (Scenario 1). Similarly, we estimate that over the next 4 weeks demand for critical care (ICU) beds will change from 319 (95% CI: 299-339) patients requiring treatment with mechanical ventilation at the current date to 435 (95% CI: 422-448) by 2020-08-04. These projections assume that approximately 5% of all infections will require treatment with high-pressure oxygen and that approximately 30% of hospitalised cases will require treatment with mechanical ventilation (based on analysis of ongoing epidemics in Europe). **N.B. These scenarios are unlikely to show significant differences for the first week since there is a delay of approximately 10 days between infection and hospital admission. Consequently, the effectiveness of a change in policy is likely to be better captured by hospital admission data approximately 2 weeks after the policy change is implemented.**

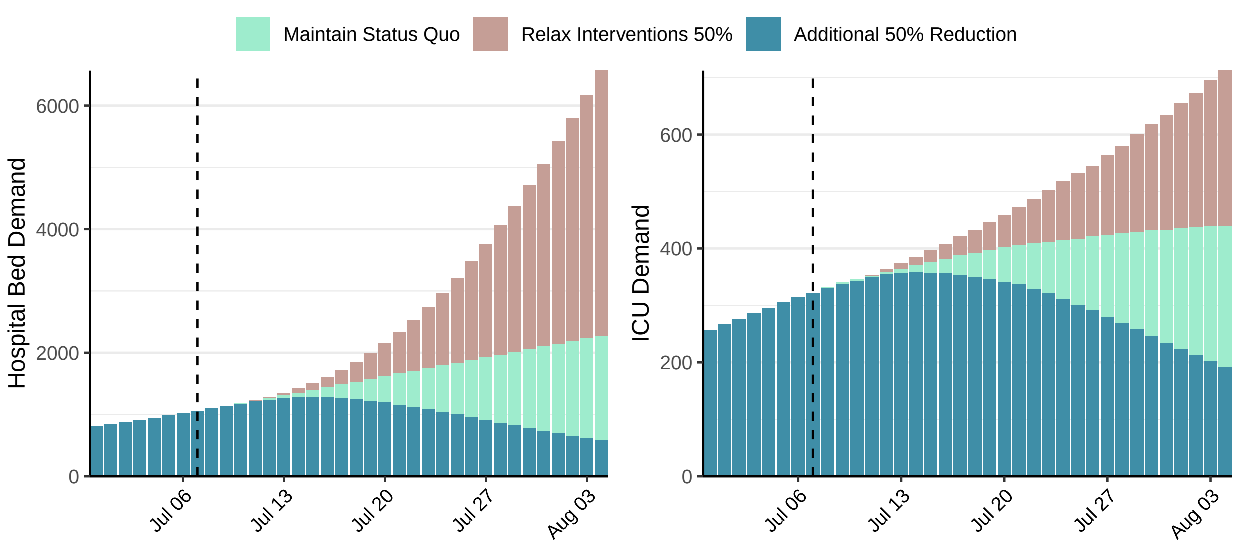

Figure 5: **Healthcare demands in the next 28 days.** Individuals needing an ICU bed are assumed to need mechanical ventilation. Projected demand for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

The impact of each scenario has a more immediate effect on the daily number of infections. The figure below shows the impact of each scenario on the estimated daily incidence of new infections. If interventions are scaled up (Scenario 2), the daily number of infections will change from 9,530 (95% CI: 8,961-10,099) at the current date to 1,395 (95% CI: 1,323-1,468) by 2020-08-04. If current interventions were relaxed by 50%, we estimate the daily number of infections will change from 9,530 (95% CI: 8,961-10,099) at the current date to 59,927 (95% CI: 57,738-62,115) by 2020-08-04.

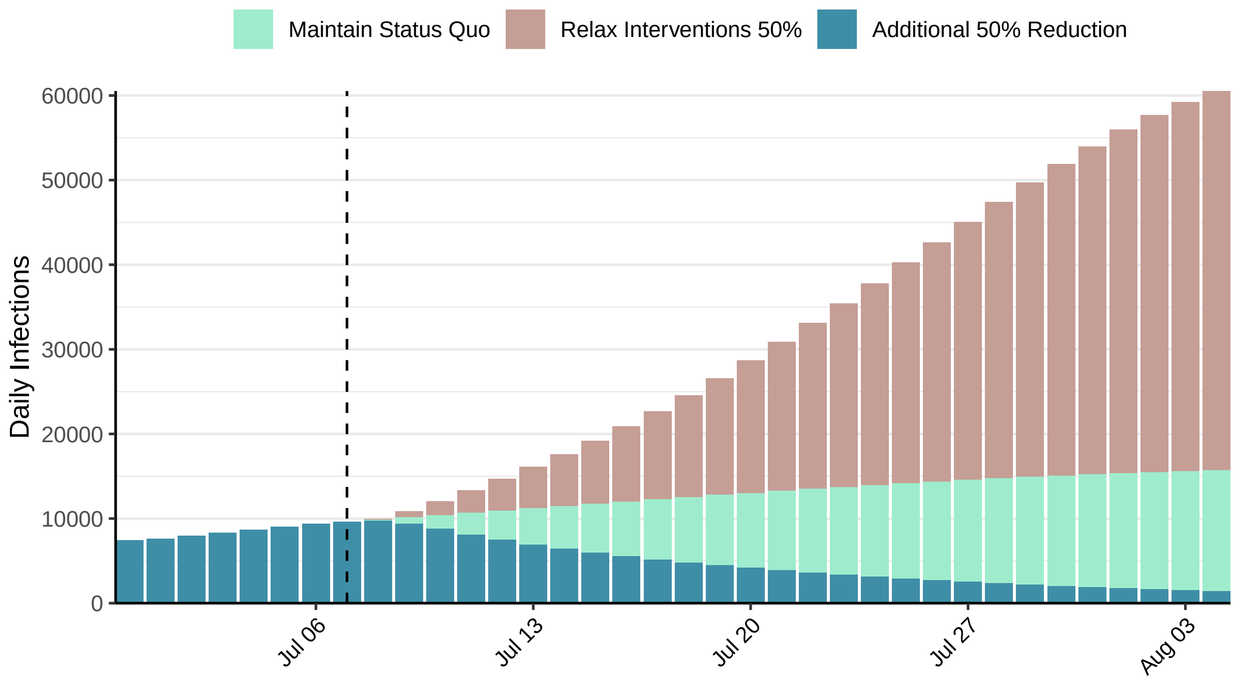

Figure 6: **Daily number of infections estimated by fitting to deaths.** Projected infections for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

To explore different scenarios, we recommend using our COVID-19 Scenario Analysis Tool - https://covidsim.org/, which can be used to simulate different intervention scenarios and explore the long term impact on healthcare demand.

Situation Report for COVID-19: Peru, 2020-07-07

Download the report for Peru, 2020-07-07 here. This report uses data from the European Centre for Disease Control. These data are updated daily and whilst there may be a short delay, they are generally consistent with Ministry reports. These data are then used to back-calculate an 'inferred number of COVID-19 infections' using mathematical modelling techniques (see Report 12 for further details) to estimate the number of people that have been infected and to make short-term projections for future healthcare needs.

Epidemiological Situation

Total Reported Cases	New Reported Cases	Total Reported Deaths	New Reported Deaths	Estimated R_t
305,703	2,985	10,772	183	1.21 (95% CI: 1.12-1.25)

The figure below shows the cumulative reported deaths as a function of the time since the 10th death was reported. Dashed lines show the expected trajectory for different doubling times of the epidemic. For example, with a doubling time of 3 days, if there are currently a total of 20 deaths reported, we would expect there to be 40 deaths in total reported in 3 days-time, 80 deaths in 6 days-time, 160 deaths in 9 days-time etc. For most epidemics, in the absence of interventions, we expect a doubling time of 3-4 days for this disease.

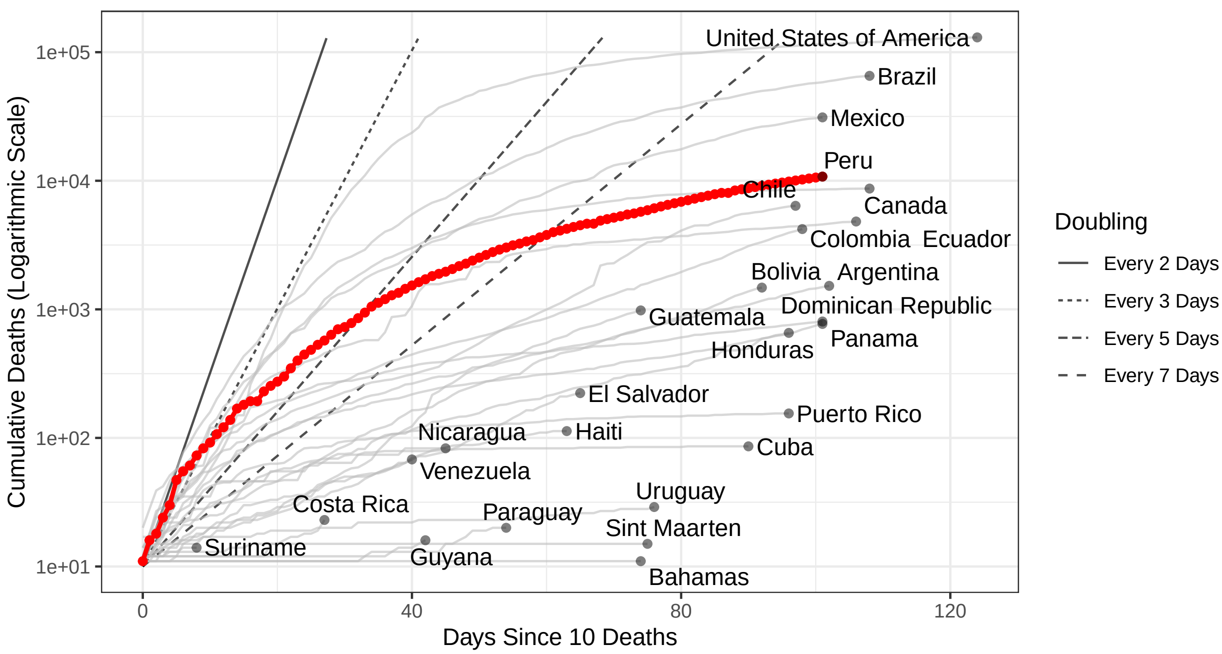

Figure 1: **Cumulative Deaths since 10 deaths.** Country not shown if fewer than 10 deaths.

COVID-19 Transmission Modelling

We assume that the deaths reported to date provide the best indication of the stage of the epidemic, as deaths are more consistently and accurately reported. Our current working estimate is that 1 death indicates that approximately 100 people will have been infected with the other 99 recovering (based on an infection fatality ratio of ~1%). These infections will have happened approximately 21 days previously – capturing a 5-day period from infection to onset of symptoms (the incubation period), 4 days from onset of symptoms to hospitalisation, and 12 days in hospital before death. With a 3-day doubling time, 100 infections that occurred 15 days ago will have generated 200 infections 12 days ago, 400 infections 9 days ago, 800 infections 6 days ago and 1,600 infections 3 days ago resulting in approximately 3,200 infections at the time the first death is observed.

To explore this, we fit our age-structured SEIR model (see Methods) to the time series of deaths in a country, in order to estimate the start date of the epidemic and the baseline R0. We assume that 100% of COVID-19 related deaths have been reported. We have also included the impact of interventions that have been put in place and their effect on human mobility and transmission based on the Google COVID-19 Community Mobility Reports. Using our mathematical model that formalises this approach, we estimate that there has been a total of 1,359,697 (95% CI: 1,319,656-1,399,738) infections over the past 4 weeks.

The figure below shows the estimated number of people infected over the past 4 weeks. The bar charts show, for comparison, the number of reported cases. The right-hand plot shows these data on a different scale as the estimated infections are likely to be much larger than the reported cases. **Importantly**, the estimated infections includes both asymptomatic and mild cases that would not necessarily be identified through surveillance. Consequently, the estimated infections are likely to be significantly higher than the reported cases (see our FAQ for further explanation of these differences and why the reported cases and estimated infections are unlikely to match).

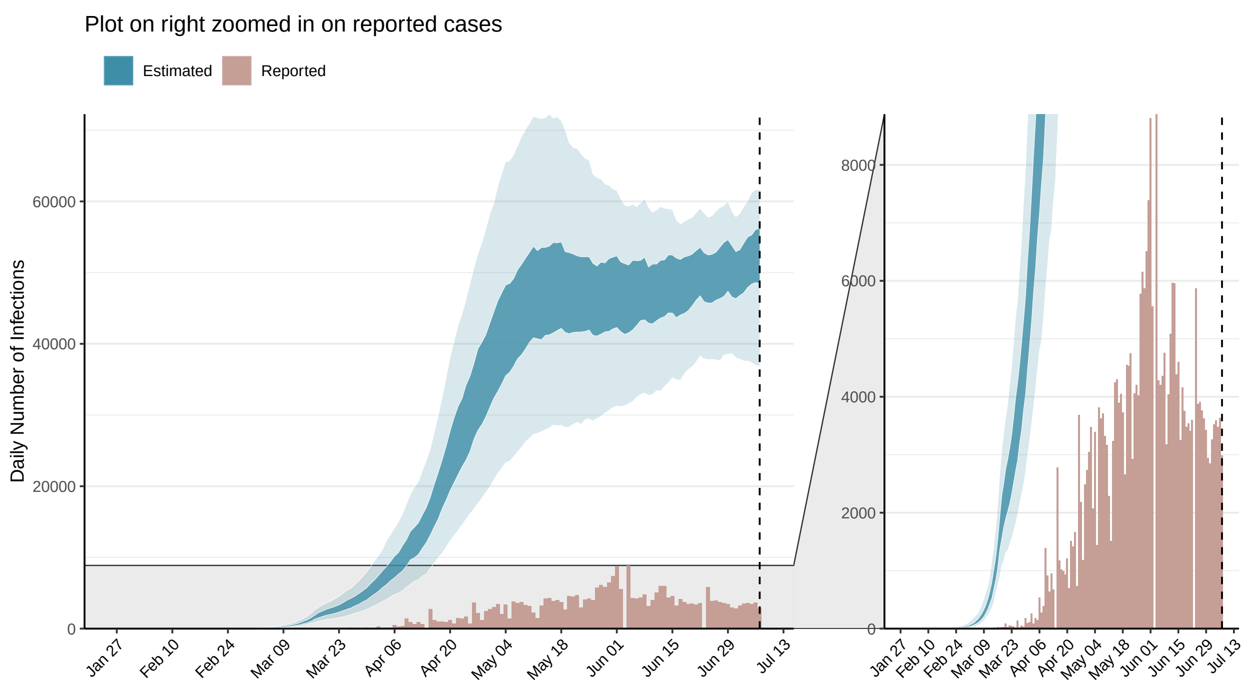

Figure 2: **Daily number of infections estimated by fitting to the current total of deaths.** Reported cases are shown in red. Model estimated infections are shown in blue (dark blue 50% interquartile range, light blue 95% quantile). The dashed line shows the current day.

By fitting to the time series of deaths, we are able to estimate a time-varying reproduction number, R_t. R_t is the the average number of secondary infections caused by a single infected person at a given time. If R_t is above 1, the rate of transmission is increasing and the number of new infections is increasing. R_t is assumed to change in relation to mobility fall in proportion. When fitting our model we assume that 100% of COVID-19 related deaths have been reported (please see our FAQ section for more information about this assumption). We also assume a fixed date at which the impact of mobility on transmission changes from pre-lockdown levels to post-lockdown levels, which may cause large changes in Rt. We are working to refine how this switch occurs and to formally calculate its shape.

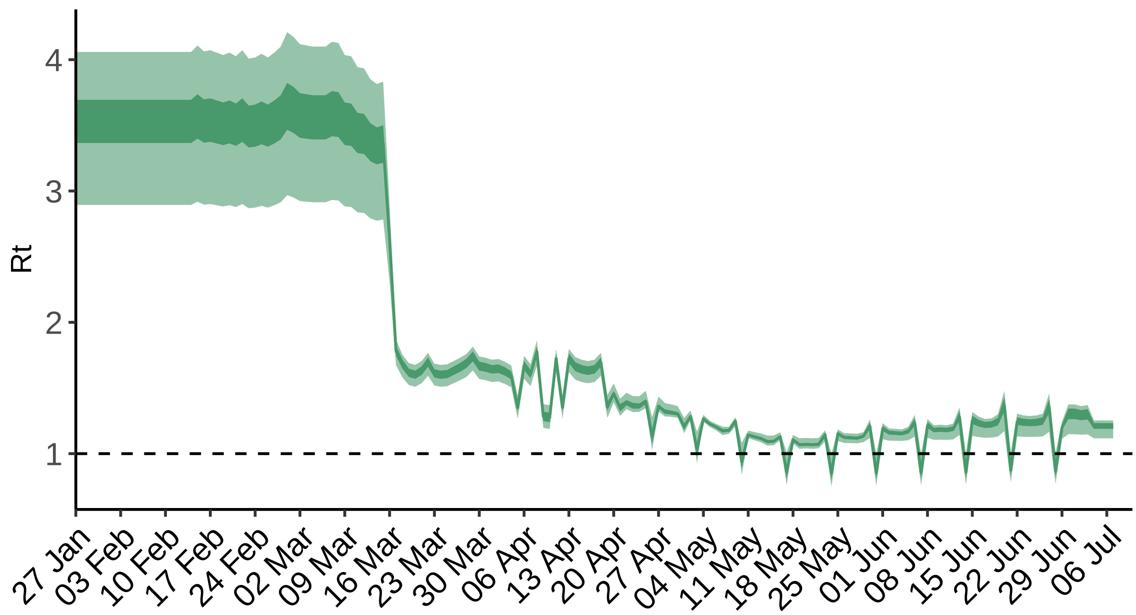

Figure 3: **Time-varying reproduction number, R_t.** R_t is the average number of secondary infections caused by a single infected person at time equal to t. $R_t < 1$ indicates a slowing epidemic in which new infections are not increasing. $R_t > 1$ indicates a growing epidemic in which new infections are increasing over time. Dark green shows the 50% CI and light green shows the 95% CI.

Using the model fit, we can forecast the expected trajectory for cumulative deaths, which is shown in the figure below. This assumes a severity pattern by age that is consistent with that observed in China, Europe and the U.S to date. This projection assumes that transmission is maintained at the current level of transmission as estimated by the final R_t value. **N.B. Peru is forecast to be close to or surpassing our best estimates for healthcare capacity in the next 28 days.** Estimates of deaths in the next 28 days may be inaccurate due to our working assumptions for mortality in individuals who do not receive appropriate treatment. See our methods for more information.

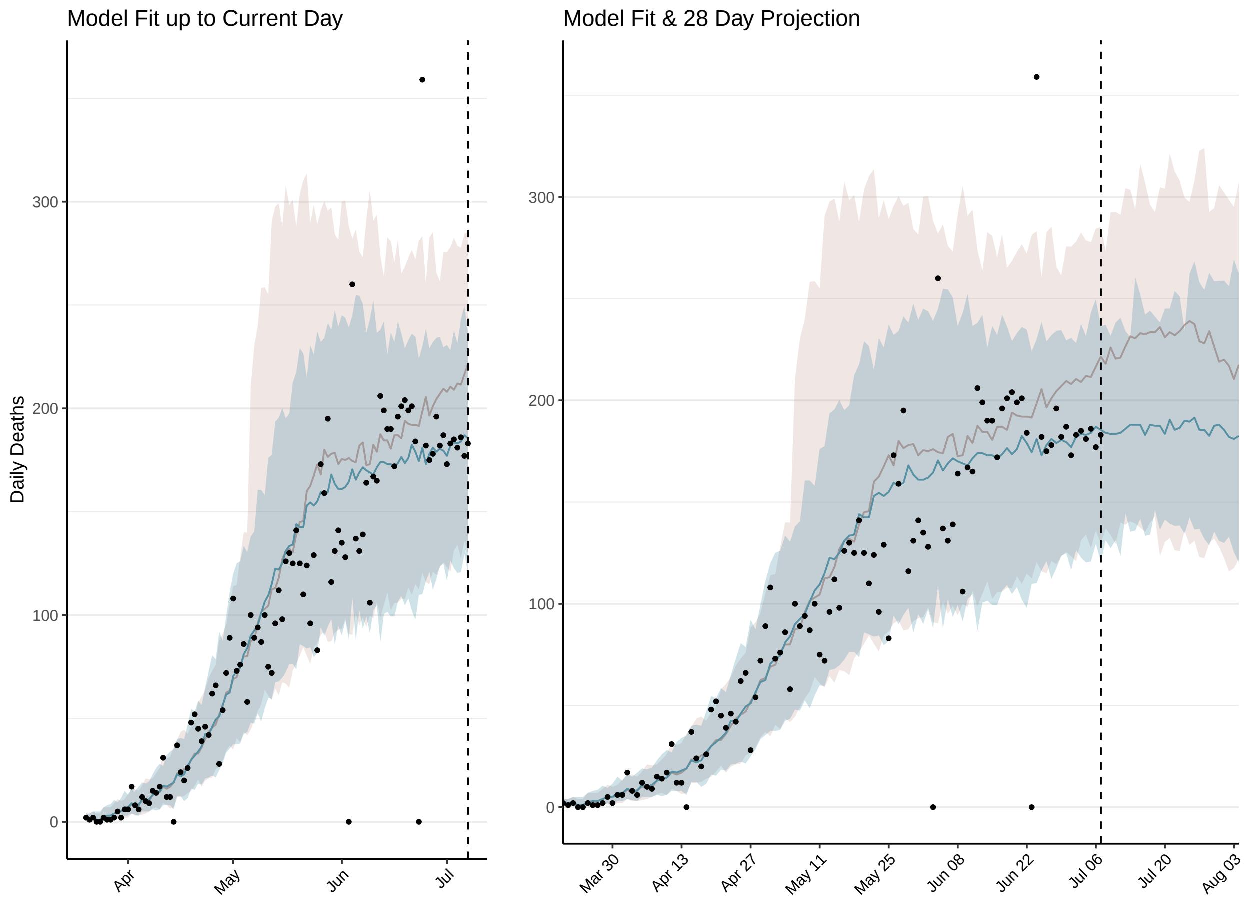

Figure 4: **Estimated daily deaths.** Projected deaths assuming the current level of interventions are maintained are shown in red (median and 95% quantile). Reported deaths are plotted in black. The plot on the left is focussed on the model fit prior to today, while the plot on the right forecasts the next 28 days. The forecasted deaths in blue assumes healthcare capacity has been surged to ensure sufficient supply of ICU and hospital beds. The red curve assumes no surging in healthcare capacity and subsequently projects increased deaths.

Short-term Epidemic Scenarios

We make the following short-term projections of healthcare demand and new infections under the following three scenarios:

- **Scenario 1.** The epidemic continues to grow at the current rate.
- **Scenario 2.** Countries will further scale up interventions (either increasing current strategies or implementing new interventions) leading to a further 50% reduction in transmission.
- **Scenario 3.** Countries will relax current interventions by 50%

N.B. These scenarios currently assume that the impact of mobility on transmission will remain the same in the future as it has in the past. We are working to extend methods to estimate the impact of increases in mobility on transmission as lockdown and interventions are reversed. Consequently, projection are likely to represent an upper estimate of the healthcare demand and case load for each scenario

We estimate that over the next 4 weeks demand for hospital beds will change from 8,214 (95% CI: 7,963-8,465) patients requiring treatment with high-pressure oxygen at the current date to 8,310 (95% CI: 7,993-8,628) hospital beds being required on 2020-08-04 if no further interventions are introduced (Scenario 1). Similarly, we estimate that over the next 4 weeks demand for critical care (ICU) beds will change from 2,119 (95% CI: 2,075-2,164) patients requiring treatment with mechanical ventilation at the current date to 2,096 (95% CI: 2,047-2,145) by 2020-08-04. These projections assume that approximately 5% of all infections will require treatment with high-pressure oxygen and that approximately 30% of hospitalised cases will require treatment with mechanical ventilation (based on analysis of ongoing epidemics in Europe). **N.B. These scenarios are unlikely to show significant differences for the first week since there is a delay of approximately 10 days between infection and hospital admission. Consequently, the effectiveness of a change in policy is likely to be better captured by hospital admission data approximately 2 weeks after the policy change is implemented.**

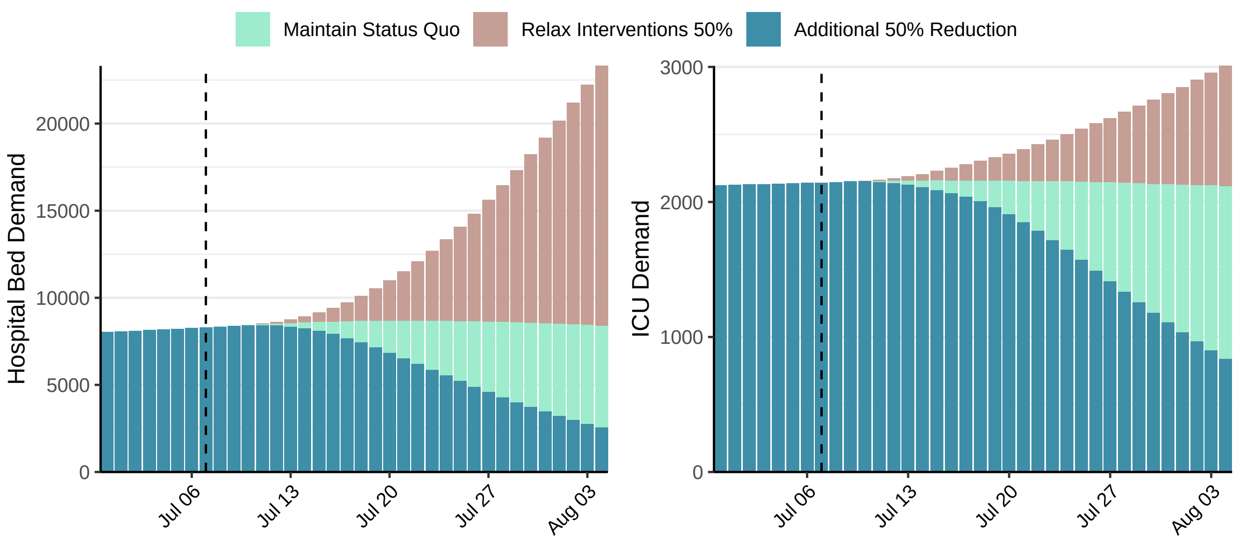

Figure 5: **Healthcare demands in the next 28 days.** Individuals needing an ICU bed are assumed to need mechanical ventilation. Projected demand for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

The impact of each scenario has a more immediate effect on the daily number of infections. The figure below shows the impact of each scenario on the estimated daily incidence of new infections. If interventions are scaled up (Scenario 2), the daily number of infections will change from 51,272 (95% CI: 49,657-52,887) at the current date to 4,093 (95% CI: 3,910-4,275) by 2020-08-04. If current interventions were relaxed by 50%, we estimate the daily number of infections will change from 51,272 (95% CI: 49,657-52,887) at the current date to 198,438 (95% CI: 189,769-207,106) by 2020-08-04.

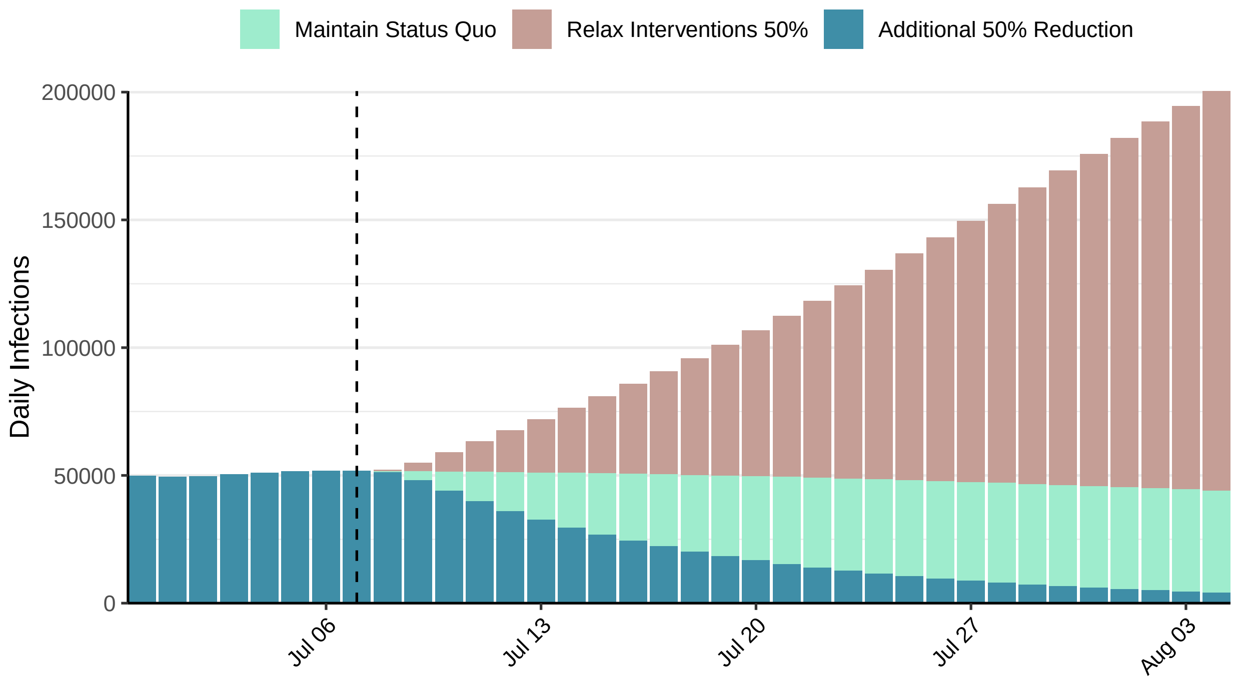

Figure 6: **Daily number of infections estimated by fitting to deaths.** Projected infections for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

To explore different scenarios, we recommend using our COVID-19 Scenario Analysis Tool - https://covidsim.org/, which can be used to simulate different intervention scenarios and explore the long term impact on healthcare demand.

Situation Report for COVID-19: Philippines, 2020-07-07

Download the report for Philippines, 2020-07-07 here. This report uses data from the European Centre for Disease Control. These data are updated daily and whilst there may be a short delay, they are generally consistent with Ministry reports. These data are then used to back-calculate an 'inferred number of COVID-19 infections' using mathematical modelling techniques (see Report 12 for further details) to estimate the number of people that have been infected and to make short-term projections for future healthcare needs.

Epidemiological Situation

Total Reported Cases	New Reported Cases	Total Reported Deaths	New Reported Deaths	Estimated R_t
46,333	4,503	1,303	13	1.05 (95% CI: 0.93-1.19)

The figure below shows the cumulative reported deaths as a function of the time since the 10th death was reported. Dashed lines show the expected trajectory for different doubling times of the epidemic. For example, with a doubling time of 3 days, if there are currently a total of 20 deaths reported, we would expect there to be 40 deaths in total reported in 3 days-time, 80 deaths in 6 days-time, 160 deaths in 9 days-time etc. For most epidemics, in the absence of interventions, we expect a doubling time of 3-4 days for this disease.

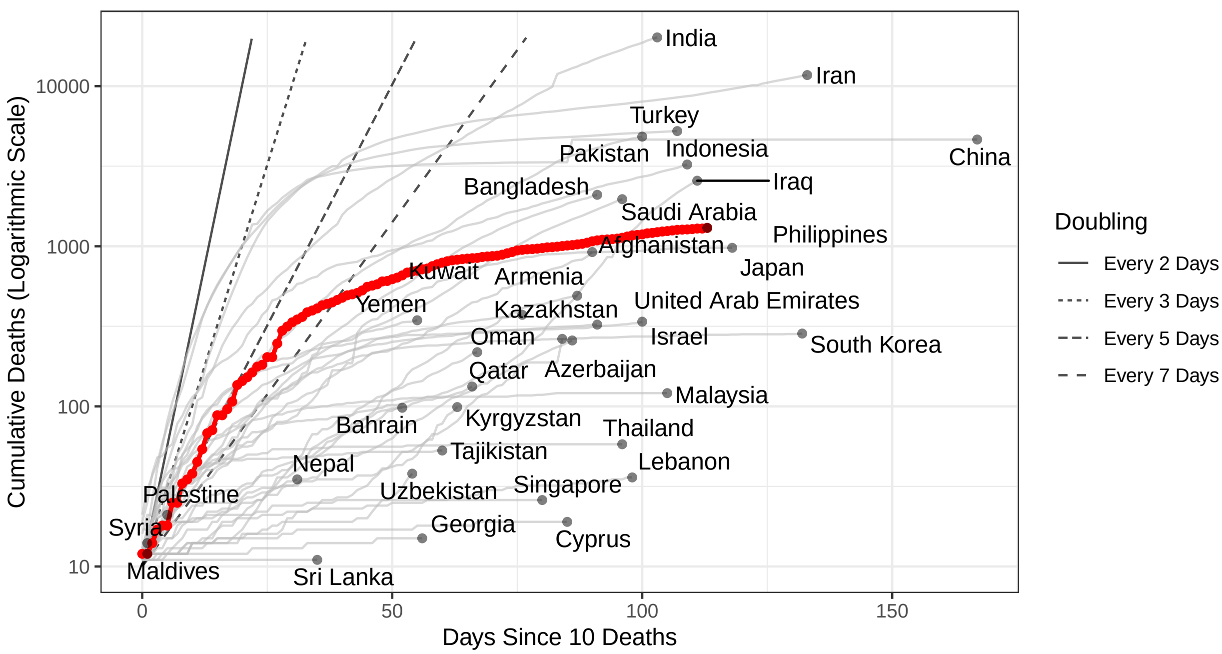

Figure 1: **Cumulative Deaths since 10 deaths.** Country not shown if fewer than 10 deaths.

COVID-19 Transmission Modelling

We assume that the deaths reported to date provide the best indication of the stage of the epidemic, as deaths are more consistently and accurately reported. Our current working estimate is that 1 death indicates that approximately 100 people will have been infected with the other 99 recovering (based on an infection fatality ratio of ~1%). These infections will have happened approximately 21 days previously – capturing a 5-day period from infection to onset of symptoms (the incubation period), 4 days from onset of symptoms to hospitalisation, and 12 days in hospital before death. With a 3-day doubling time, 100 infections that occurred 15 days ago will have generated 200 infections 12 days ago, 400 infections 9 days ago, 800 infections 6 days ago and 1,600 infections 3 days ago resulting in approximately 3,200 infections at the time the first death is observed.

To explore this, we fit our age-structured SEIR model (see Methods) to the time series of deaths in a country, in order to estimate the start date of the epidemic and the baseline R0. We assume that 100% of COVID-19 related deaths have been reported. We have also included the impact of interventions that have been put in place and their effect on human mobility and transmission based on the Google COVID-19 Community Mobility Reports. Using our mathematical model that formalises this approach, we estimate that there has been a total of 84,866 (95% CI: 79,654-90,078) infections over the past 4 weeks.

The figure below shows the estimated number of people infected over the past 4 weeks. The bar charts show, for comparison, the number of reported cases. The right-hand plot shows these data on a different scale as the estimated infections are likely to be much larger than the reported cases. **Importantly**, the estimated infections includes both asymptomatic and mild cases that would not necessarily be identified through surveillance. Consequently, the estimated infections are likely to be significantly higher than the reported cases (see our FAQ for further explanation of these differences and why the reported cases and estimated infections are unlikely to match).

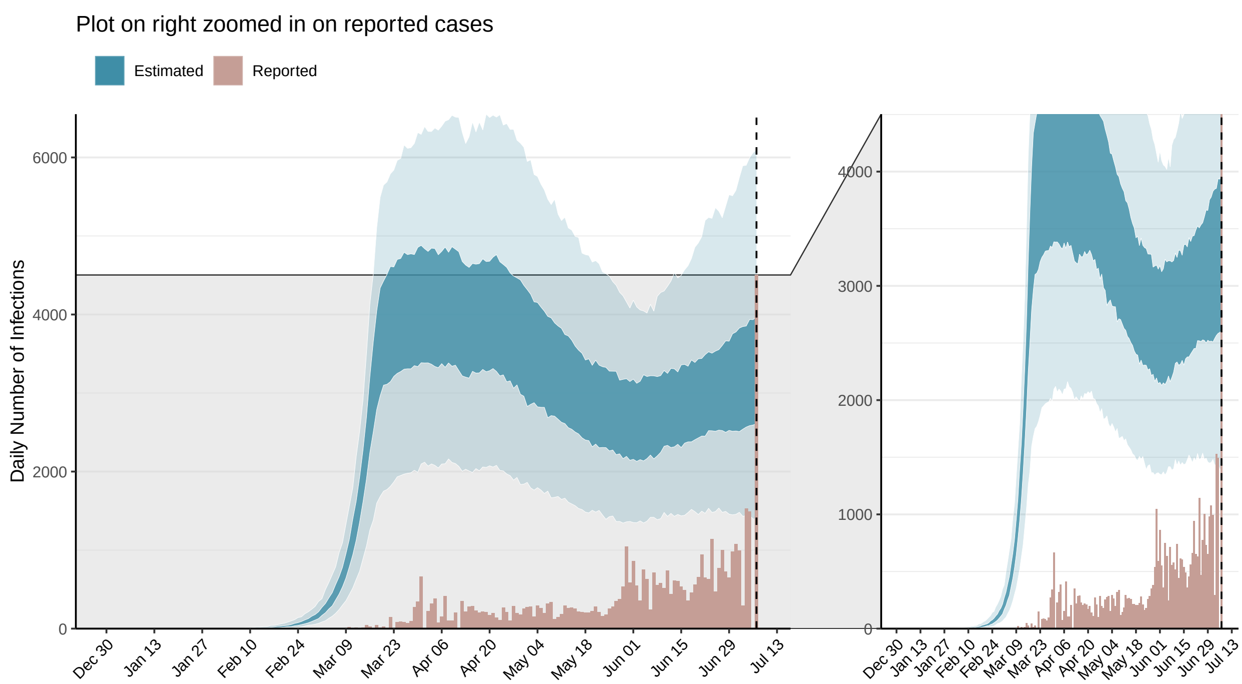

Figure 2: **Daily number of infections estimated by fitting to the current total of deaths.** Reported cases are shown in red. Model estimated infections are shown in blue (dark blue 50% interquartile range, light blue 95% quantile). The dashed line shows the current day.

By fitting to the time series of deaths, we are able to estimate a time-varying reproduction number, R_t. R_t is the the average number of secondary infections caused by a single infected person at a given time. If R_t is above 1, the rate of transmission is increasing and the number of new infections is increasing. R_t is assumed to change in relation to mobility fall in proportion. When fitting our model we assume that 100% of COVID-19 related deaths have been reported (please see our FAQ section for more information about this assumption). We also assume a fixed date at which the impact of mobility on transmission changes from pre-lockdown levels to post-lockdown levels, which may cause large changes in Rt. We are working to refine how this switch occurs and to formally calculate its shape.

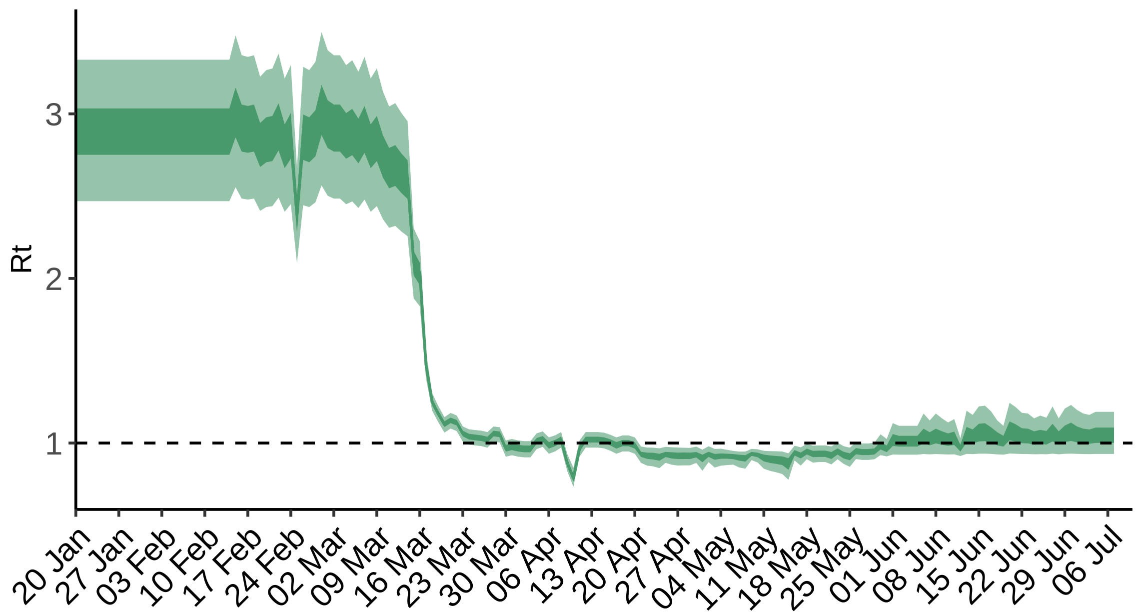

Figure 3: **Time-varying reproduction number, R_t.** R_t is the average number of secondary infections caused by a single infected person at time equal to t. $R_t < 1$ indicates a slowing epidemic in which new infections are not increasing. $R_t > 1$ indicates a growing epidemic in which new infections are increasing over time. Dark green shows the 50% CI and light green shows the 95% CI.

Using the model fit, we can forecast the expected trajectory for cumulative deaths, which is shown in the figure below. This assumes a severity pattern by age that is consistent with that observed in China, Europe and the U.S to date. This projection assumes that transmission is maintained at the current level of transmission as estimated by the final R_t value.

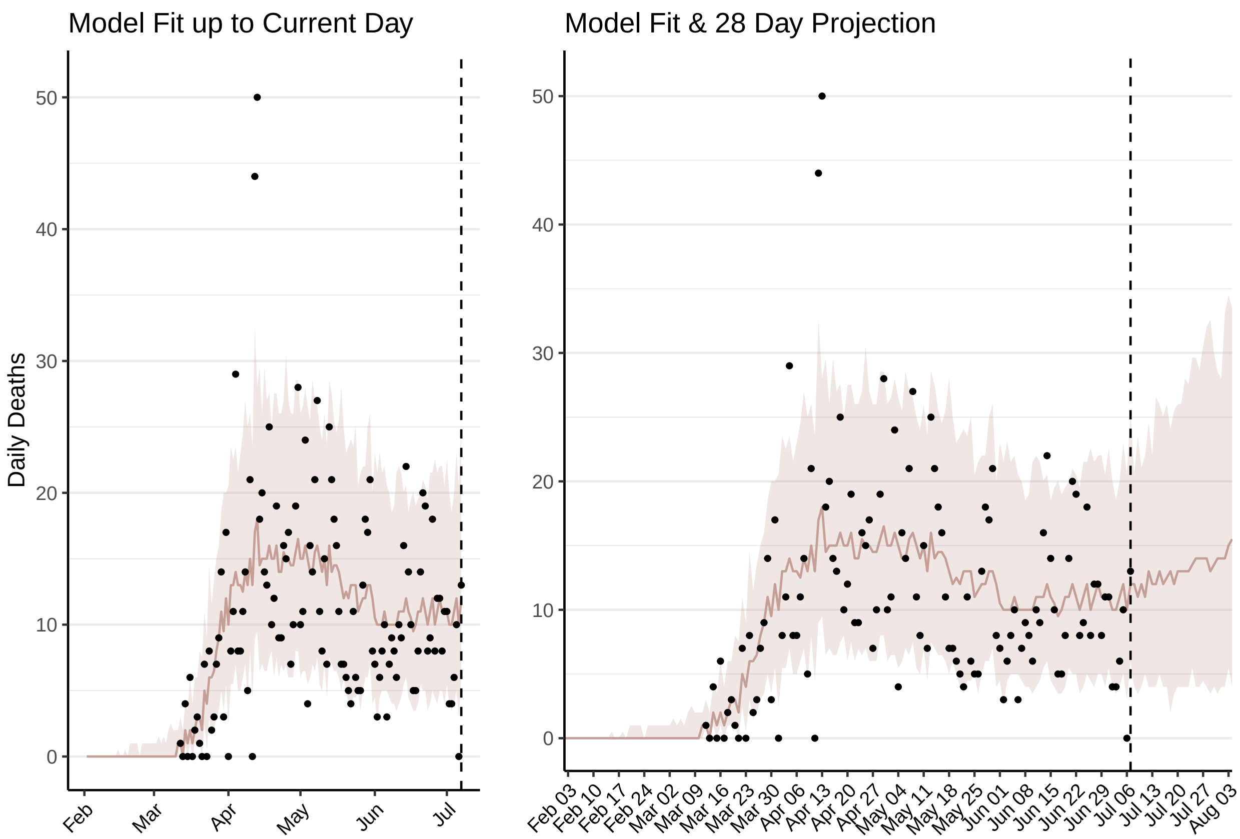

Figure 4: **Estimated daily deaths.** Projected deaths assuming the current level of interventions are maintained are shown in red (median and 95% quantile). Reported deaths are plotted in black. The plot on the left is focussed on the model fit prior to today, while the plot on the right forecasts the next 28 days.

Short-term Epidemic Scenarios

We make the following short-term projections of healthcare demand and new infections under the following three scenarios:

- **Scenario 1.** The epidemic continues to grow at the current rate.
- **Scenario 2.** Countries will further scale up interventions (either increasing current strategies or implementing new interventions) leading to a further 50% reduction in transmission.
- **Scenario 3.** Countries will relax current interventions by 50%

N.B. These scenarios currently assume that the impact of mobility on transmission will remain the same in the future as it has in the past. We are working to extend methods to estimate the impact of increases in mobility on transmission as lockdown and interventions are reversed. Consequently, projection are likely to represent an upper estimate of the healthcare demand and case load for each scenario

We estimate that over the next 4 weeks demand for hospital beds will change from 668 (95% CI: 627-710) patients requiring treatment with high-pressure oxygen at the current date to 883 (95% CI: 797-969) hospital beds being required on 2020-08-04 if no further interventions are introduced (Scenario 1). Similarly, we estimate that over the next 4 weeks demand for critical care (ICU) beds will change from 175 (95% CI: 163-187) patients requiring treatment with mechanical ventilation at the current date to 234 (95% CI: 211-256) by 2020-08-04. These projections assume that approximately 5% of all infections will require treatment with high-pressure oxygen and that approximately 30% of hospitalised cases will require treatment with mechanical ventilation (based on analysis of ongoing epidemics in Europe). **N.B. These scenarios are unlikely to show significant differences for the first week since there is a delay of approximately 10 days between infection and hospital admission. Consequently, the effectiveness of a change in policy is likely to be better captured by hospital admission data approximately 2 weeks after the policy change is implemented.**

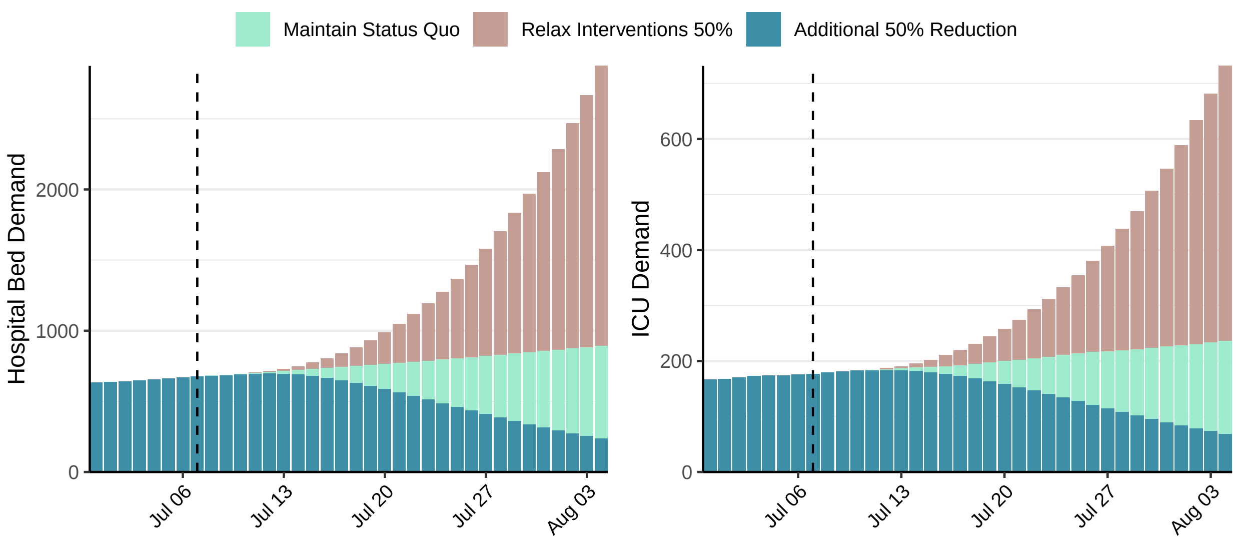

Figure 5: **Healthcare demands in the next 28 days.** Individuals needing an ICU bed are assumed to need mechanical ventilation. Projected demand for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

The impact of each scenario has a more immediate effect on the daily number of infections. The figure below shows the impact of each scenario on the estimated daily incidence of new infections. If interventions are scaled up (Scenario 2), the daily number of infections will change from 3,411 (95% CI: 3,162-3,660) at the current date to 372 (95% CI: 333-412) by 2020-08-04. If current interventions were relaxed by 50%, we estimate the daily number of infections will change from 3,411 (95% CI: 3,162-3,660) at the current date to 27,958 (95% CI: 24,492-31,424) by 2020-08-04.

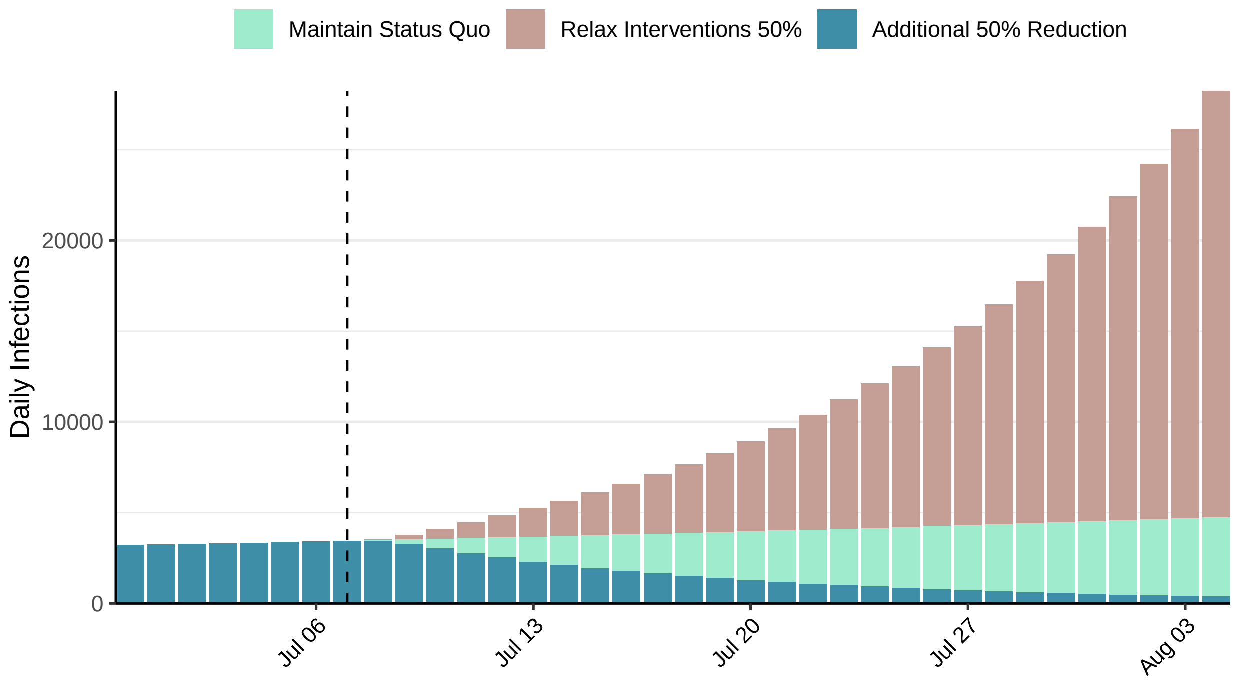

Figure 6: **Daily number of infections estimated by fitting to deaths.** Projected infections for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

To explore different scenarios, we recommend using our COVID-19 Scenario Analysis Tool - https://covidsim.org/, which can be used to simulate different intervention scenarios and explore the long term impact on healthcare demand.

Situation Report for COVID-19: Paraguay, 2020-07-07

Download the report for Paraguay, 2020-07-07 here. This report uses data from the European Centre for Disease Control. These data are updated daily and whilst there may be a short delay, they are generally consistent with Ministry reports. These data are then used to back-calculate an 'inferred number of COVID-19 infections' using mathematical modelling techniques (see Report 12 for further details) to estimate the number of people that have been infected and to make short-term projections for future healthcare needs.

Epidemiological Situation

Total Reported Cases	New Reported Cases	Total Reported Deaths	New Reported Deaths	Estimated R_t
2,456	29	20	0	1.58 (95% CI: 1.37-1.78)

The figure below shows the cumulative reported deaths as a function of the time since the 10th death was reported. Dashed lines show the expected trajectory for different doubling times of the epidemic. For example, with a doubling time of 3 days, if there are currently a total of 20 deaths reported, we would expect there to be 40 deaths in total reported in 3 days-time, 80 deaths in 6 days-time, 160 deaths in 9 days-time etc. For most epidemics, in the absence of interventions, we expect a doubling time of 3-4 days for this disease.

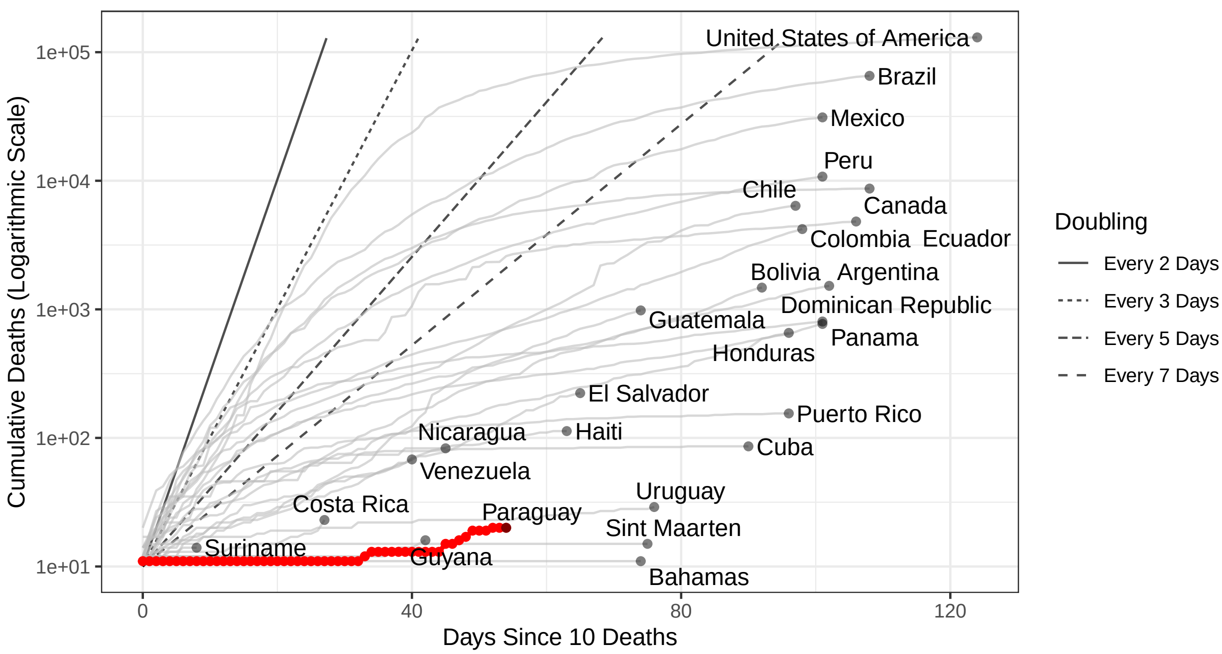

Figure 1: **Cumulative Deaths since 10 deaths.** Country not shown if fewer than 10 deaths.

COVID-19 Transmission Modelling

We assume that the deaths reported to date provide the best indication of the stage of the epidemic, as deaths are more consistently and accurately reported. Our current working estimate is that 1 death indicates that approximately 100 people will have been infected with the other 99 recovering (based on an infection fatality ratio of ~1%). These infections will have happened approximately 21 days previously – capturing a 5-day period from infection to onset of symptoms (the incubation period), 4 days from onset of symptoms to hospitalisation, and 12 days in hospital before death. With a 3-day doubling time, 100 infections that occurred 15 days ago will have generated 200 infections 12 days ago, 400 infections 9 days ago, 800 infections 6 days ago and 1,600 infections 3 days ago resulting in approximately 3,200 infections at the time the first death is observed.

To explore this, we fit our age-structured SEIR model (see Methods) to the time series of deaths in a country, in order to estimate the start date of the epidemic and the baseline R0. We assume that 100% of COVID-19 related deaths have been reported. We have also included the impact of interventions that have been put in place and their effect on human mobility and transmission based on the Google COVID-19 Community Mobility Reports. Using our mathematical model that formalises this approach, we estimate that there has been a total of 8,368 (95% CI: 7,195-9,541) infections over the past 4 weeks.

The figure below shows the estimated number of people infected over the past 4 weeks. The bar charts show, for comparison, the number of reported cases. The right-hand plot shows these data on a different scale as the estimated infections are likely to be much larger than the reported cases. **Importantly**, the estimated infections includes both asymptomatic and mild cases that would not necessarily be identified through surveillance. Consequently, the estimated infections are likely to be significantly higher than the reported cases (see our FAQ for further explanation of these differences and why the reported cases and estimated infections are unlikely to match).

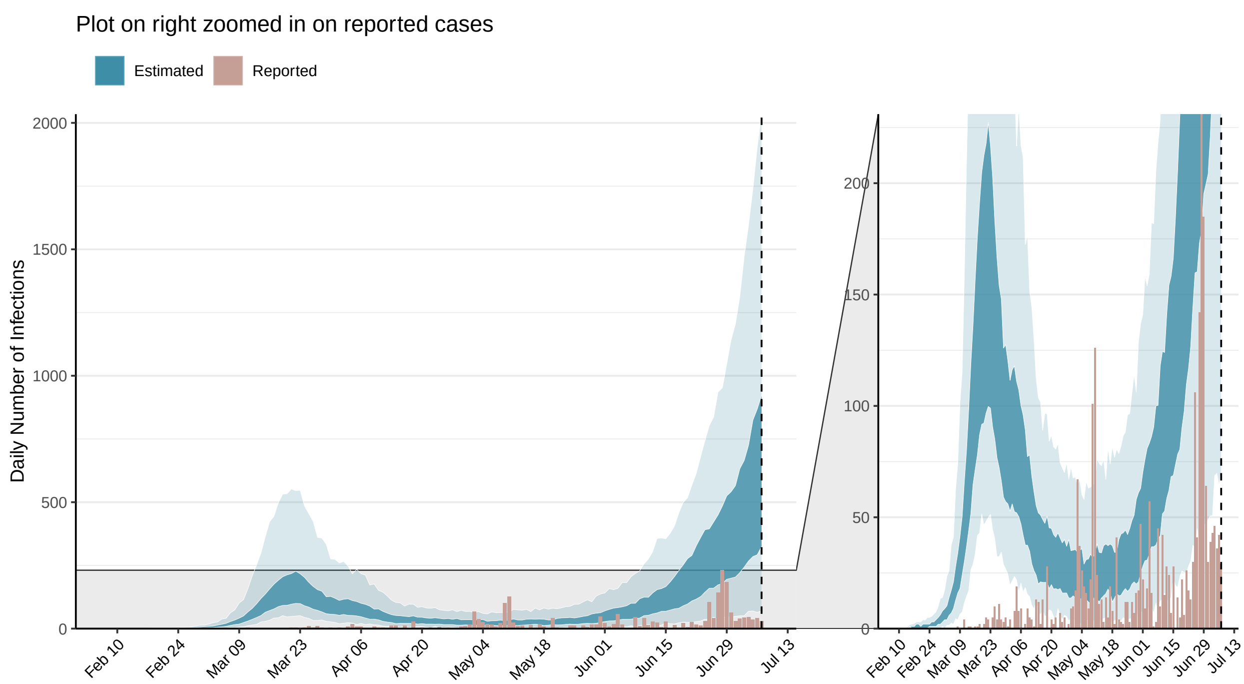

Figure 2: **Daily number of infections estimated by fitting to the current total of deaths.** Reported cases are shown in red. Model estimated infections are shown in blue (dark blue 50% interquartile range, light blue 95% quantile). The dashed line shows the current day.

By fitting to the time series of deaths, we are able to estimate a time-varying reproduction number, R_t. R_t is the the average number of secondary infections caused by a single infected person at a given time. If R_t is above 1, the rate of transmission is increasing and the number of new infections is increasing. R_t is assumed to change in relation to mobility fall in proportion. When fitting our model we assume that 100% of COVID-19 related deaths have been reported (please see our FAQ section for more information about this assumption). We also assume a fixed date at which the impact of mobility on transmission changes from pre-lockdown levels to post-lockdown levels, which may cause large changes in Rt. We are working to refine how this switch occurs and to formally calculate its shape.

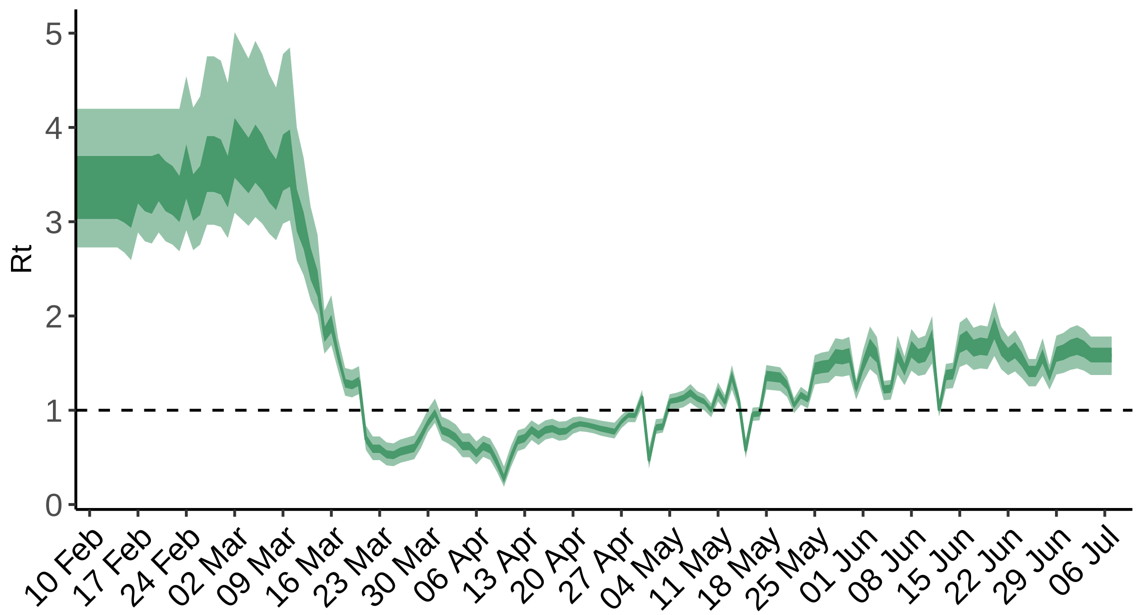

Figure 3: **Time-varying reproduction number, R_t.** R_t is the average number of secondary infections caused by a single infected person at time equal to t. $R_t < 1$ indicates a slowing epidemic in which new infections are not increasing. $R_t > 1$ indicates a growing epidemic in which new infections are increasing over time. Dark green shows the 50% CI and light green shows the 95% CI.

Using the model fit, we can forecast the expected trajectory for cumulative deaths, which is shown in the figure below. This assumes a severity pattern by age that is consistent with that observed in China, Europe and the U.S to date. This projection assumes that transmission is maintained at the current level of transmission as estimated by the final R_t value.

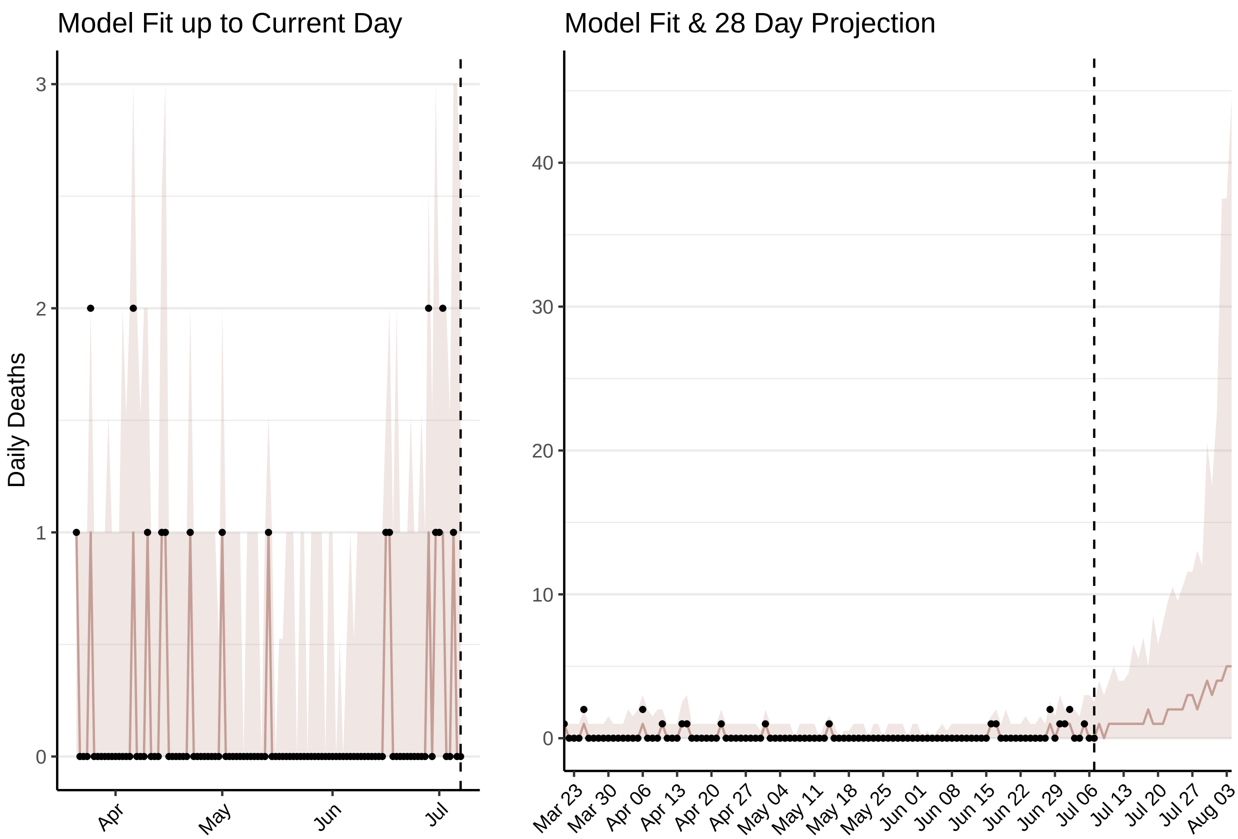

Figure 4: **Estimated daily deaths.** Projected deaths assuming the current level of interventions are maintained are shown in red (median and 95% quantile). Reported deaths are plotted in black. The plot on the left is focussed on the model fit prior to today, while the plot on the right forecasts the next 28 days.

Short-term Epidemic Scenarios

We make the following short-term projections of healthcare demand and new infections under the following three scenarios:

- **Scenario 1.** The epidemic continues to grow at the current rate.
- **Scenario 2.** Countries will further scale up interventions (either increasing current strategies or implementing new interventions) leading to a further 50% reduction in transmission.
- **Scenario 3.** Countries will relax current interventions by 50%

N.B. These scenarios currently assume that the impact of mobility on transmission will remain the same in the future as it has in the past. We are working to extend methods to estimate the impact of increases in mobility on transmission as lockdown and interventions are reversed. Consequently, projection are likely to represent an upper estimate of the healthcare demand and case load for each scenario

We estimate that over the next 4 weeks demand for hospital beds will change from 44 (95% CI: 38-51) patients requiring treatment with high-pressure oxygen at the current date to 391 (95% CI: 324-458) hospital beds being required on 2020-08-04 if no further interventions are introduced (Scenario 1). Similarly, we estimate that over the next 4 weeks demand for critical care (ICU) beds will change from 12 (95% CI: 10-14) patients requiring treatment with mechanical ventilation at the current date to 108 (95% CI: 91-125) by 2020-08-04. These projections assume that approximately 5% of all infections will require treatment with high-pressure oxygen and that approximately 30% of hospitalised cases will require treatment with mechanical ventilation (based on analysis of ongoing epidemics in Europe). **N.B. These scenarios are unlikely to show significant differences for the first week since there is a delay of approximately 10 days between infection and hospital admission. Consequently, the effectiveness of a change in policy is likely to be better captured by hospital admission data approximately 2 weeks after the policy change is implemented.**

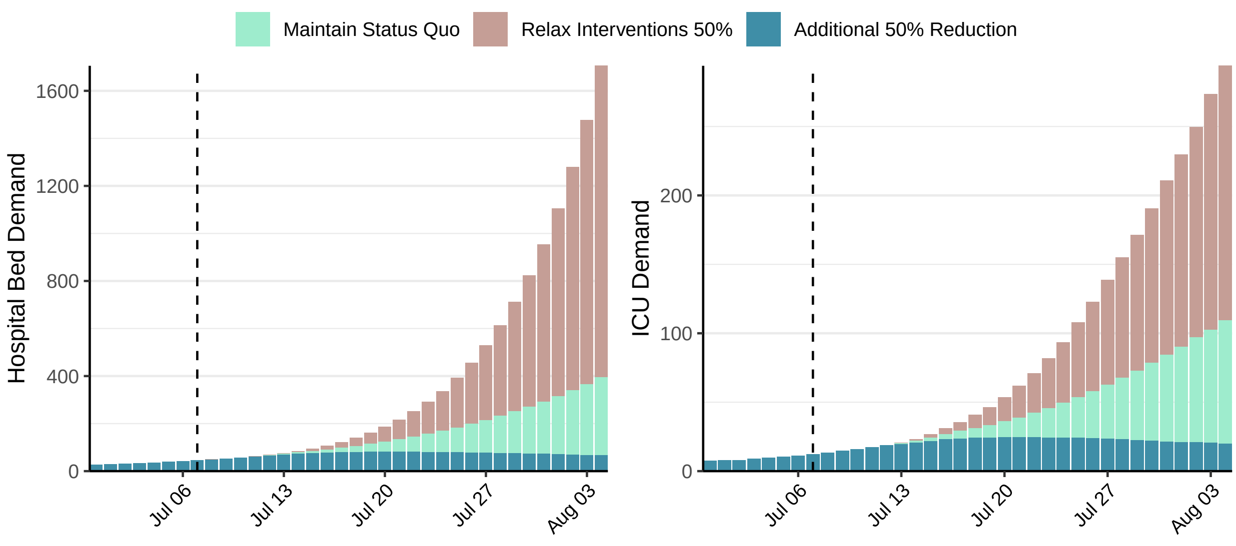

Figure 5: **Healthcare demands in the next 28 days.** Individuals needing an ICU bed are assumed to need mechanical ventilation. Projected demand for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

The impact of each scenario has a more immediate effect on the daily number of infections. The figure below shows the impact of each scenario on the estimated daily incidence of new infections. If interventions are scaled up (Scenario 2), the daily number of infections will change from 702 (95% CI: 597-807) at the current date to 344 (95% CI: 284-404) by 2020-08-04. If current interventions were relaxed by 50%, we estimate the daily number of infections will change from 702 (95% CI: 597-807) at the current date to 40,911 (95% CI: 34,223-47,599) by 2020-08-04.

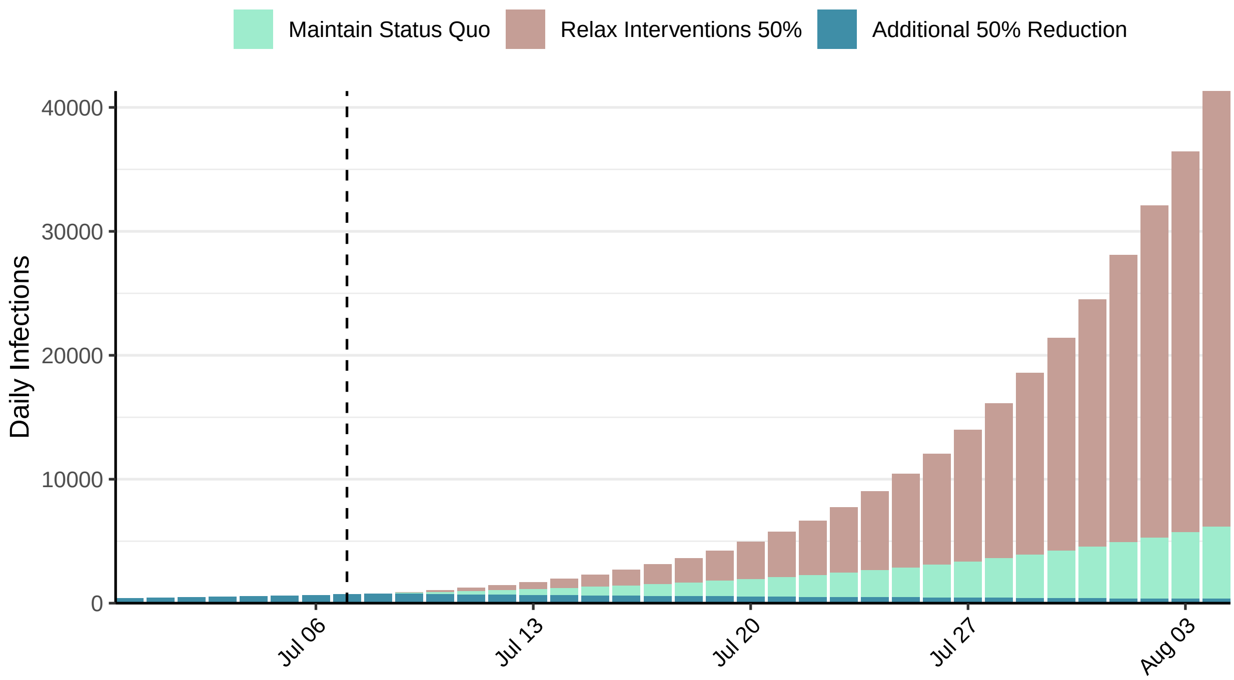

Figure 6: **Daily number of infections estimated by fitting to deaths.** Projected infections for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

To explore different scenarios, we recommend using our COVID-19 Scenario Analysis Tool - https://covidsim.org/, which can be used to simulate different intervention scenarios and explore the long term impact on healthcare demand.

Situation Report for COVID-19: State of Palestine, 2020-07-07

Download the report for State of Palestine, 2020-07-07 here. This report uses data from the European Centre for Disease Control. These data are updated daily and whilst there may be a short delay, they are generally consistent with Ministry reports. These data are then used to back-calculate an 'inferred number of COVID-19 infections' using mathematical modelling techniques (see Report 12 for further details) to estimate the number of people that have been infected and to make short-term projections for future healthcare needs.

Epidemiological Situation

Total Reported Cases	New Reported Cases	Total Reported Deaths	New Reported Deaths	Estimated R_t
4,786	328	21	1	1.6 (95% CI: 1.42-1.78)

The figure below shows the cumulative reported deaths as a function of the time since the 10th death was reported. Dashed lines show the expected trajectory for different doubling times of the epidemic. For example, with a doubling time of 3 days, if there are currently a total of 20 deaths reported, we would expect there to be 40 deaths in total reported in 3 days-time, 80 deaths in 6 days-time, 160 deaths in 9 days-time etc. For most epidemics, in the absence of interventions, we expect a doubling time of 3-4 days for this disease.

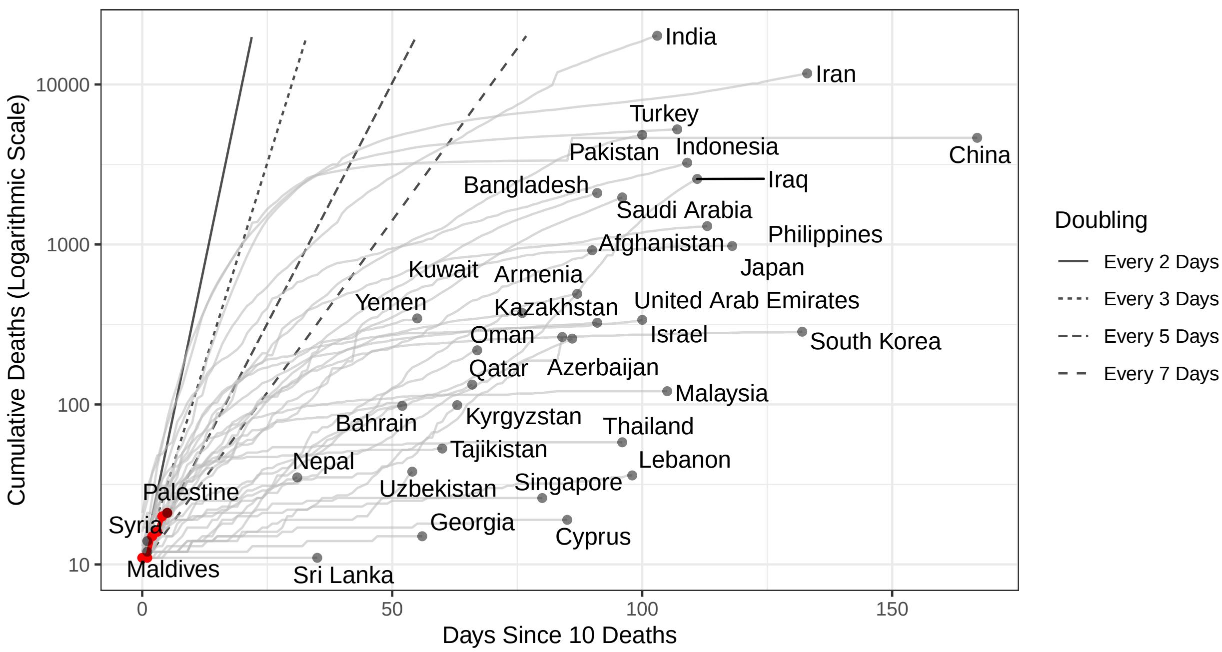

Figure 1: **Cumulative Deaths since 10 deaths.** Country not shown if fewer than 10 deaths.

COVID-19 Transmission Modelling

We assume that the deaths reported to date provide the best indication of the stage of the epidemic, as deaths are more consistently and accurately reported. Our current working estimate is that 1 death indicates that approximately 100 people will have been infected with the other 99 recovering (based on an infection fatality ratio of ~1%). These infections will have happened approximately 21 days previously – capturing a 5-day period from infection to onset of symptoms (the incubation period), 4 days from onset of symptoms to hospitalisation, and 12 days in hospital before death. With a 3-day doubling time, 100 infections that occurred 15 days ago will have generated 200 infections 12 days ago, 400 infections 9 days ago, 800 infections 6 days ago and 1,600 infections 3 days ago resulting in approximately 3,200 infections at the time the first death is observed.

To explore this, we fit our age-structured SEIR model (see Methods) to the time series of deaths in a country, in order to estimate the start date of the epidemic and the baseline R0. We assume that 100% of COVID-19 related deaths have been reported. We have also included the impact of interventions that have been put in place and their effect on human mobility and transmission based on the Google COVID-19 Community Mobility Reports. Using our mathematical model that formalises this approach, we estimate that there has been a total of 10,408 (95% CI: 8,679-12,137) infections over the past 4 weeks.

The figure below shows the estimated number of people infected over the past 4 weeks. The bar charts show, for comparison, the number of reported cases. The right-hand plot shows these data on a different scale as the estimated infections are likely to be much larger than the reported cases. **Importantly**, the estimated infections includes both asymptomatic and mild cases that would not necessarily be identified through surveillance. Consequently, the estimated infections are likely to be significantly higher than the reported cases (see our FAQ for further explanation of these differences and why the reported cases and estimated infections are unlikely to match).

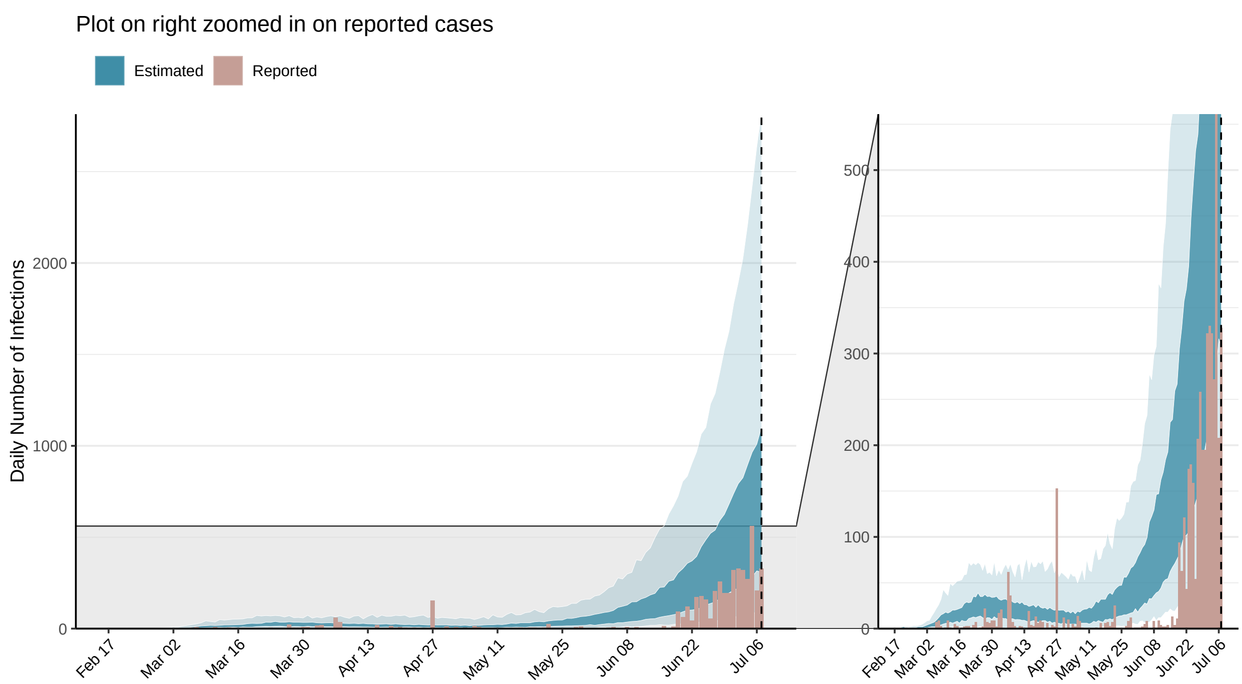

Figure 2: **Daily number of infections estimated by fitting to the current total of deaths.** Reported cases are shown in red. Model estimated infections are shown in blue (dark blue 50% interquartile range, light blue 95% quantile). The dashed line shows the current day.

By fitting to the time series of deaths, we are able to estimate a time-varying reproduction number, R_t. R_t is the the average number of secondary infections caused by a single infected person at a given time. If R_t is above 1, the rate of transmission is increasing and the number of new infections is increasing. R_t is assumed to change in relation to mobility fall in proportion. When fitting our model we assume that 100% of COVID-19 related deaths have been reported (please see our FAQ section for more information about this assumption). We also assume a fixed date at which the impact of mobility on transmission changes from pre-lockdown levels to post-lockdown levels, which may cause large changes in Rt. We are working to refine how this switch occurs and to formally calculate its shape.

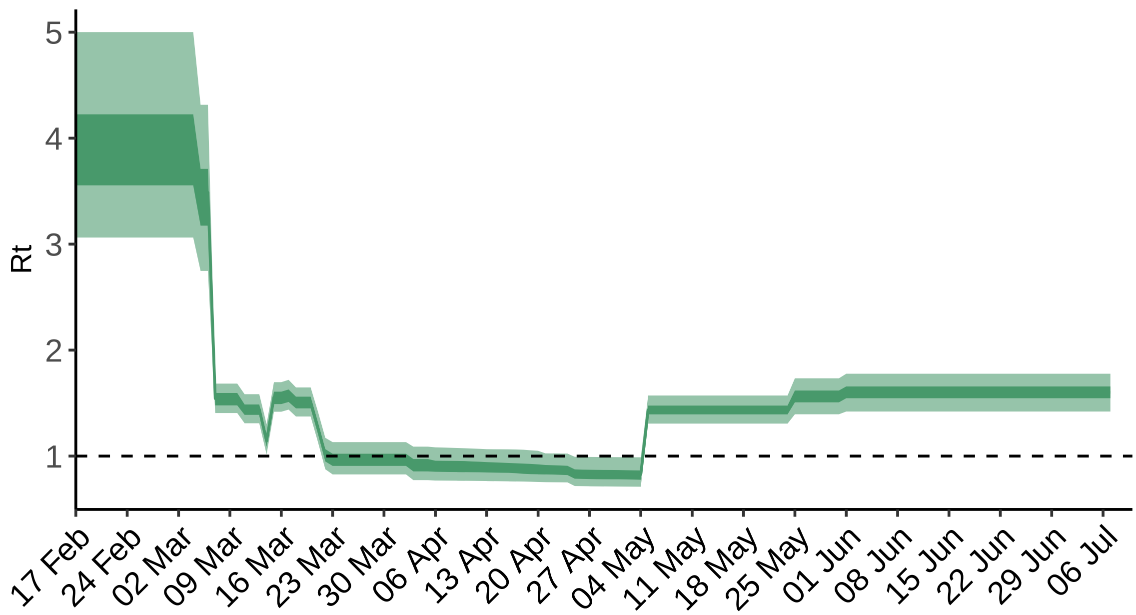

Figure 3: **Time-varying reproduction number, R_t.** R_t is the average number of secondary infections caused by a single infected person at time equal to t. $R_t < 1$ indicates a slowing epidemic in which new infections are not increasing. $R_t > 1$ indicates a growing epidemic in which new infections are increasing over time. Dark green shows the 50% CI and light green shows the 95% CI.

Using the model fit, we can forecast the expected trajectory for cumulative deaths, which is shown in the figure below. This assumes a severity pattern by age that is consistent with that observed in China, Europe and the U.S to date. This projection assumes that transmission is maintained at the current level of transmission as estimated by the final R_t value.

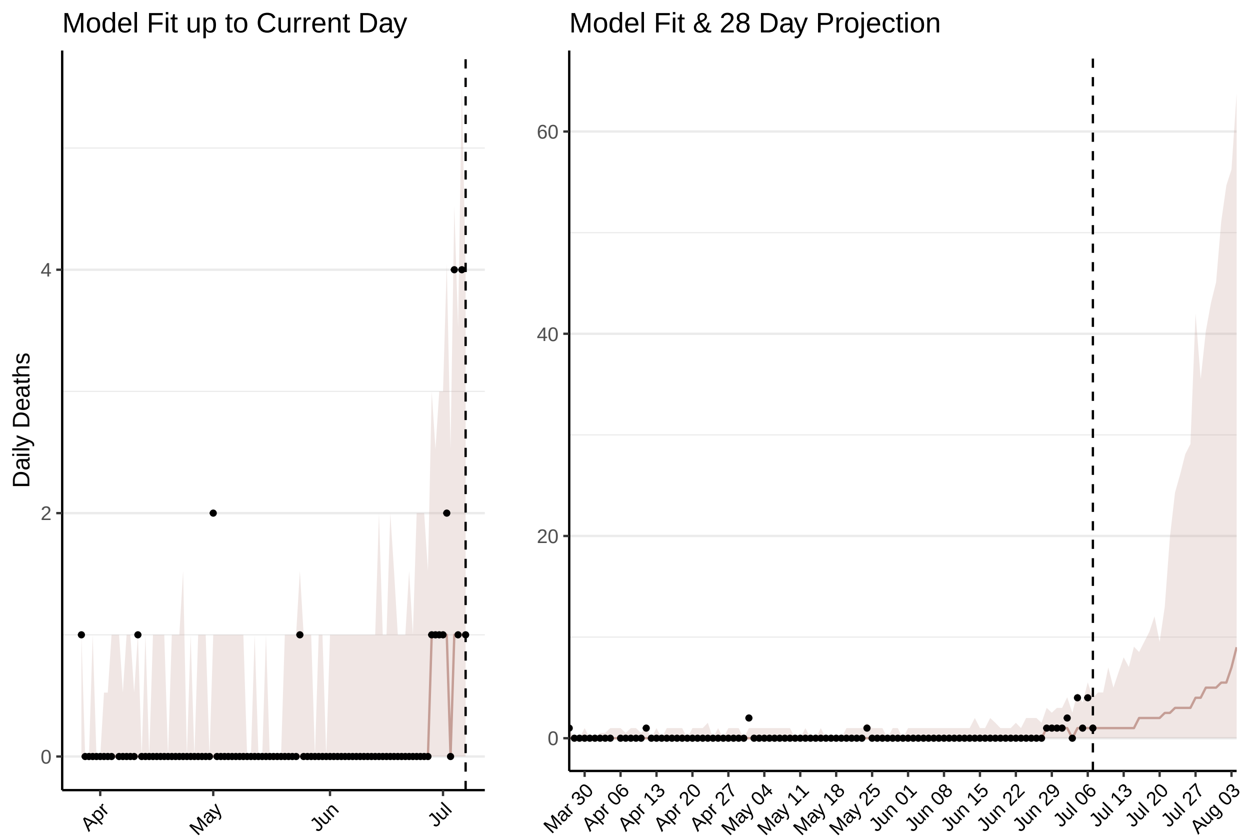

Figure 4: **Estimated daily deaths.** Projected deaths assuming the current level of interventions are maintained are shown in red (median and 95% quantile). Reported deaths are plotted in black. The plot on the left is focussed on the model fit prior to today, while the plot on the right forecasts the next 28 days.

Short-term Epidemic Scenarios

We make the following short-term projections of healthcare demand and new infections under the following three scenarios:

- **Scenario 1.** The epidemic continues to grow at the current rate.
- **Scenario 2.** Countries will further scale up interventions (either increasing current strategies or implementing new interventions) leading to a further 50% reduction in transmission.
- **Scenario 3.** Countries will relax current interventions by 50%

N.B. These scenarios currently assume that the impact of mobility on transmission will remain the same in the future as it has in the past. We are working to extend methods to estimate the impact of increases in mobility on transmission as lockdown and interventions are reversed. Consequently, projection are likely to represent an upper estimate of the healthcare demand and case load for each scenario

We estimate that over the next 4 weeks demand for hospital beds will change from 79 (95% CI: 66-92) patients requiring treatment with high-pressure oxygen at the current date to 639 (95% CI: 534-745) hospital beds being required on 2020-08-04 if no further interventions are introduced (Scenario 1). Similarly, we estimate that over the next 4 weeks demand for critical care (ICU) beds will change from 18 (95% CI: 15-21) patients requiring treatment with mechanical ventilation at the current date to 125 (95% CI: 111-140) by 2020-08-04. These projections assume that approximately 5% of all infections will require treatment with high-pressure oxygen and that approximately 30% of hospitalised cases will require treatment with mechanical ventilation (based on analysis of ongoing epidemics in Europe). **N.B. These scenarios are unlikely to show significant differences for the first week since there is a delay of approximately 10 days between infection and hospital admission. Consequently, the effectiveness of a change in policy is likely to be better captured by hospital admission data approximately 2 weeks after the policy change is implemented.**

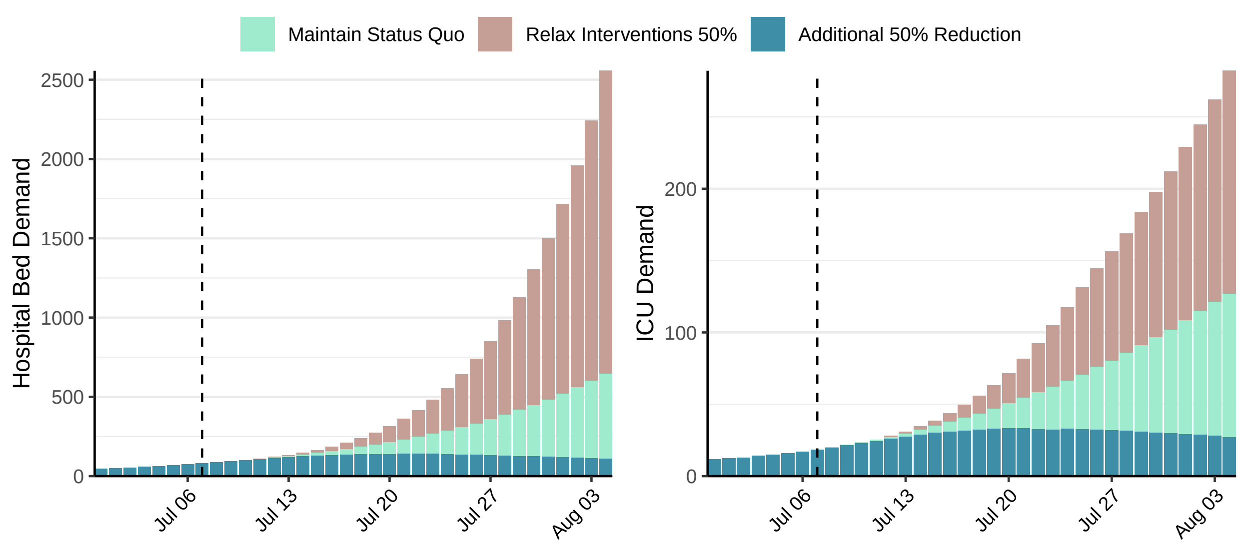

Figure 5: **Healthcare demands in the next 28 days.** Individuals needing an ICU bed are assumed to need mechanical ventilation. Projected demand for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

The impact of each scenario has a more immediate effect on the daily number of infections. The figure below shows the impact of each scenario on the estimated daily incidence of new infections. If interventions are scaled up (Scenario 2), the daily number of infections will change from 860 (95% CI: 718-1,001) at the current date to 400 (95% CI: 332-468) by 2020-08-04. If current interventions were relaxed by 50%, we estimate the daily number of infections will change from 860 (95% CI: 718-1,001) at the current date to 42,706 (95% CI: 36,806-48,606) by 2020-08-04.

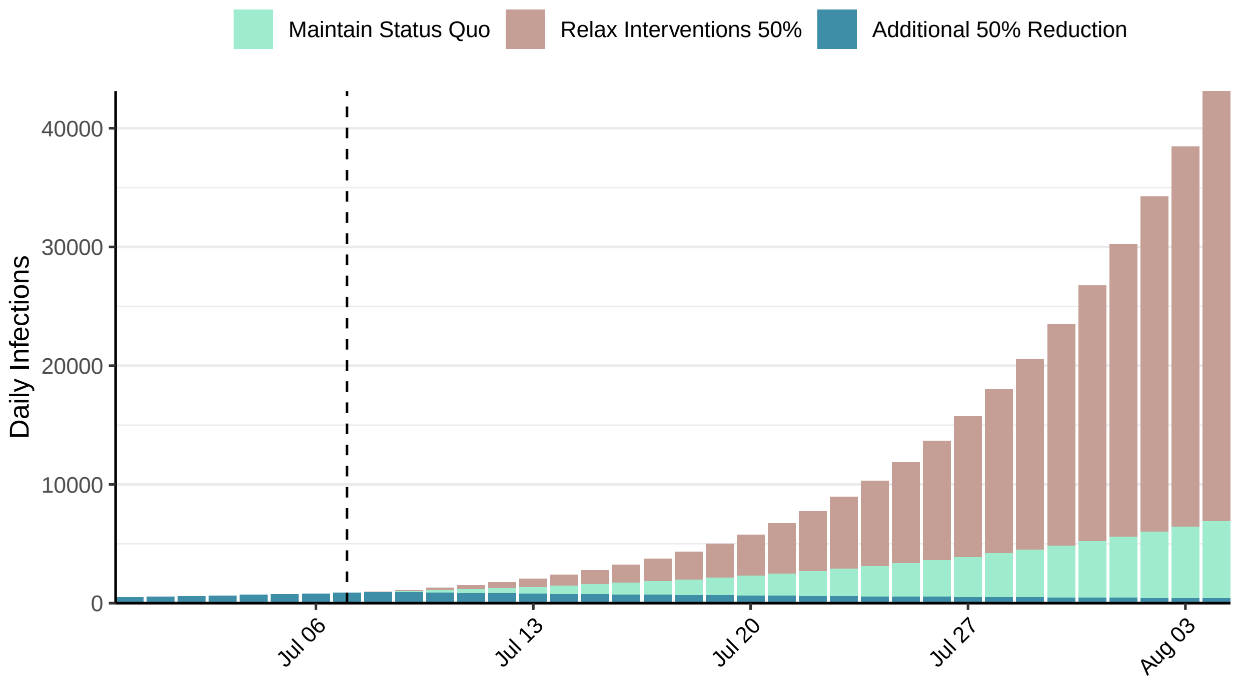

Figure 6: **Daily number of infections estimated by fitting to deaths.** Projected infections for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

To explore different scenarios, we recommend using our COVID-19 Scenario Analysis Tool - https://covidsim.org/, which can be used to simulate different intervention scenarios and explore the long term impact on healthcare demand.

Situation Report for COVID-19: Romania, 2020-07-07

Download the report for Romania, 2020-07-07 here. This report uses data from the European Centre for Disease Control. These data are updated daily and whilst there may be a short delay, they are generally consistent with Ministry reports. These data are then used to back-calculate an 'inferred number of COVID-19 infections' using mathematical modelling techniques (see Report 12 for further details) to estimate the number of people that have been infected and to make short-term projections for future healthcare needs.

Epidemiological Situation

Total Reported Cases	New Reported Cases	Total Reported Deaths	New Reported Deaths	Estimated R_t
29,223	250	1,768	18	1.33 (95% CI: 1.18-1.46)

The figure below shows the cumulative reported deaths as a function of the time since the 10th death was reported. Dashed lines show the expected trajectory for different doubling times of the epidemic. For example, with a doubling time of 3 days, if there are currently a total of 20 deaths reported, we would expect there to be 40 deaths in total reported in 3 days-time, 80 deaths in 6 days-time, 160 deaths in 9 days-time etc. For most epidemics, in the absence of interventions, we expect a doubling time of 3-4 days for this disease.

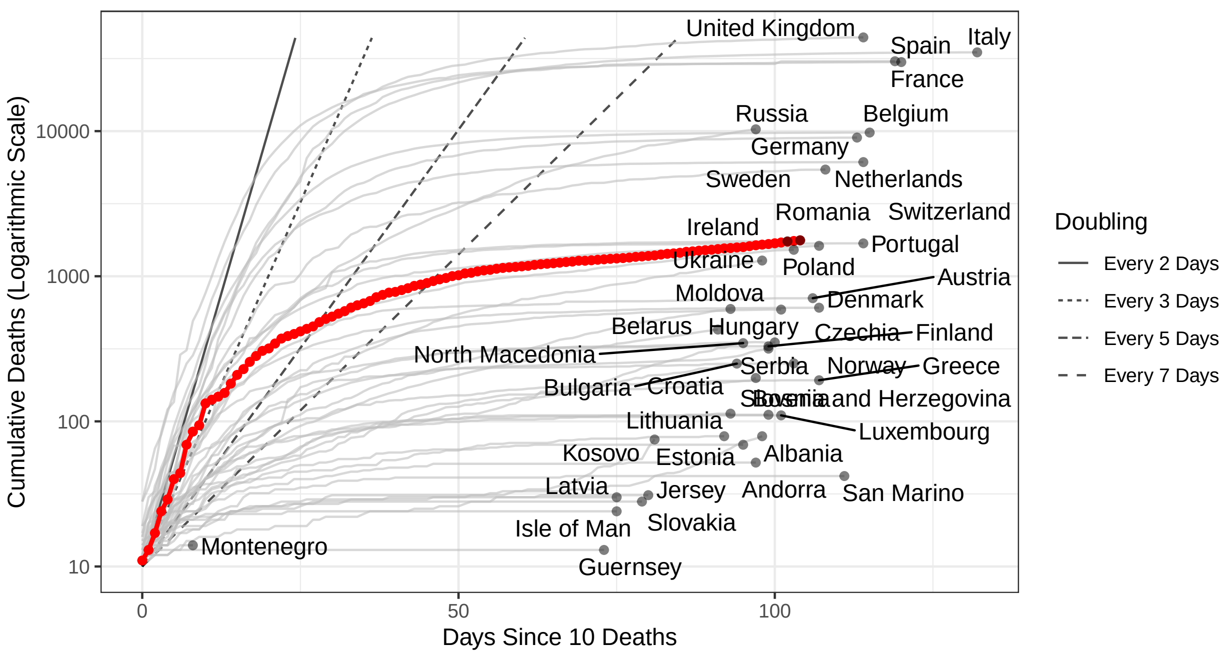

Figure 1: **Cumulative Deaths since 10 deaths.** Country not shown if fewer than 10 deaths.

COVID-19 Transmission Modelling

We assume that the deaths reported to date provide the best indication of the stage of the epidemic, as deaths are more consistently and accurately reported. Our current working estimate is that 1 death indicates that approximately 100 people will have been infected with the other 99 recovering (based on an infection fatality ratio of ~1%). These infections will have happened approximately 21 days previously – capturing a 5-day period from infection to onset of symptoms (the incubation period), 4 days from onset of symptoms to hospitalisation, and 12 days in hospital before death. With a 3-day doubling time, 100 infections that occurred 15 days ago will have generated 200 infections 12 days ago, 400 infections 9 days ago, 800 infections 6 days ago and 1,600 infections 3 days ago resulting in approximately 3,200 infections at the time the first death is observed.

To explore this, we fit our age-structured SEIR model (see Methods) to the time series of deaths in a country, in order to estimate the start date of the epidemic and the baseline R0. We assume that 100% of COVID-19 related deaths have been reported. We have also included the impact of interventions that have been put in place and their effect on human mobility and transmission based on the Google COVID-19 Community Mobility Reports. Using our mathematical model that formalises this approach, we estimate that there has been a total of 158,312 (95% CI: 151,512-165,113) infections over the past 4 weeks.

The figure below shows the estimated number of people infected over the past 4 weeks. The bar charts show, for comparison, the number of reported cases. The right-hand plot shows these data on a different scale as the estimated infections are likely to be much larger than the reported cases. **Importantly**, the estimated infections includes both asymptomatic and mild cases that would not necessarily be identified through surveillance. Consequently, the estimated infections are likely to be significantly higher than the reported cases (see our FAQ for further explanation of these differences and why the reported cases and estimated infections are unlikely to match).

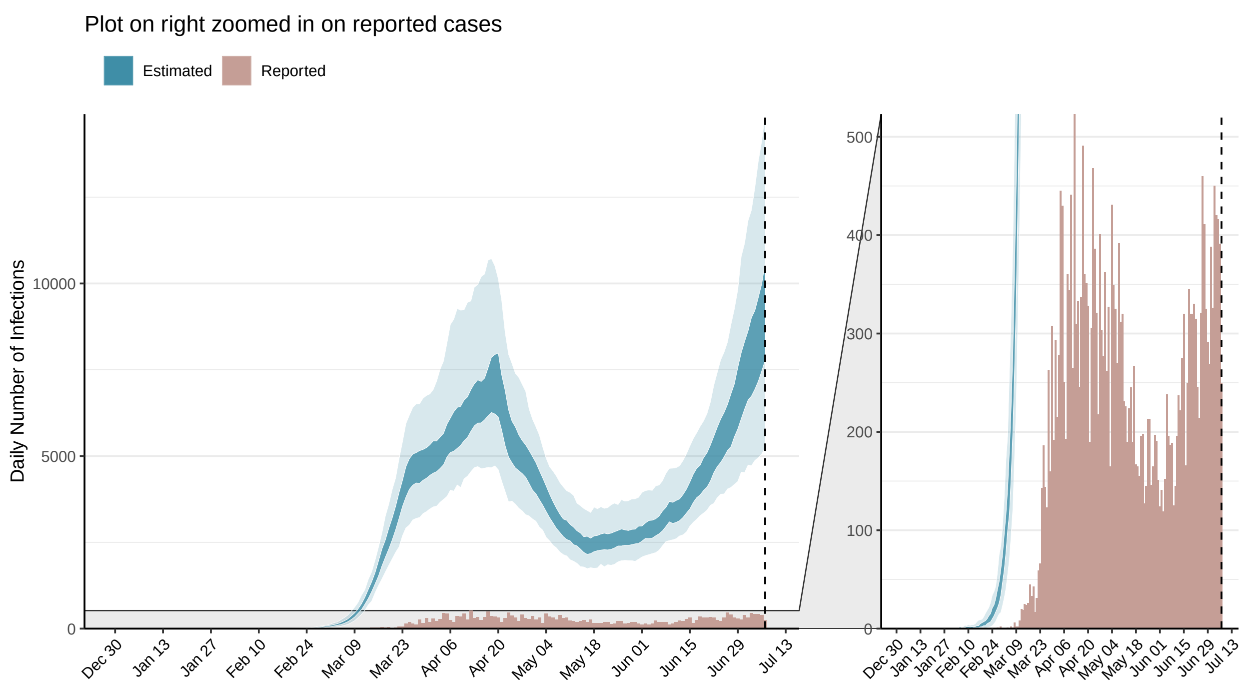

Figure 2: **Daily number of infections estimated by fitting to the current total of deaths.** Reported cases are shown in red. Model estimated infections are shown in blue (dark blue 50% interquartile range, light blue 95% quantile). The dashed line shows the current day.

By fitting to the time series of deaths, we are able to estimate a time-varying reproduction number, R_t. R_t is the the average number of secondary infections caused by a single infected person at a given time. If R_t is above 1, the rate of transmission is increasing and the number of new infections is increasing. R_t is assumed to change in relation to mobility fall in proportion. When fitting our model we assume that 100% of COVID-19 related deaths have been reported (please see our FAQ section for more information about this assumption). We also assume a fixed date at which the impact of mobility on transmission changes from pre-lockdown levels to post-lockdown levels, which may cause large changes in Rt. We are working to refine how this switch occurs and to formally calculate its shape.

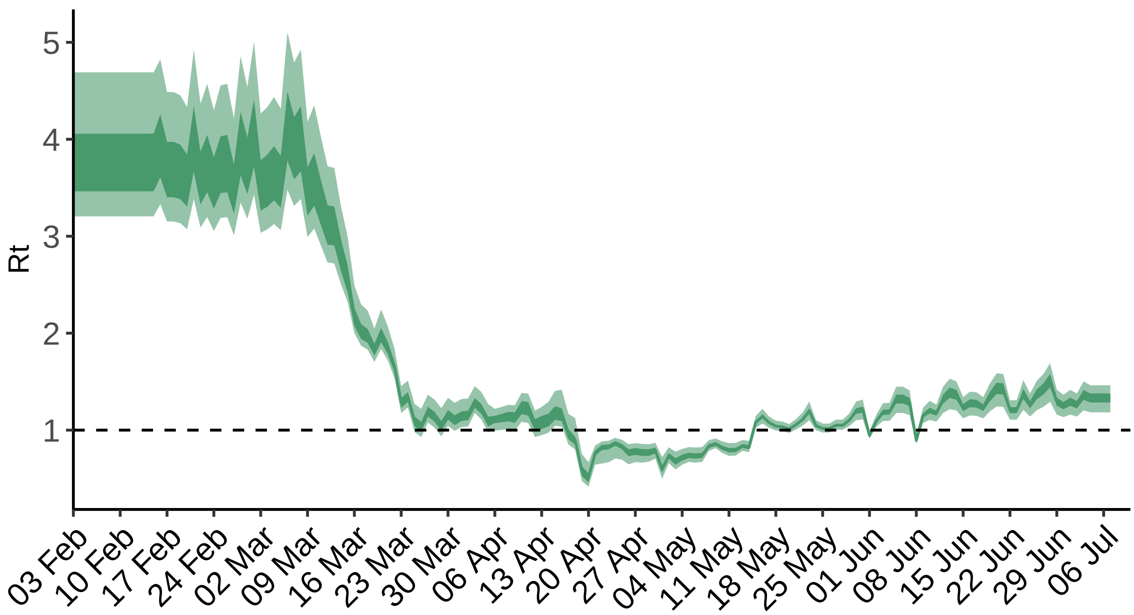

Figure 3: **Time-varying reproduction number, R_t.** R_t is the average number of secondary infections caused by a single infected person at time equal to t. $R_t < 1$ indicates a slowing epidemic in which new infections are not increasing. $R_t > 1$ indicates a growing epidemic in which new infections are increasing over time. Dark green shows the 50% CI and light green shows the 95% CI.

Using the model fit, we can forecast the expected trajectory for cumulative deaths, which is shown in the figure below. This assumes a severity pattern by age that is consistent with that observed in China, Europe and the U.S to date. This projection assumes that transmission is maintained at the current level of transmission as estimated by the final R_t value.

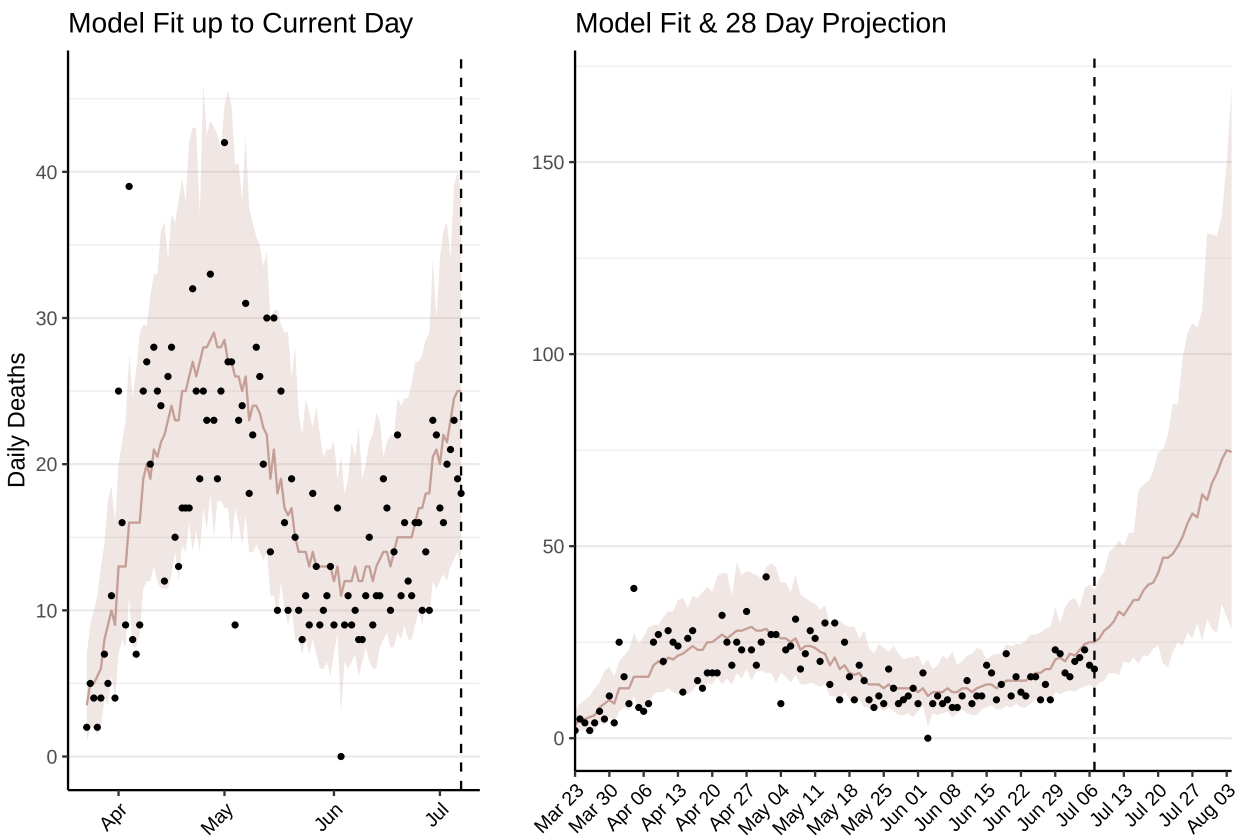

Figure 4: **Estimated daily deaths.** Projected deaths assuming the current level of interventions are maintained are shown in red (median and 95% quantile). Reported deaths are plotted in black. The plot on the left is focussed on the model fit prior to today, while the plot on the right forecasts the next 28 days.

Short-term Epidemic Scenarios

We make the following short-term projections of healthcare demand and new infections under the following three scenarios:

- **Scenario 1.** The epidemic continues to grow at the current rate.
- **Scenario 2.** Countries will further scale up interventions (either increasing current strategies or implementing new interventions) leading to a further 50% reduction in transmission.
- **Scenario 3.** Countries will relax current interventions by 50%

N.B. These scenarios currently assume that the impact of mobility on transmission will remain the same in the future as it has in the past. We are working to extend methods to estimate the impact of increases in mobility on transmission as lockdown and interventions are reversed. Consequently, projection are likely to represent an upper estimate of the healthcare demand and case load for each scenario

We estimate that over the next 4 weeks demand for hospital beds will change from 1,342 (95% CI: 1,282-1,402) patients requiring treatment with high-pressure oxygen at the current date to 4,033 (95% CI: 3,717-4,349) hospital beds being required on 2020-08-04 if no further interventions are introduced (Scenario 1). Similarly, we estimate that over the next 4 weeks demand for critical care (ICU) beds will change from 415 (95% CI: 396-433) patients requiring treatment with mechanical ventilation at the current date to 1,240 (95% CI: 1,142-1,339) by 2020-08-04. These projections assume that approximately 5% of all infections will require treatment with high-pressure oxygen and that approximately 30% of hospitalised cases will require treatment with mechanical ventilation (based on analysis of ongoing epidemics in Europe). **N.B. These scenarios are unlikely to show significant differences for the first week since there is a delay of approximately 10 days between infection and hospital admission. Consequently, the effectiveness of a change in policy is likely to be better captured by hospital admission data approximately 2 weeks after the policy change is implemented.**

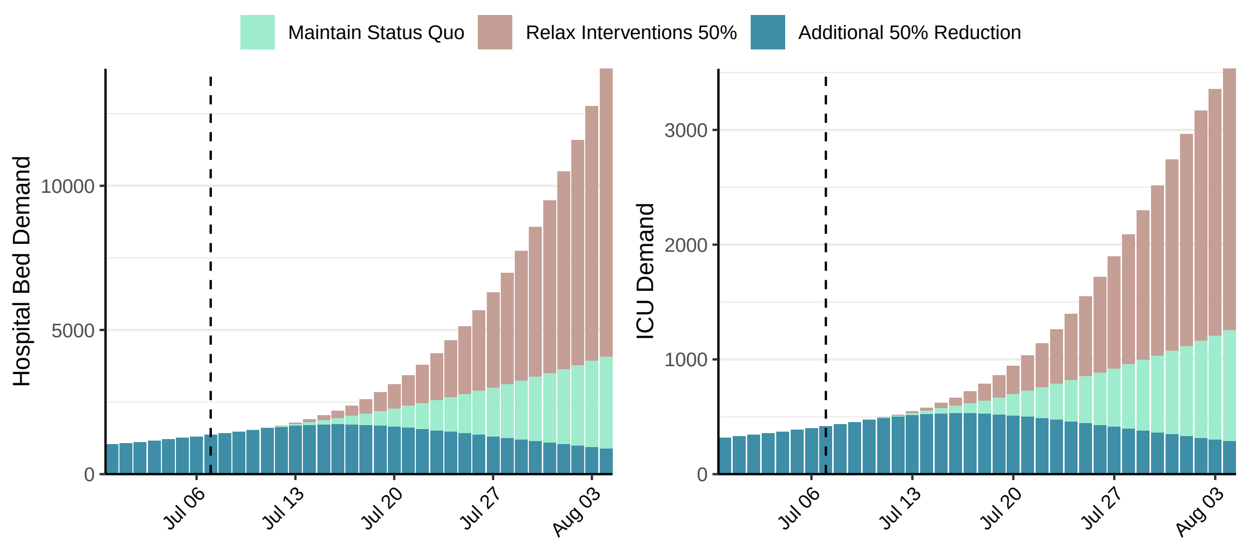

Figure 5: **Healthcare demands in the next 28 days.** Individuals needing an ICU bed are assumed to need mechanical ventilation. Projected demand for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

The impact of each scenario has a more immediate effect on the daily number of infections. The figure below shows the impact of each scenario on the estimated daily incidence of new infections. If interventions are scaled up (Scenario 2), the daily number of infections will change from 9,151 (95% CI: 8,646-9,657) at the current date to 1,873 (95% CI: 1,713-2,033) by 2020-08-04. If current interventions were relaxed by 50%, we estimate the daily number of infections will change from 9,151 (95% CI: 8,646-9,657) at the current date to 141,830 (95% CI: 130,792-152,869) by 2020-08-04.

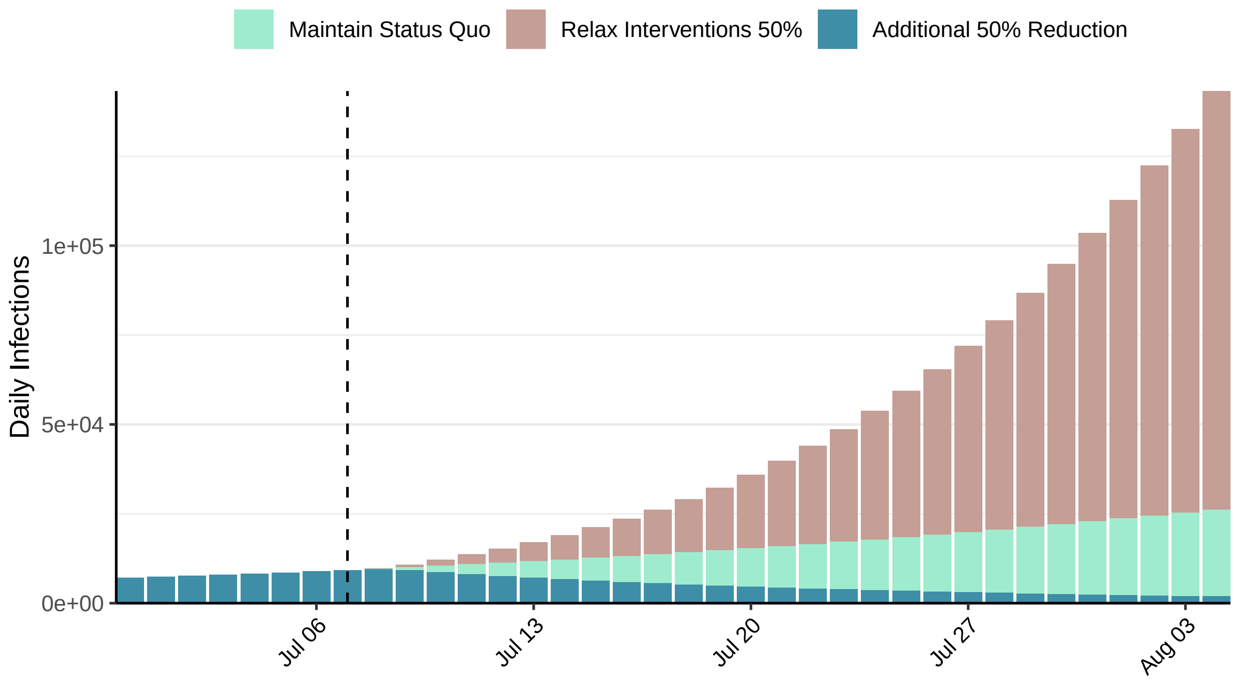

Figure 6: **Daily number of infections estimated by fitting to deaths.** Projected infections for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

To explore different scenarios, we recommend using our COVID-19 Scenario Analysis Tool - https://covidsim.org/, which can be used to simulate different intervention scenarios and explore the long term impact on healthcare demand.

Situation Report for COVID-19: Russia, 2020-07-07

Download the report for Russia, 2020-07-07 here. This report uses data from the European Centre for Disease Control. These data are updated daily and whilst there may be a short delay, they are generally consistent with Ministry reports. These data are then used to back-calculate an 'inferred number of COVID-19 infections' using mathematical modelling techniques (see Report 12 for further details) to estimate the number of people that have been infected and to make short-term projections for future healthcare needs.

Epidemiological Situation

Total Reported Cases	New Reported Cases	Total Reported Deaths	New Reported Deaths	Estimated R_t
687,862	6,611	10,296	135	1.06 (95% CI: 0.99-1.16)

The figure below shows the cumulative reported deaths as a function of the time since the 10th death was reported. Dashed lines show the expected trajectory for different doubling times of the epidemic. For example, with a doubling time of 3 days, if there are currently a total of 20 deaths reported, we would expect there to be 40 deaths in total reported in 3 days-time, 80 deaths in 6 days-time, 160 deaths in 9 days-time etc. For most epidemics, in the absence of interventions, we expect a doubling time of 3-4 days for this disease.

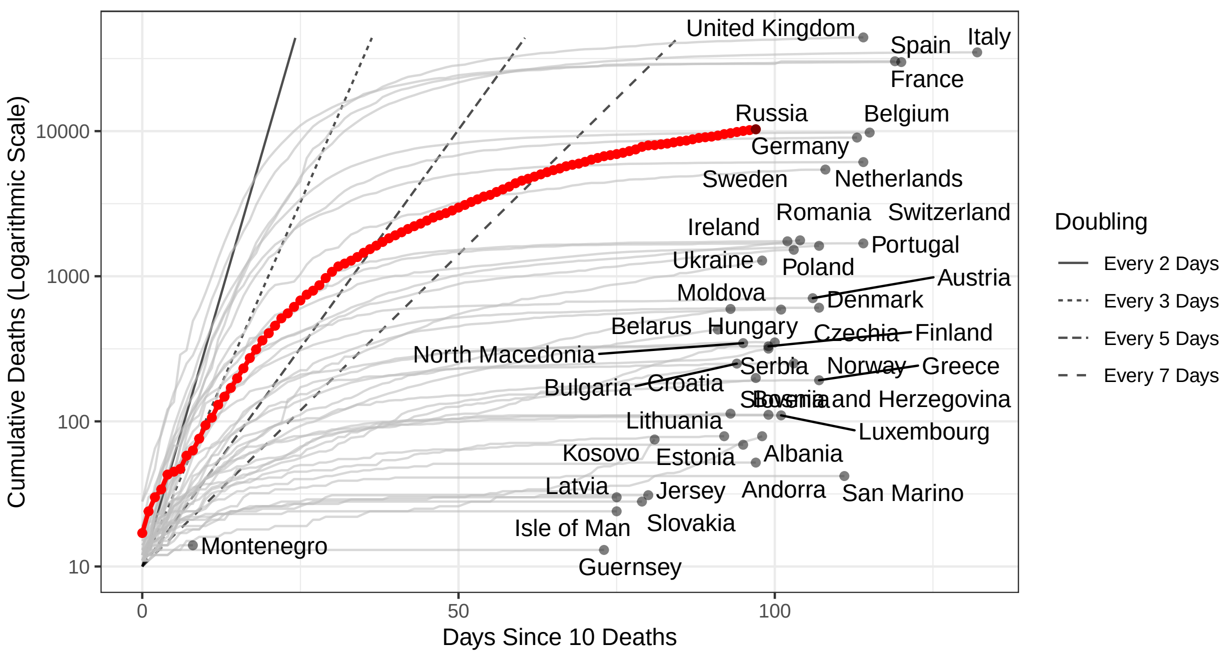

Figure 1: **Cumulative Deaths since 10 deaths.** Country not shown if fewer than 10 deaths.

COVID-19 Transmission Modelling

We assume that the deaths reported to date provide the best indication of the stage of the epidemic, as deaths are more consistently and accurately reported. Our current working estimate is that 1 death indicates that approximately 100 people will have been infected with the other 99 recovering (based on an infection fatality ratio of ~1%). These infections will have happened approximately 21 days previously – capturing a 5-day period from infection to onset of symptoms (the incubation period), 4 days from onset of symptoms to hospitalisation, and 12 days in hospital before death. With a 3-day doubling time, 100 infections that occurred 15 days ago will have generated 200 infections 12 days ago, 400 infections 9 days ago, 800 infections 6 days ago and 1,600 infections 3 days ago resulting in approximately 3,200 infections at the time the first death is observed.

To explore this, we fit our age-structured SEIR model (see Methods) to the time series of deaths in a country, in order to estimate the start date of the epidemic and the baseline R0. We assume that 100% of COVID-19 related deaths have been reported. We have also included the impact of interventions that have been put in place and their effect on human mobility and transmission based on the Google COVID-19 Community Mobility Reports. Using our mathematical model that formalises this approach, we estimate that there has been a total of 1,312,630 (95% CI: 1,247,761-1,377,499) infections over the past 4 weeks.

The figure below shows the estimated number of people infected over the past 4 weeks. The bar charts show, for comparison, the number of reported cases. The right-hand plot shows these data on a different scale as the estimated infections are likely to be much larger than the reported cases. **Importantly**, the estimated infections includes both asymptomatic and mild cases that would not necessarily be identified through surveillance. Consequently, the estimated infections are likely to be significantly higher than the reported cases (see our FAQ for further explanation of these differences and why the reported cases and estimated infections are unlikely to match).

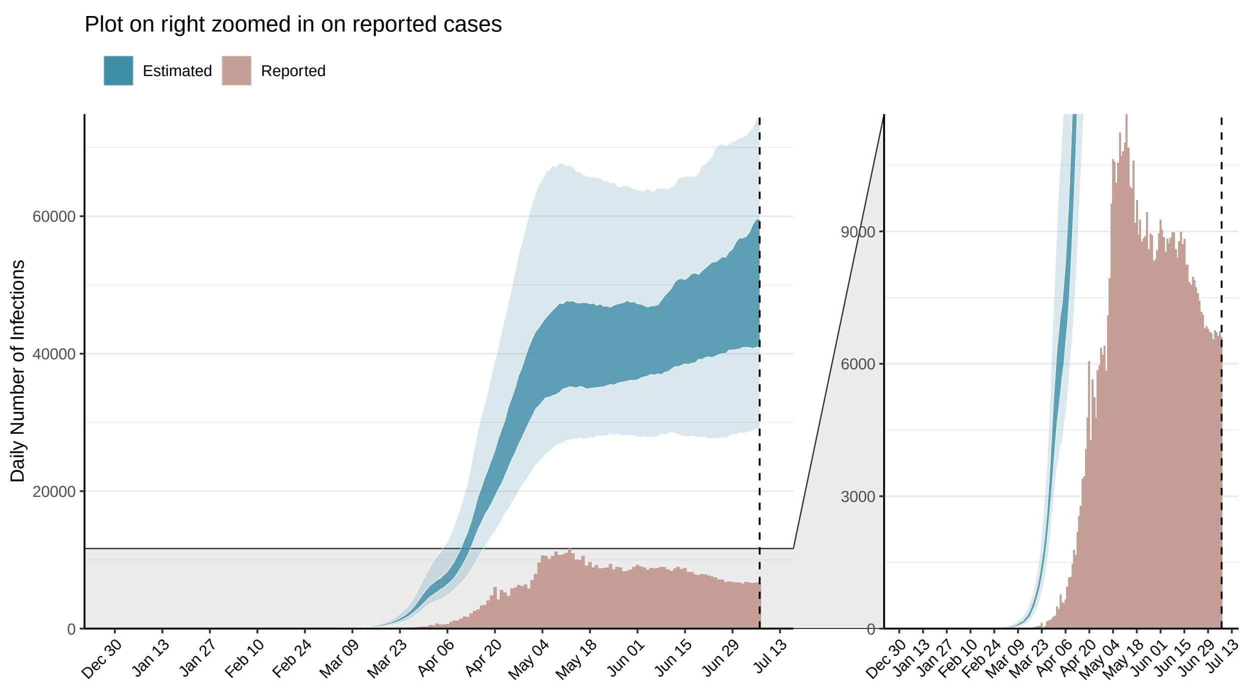

Figure 2: **Daily number of infections estimated by fitting to the current total of deaths.** Reported cases are shown in red. Model estimated infections are shown in blue (dark blue 50% interquartile range, light blue 95% quantile). The dashed line shows the current day.

By fitting to the time series of deaths, we are able to estimate a time-varying reproduction number, R_t. R_t is the the average number of secondary infections caused by a single infected person at a given time. If R_t is above 1, the rate of transmission is increasing and the number of new infections is increasing. R_t is assumed to change in relation to mobility fall in proportion. When fitting our model we assume that 100% of COVID-19 related deaths have been reported (please see our FAQ section for more information about this assumption). We also assume a fixed date at which the impact of mobility on transmission changes from pre-lockdown levels to post-lockdown levels, which may cause large changes in Rt. We are working to refine how this switch occurs and to formally calculate its shape.

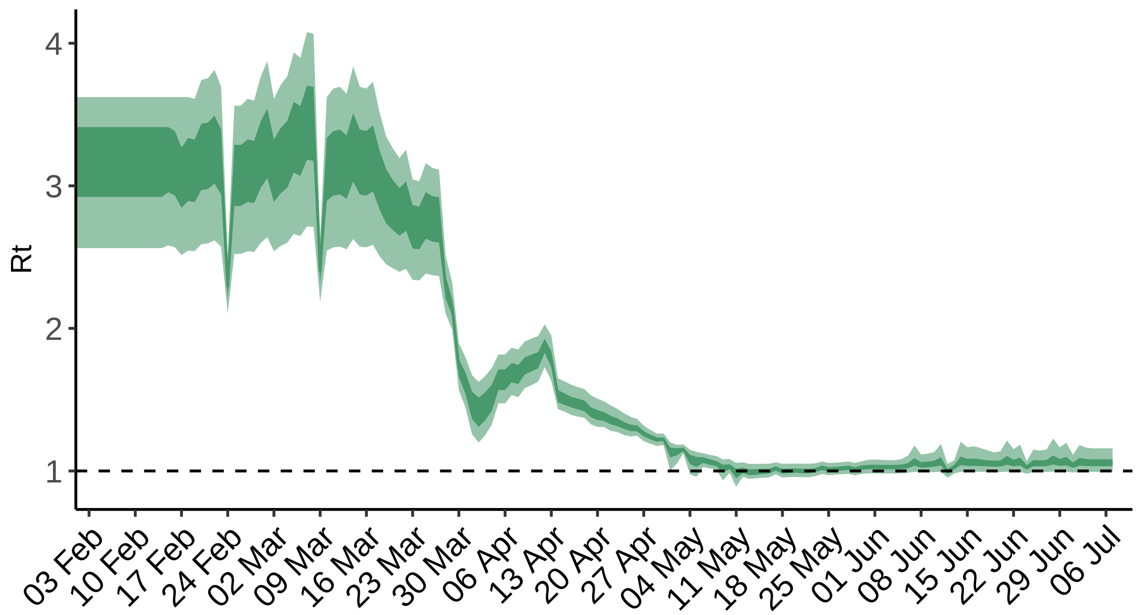

Figure 3: **Time-varying reproduction number, R_t.** R_t is the average number of secondary infections caused by a single infected person at time equal to t. $R_t < 1$ indicates a slowing epidemic in which new infections are not increasing. $R_t > 1$ indicates a growing epidemic in which new infections are increasing over time. Dark green shows the 50% CI and light green shows the 95% CI.

Using the model fit, we can forecast the expected trajectory for cumulative deaths, which is shown in the figure below. This assumes a severity pattern by age that is consistent with that observed in China, Europe and the U.S to date. This projection assumes that transmission is maintained at the current level of transmission as estimated by the final R_t value.

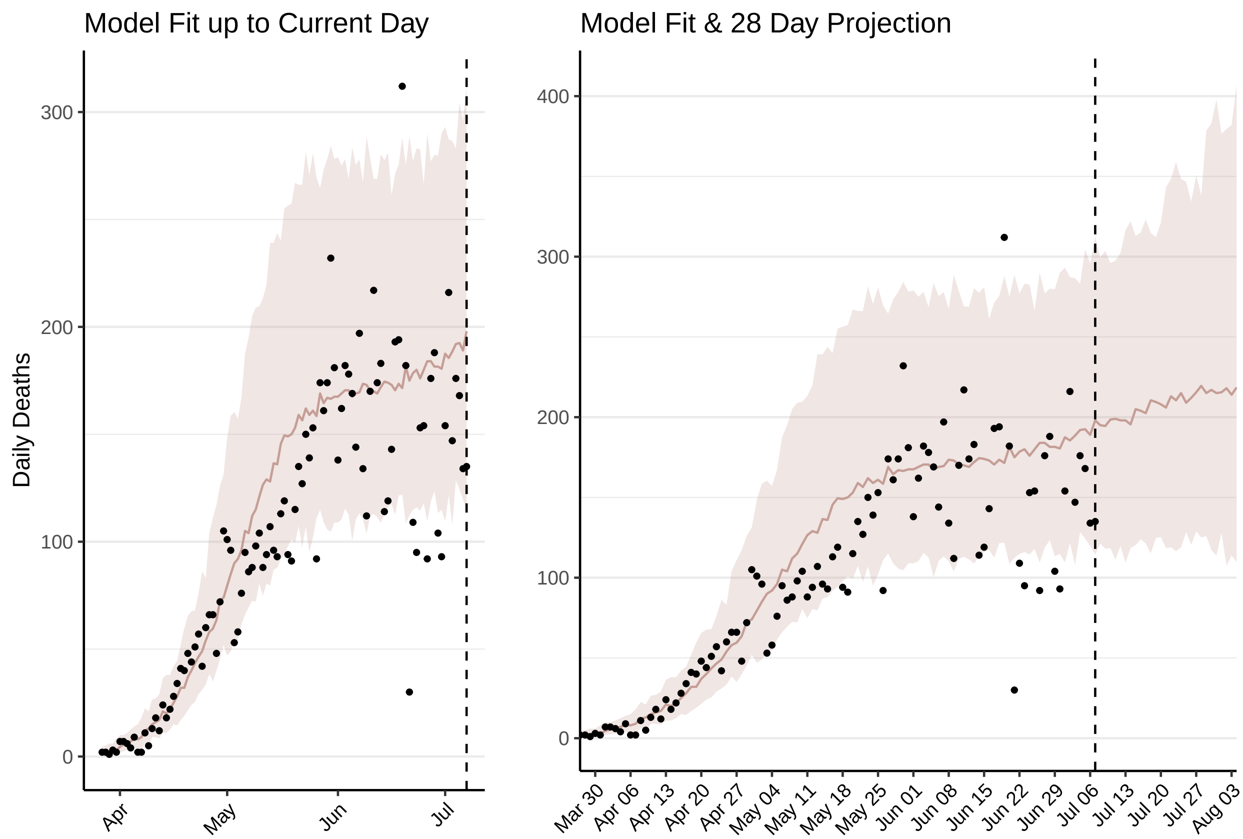

Figure 4: **Estimated daily deaths.** Projected deaths assuming the current level of interventions are maintained are shown in red (median and 95% quantile). Reported deaths are plotted in black. The plot on the left is focussed on the model fit prior to today, while the plot on the right forecasts the next 28 days.

Short-term Epidemic Scenarios

We make the following short-term projections of healthcare demand and new infections under the following three scenarios:

- **Scenario 1.** The epidemic continues to grow at the current rate.
- **Scenario 2.** Countries will further scale up interventions (either increasing current strategies or implementing new interventions) leading to a further 50% reduction in transmission.
- **Scenario 3.** Countries will relax current interventions by 50%

N.B. These scenarios currently assume that the impact of mobility on transmission will remain the same in the future as it has in the past. We are working to extend methods to estimate the impact of increases in mobility on transmission as lockdown and interventions are reversed. Consequently, projection are likely to represent an upper estimate of the healthcare demand and case load for each scenario

We estimate that over the next 4 weeks demand for hospital beds will change from 10,047 (95% CI: 9,535-10,560) patients requiring treatment with high-pressure oxygen at the current date to 11,697 (95% CI: 10,847-12,548) hospital beds being required on 2020-08-04 if no further interventions are introduced (Scenario 1). Similarly, we estimate that over the next 4 weeks demand for critical care (ICU) beds will change from 2,919 (95% CI: 2,770-3,067) patients requiring treatment with mechanical ventilation at the current date to 3,419 (95% CI: 3,171-3,667) by 2020-08-04. These projections assume that approximately 5% of all infections will require treatment with high-pressure oxygen and that approximately 30% of hospitalised cases will require treatment with mechanical ventilation (based on analysis of ongoing epidemics in Europe). **N.B. These scenarios are unlikely to show significant differences for the first week since there is a delay of approximately 10 days between infection and hospital admission. Consequently, the effectiveness of a change in policy is likely to be better captured by hospital admission data approximately 2 weeks after the policy change is implemented.**

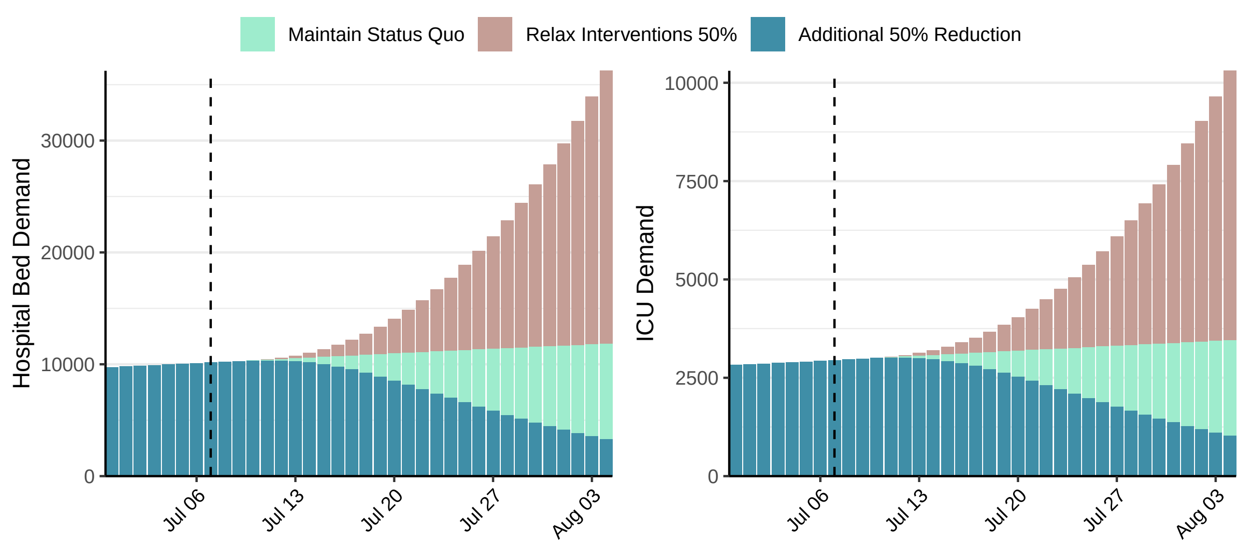

Figure 5: **Healthcare demands in the next 28 days.** Individuals needing an ICU bed are assumed to need mechanical ventilation. Projected demand for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

The impact of each scenario has a more immediate effect on the daily number of infections. The figure below shows the impact of each scenario on the estimated daily incidence of new infections. If interventions are scaled up (Scenario 2), the daily number of infections will change from 50,542 (95% CI: 47,672-53,413) at the current date to 4,821 (95% CI: 4,443-5,199) by 2020-08-04. If current interventions were relaxed by 50%, we estimate the daily number of infections will change from 50,542 (95% CI: 47,672-53,413) at the current date to 315,753 (95% CI: 289,860-341,645) by 2020-08-04.

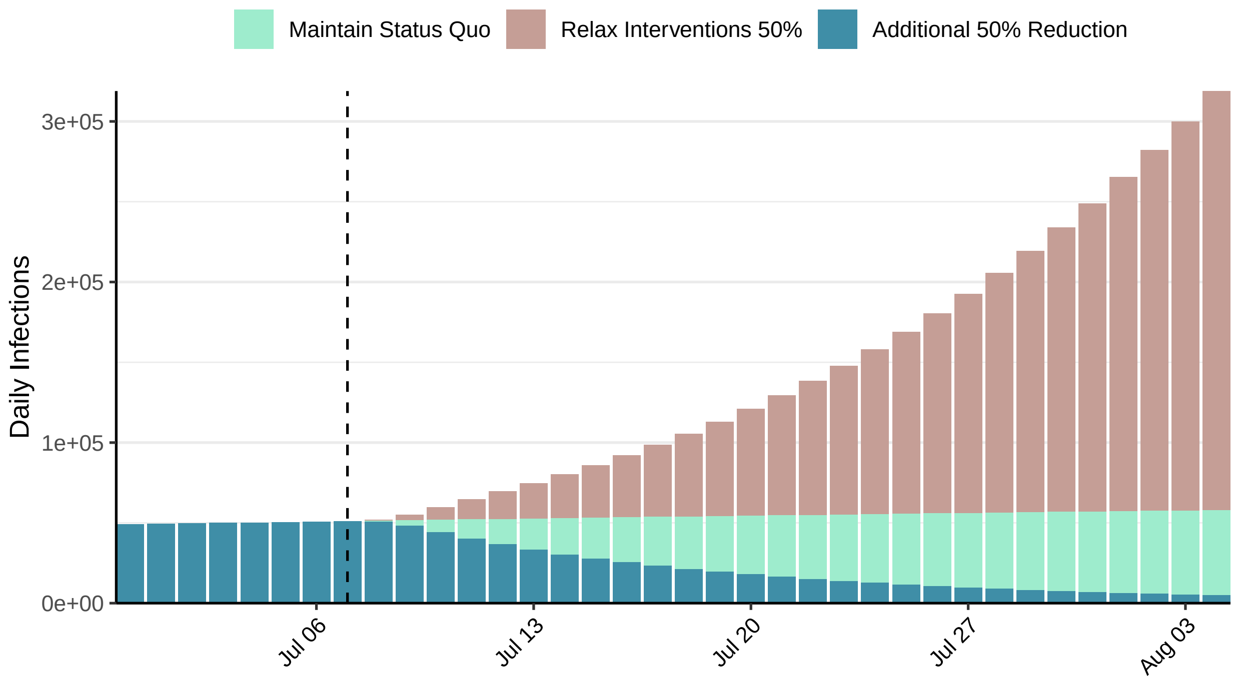

Figure 6: **Daily number of infections estimated by fitting to deaths.** Projected infections for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

To explore different scenarios, we recommend using our COVID-19 Scenario Analysis Tool - https://covidsim.org/, which can be used to simulate different intervention scenarios and explore the long term impact on healthcare demand.

Situation Report for COVID-19: Rwanda, 2020-07-07

Download the report for Rwanda, 2020-07-07 here. This report uses data from the European Centre for Disease Control. These data are updated daily and whilst there may be a short delay, they are generally consistent with Ministry reports. These data are then used to back-calculate an 'inferred number of COVID-19 infections' using mathematical modelling techniques (see Report 12 for further details) to estimate the number of people that have been infected and to make short-term projections for future healthcare needs.

Epidemiological Situation

Total Reported Cases	New Reported Cases	Total Reported Deaths	New Reported Deaths	Estimated R_t
1,113	8	3	0	1.62 (95% CI: 1.18-2.06)

The figure below shows the cumulative reported deaths as a function of the time since the 10th death was reported. Dashed lines show the expected trajectory for different doubling times of the epidemic. For example, with a doubling time of 3 days, if there are currently a total of 20 deaths reported, we would expect there to be 40 deaths in total reported in 3 days-time, 80 deaths in 6 days-time, 160 deaths in 9 days-time etc. For most epidemics, in the absence of interventions, we expect a doubling time of 3-4 days for this disease. **N.B. Rwanda is not shown in the following plot as only 3 deaths have been reported to date**

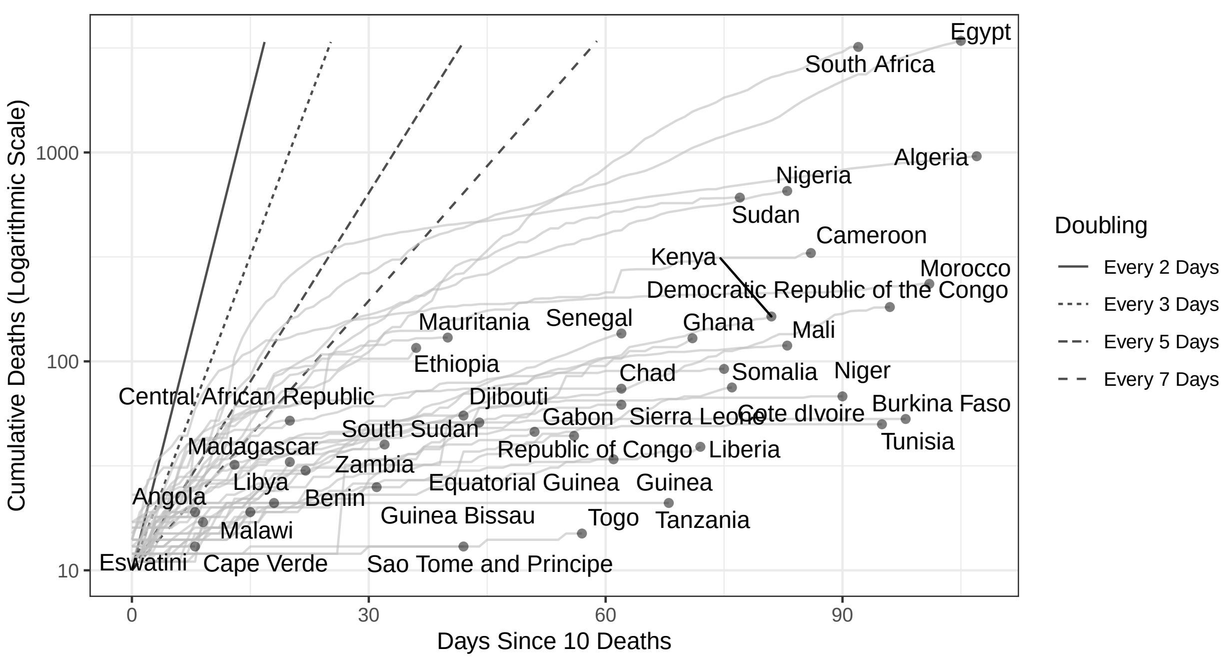

Figure 1: **Cumulative Deaths since 10 deaths.** Country not shown if fewer than 10 deaths.

COVID-19 Transmission Modelling

We assume that the deaths reported to date provide the best indication of the stage of the epidemic, as deaths are more consistently and accurately reported. Our current working estimate is that 1 death indicates that approximately 100 people will have been infected with the other 99 recovering (based on an infection fatality ratio of ~1%). These infections will have happened approximately 21 days previously – capturing a 5-day period from infection to onset of symptoms (the incubation period), 4 days from onset of symptoms to hospitalisation, and 12 days in hospital before death. With a 3-day doubling time, 100 infections that occurred 15 days ago will have generated 200 infections 12 days ago, 400 infections 9 days ago, 800 infections 6 days ago and 1,600 infections 3 days ago resulting in approximately 3,200 infections at the time the first death is observed.

To explore this, we fit our age-structured SEIR model (see Methods) to the time series of deaths in a country, in order to estimate the start date of the epidemic and the baseline R0. We assume that 100% of COVID-19 related deaths have been reported. We have also included the impact of interventions that have been put in place and their effect on human mobility and transmission based on the Google COVID-19 Community Mobility Reports. Using our mathematical model that formalises this approach, we estimate that there has been a total of 2,054 (95% CI: 1,271-2,836) infections over the past 4 weeks.

The figure below shows the estimated number of people infected over the past 4 weeks. The bar charts show, for comparison, the number of reported cases. The right-hand plot shows these data on a different scale as the estimated infections are likely to be much larger than the reported cases. **Importantly**, the estimated infections includes both asymptomatic and mild cases that would not necessarily be identified through surveillance. Consequently, the estimated infections are likely to be significantly higher than the reported cases (see our FAQ for further explanation of these differences and why the reported cases and estimated infections are unlikely to match).

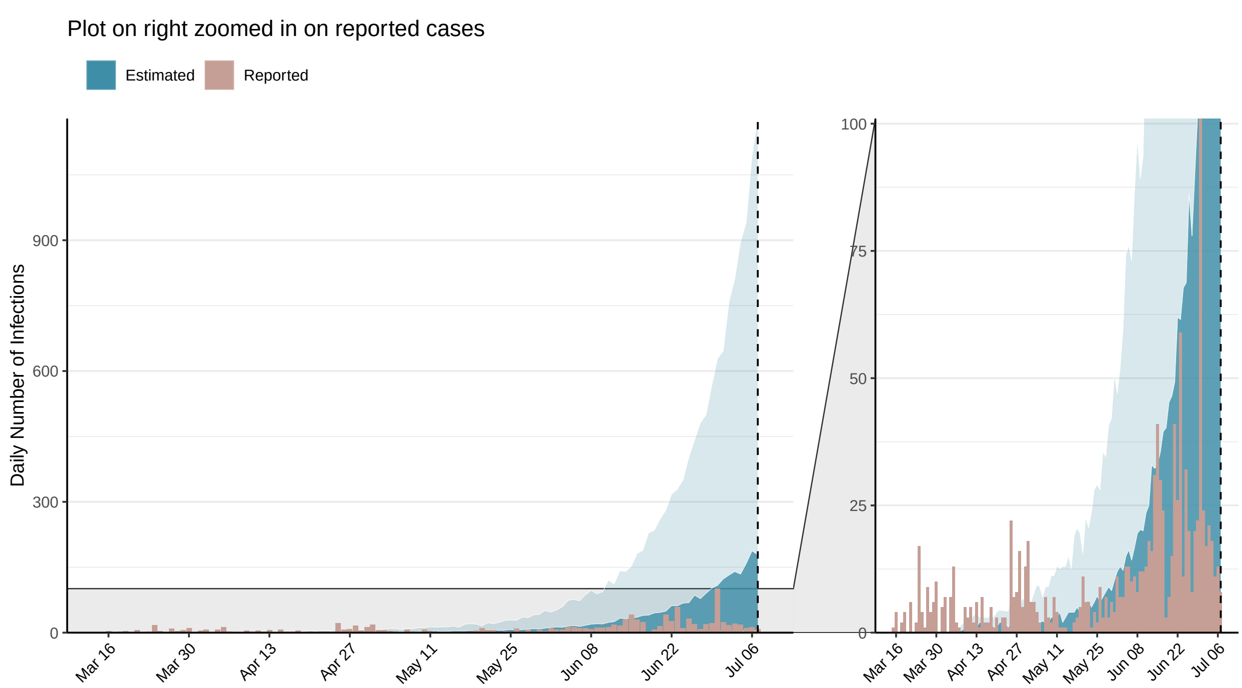

Figure 2: **Daily number of infections estimated by fitting to the current total of deaths.** Reported cases are shown in red. Model estimated infections are shown in blue (dark blue 50% interquartile range, light blue 95% quantile). The dashed line shows the current day.

By fitting to the time series of deaths, we are able to estimate a time-varying reproduction number, R_t. R_t is the the average number of secondary infections caused by a single infected person at a given time. If R_t is above 1, the rate of transmission is increasing and the number of new infections is increasing. R_t is assumed to change in relation to mobility fall in proportion. When fitting our model we assume that 100% of COVID-19 related deaths have been reported (please see our FAQ section for more information about this assumption). We also assume a fixed date at which the impact of mobility on transmission changes from pre-lockdown levels to post-lockdown levels, which may cause large changes in Rt. We are working to refine how this switch occurs and to formally calculate its shape.

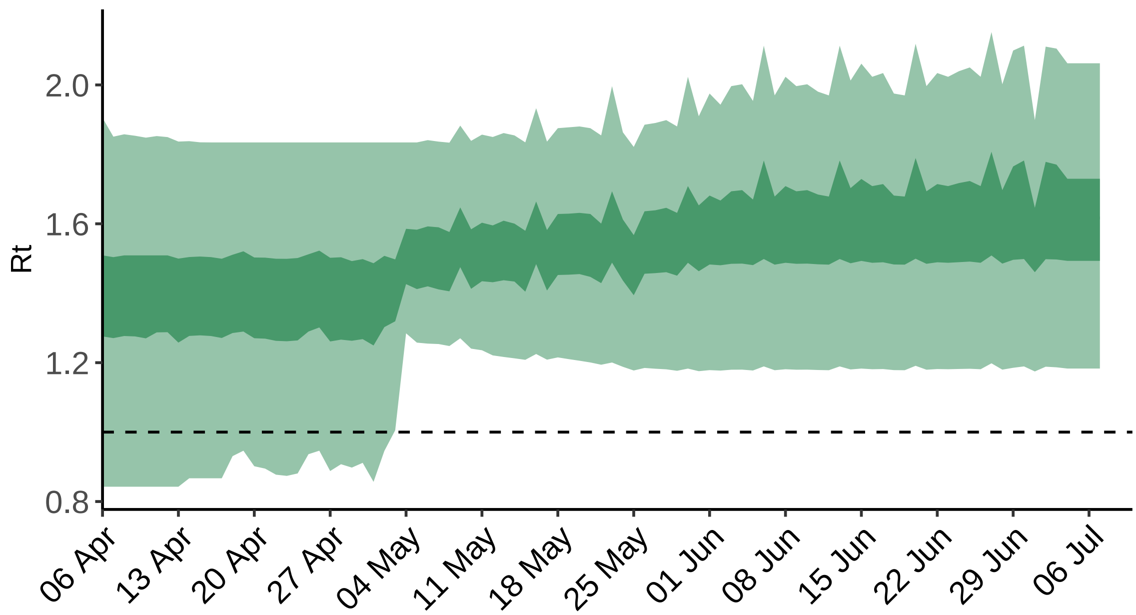

Figure 3: **Time-varying reproduction number, R_t.** R_t is the average number of secondary infections caused by a single infected person at time equal to t. $R_t < 1$ indicates a slowing epidemic in which new infections are not increasing. $R_t > 1$ indicates a growing epidemic in which new infections are increasing over time. Dark green shows the 50% CI and light green shows the 95% CI.

Using the model fit, we can forecast the expected trajectory for cumulative deaths, which is shown in the figure below. This assumes a severity pattern by age that is consistent with that observed in China, Europe and the U.S to date. This projection assumes that transmission is maintained at the current level of transmission as estimated by the final R_t value.

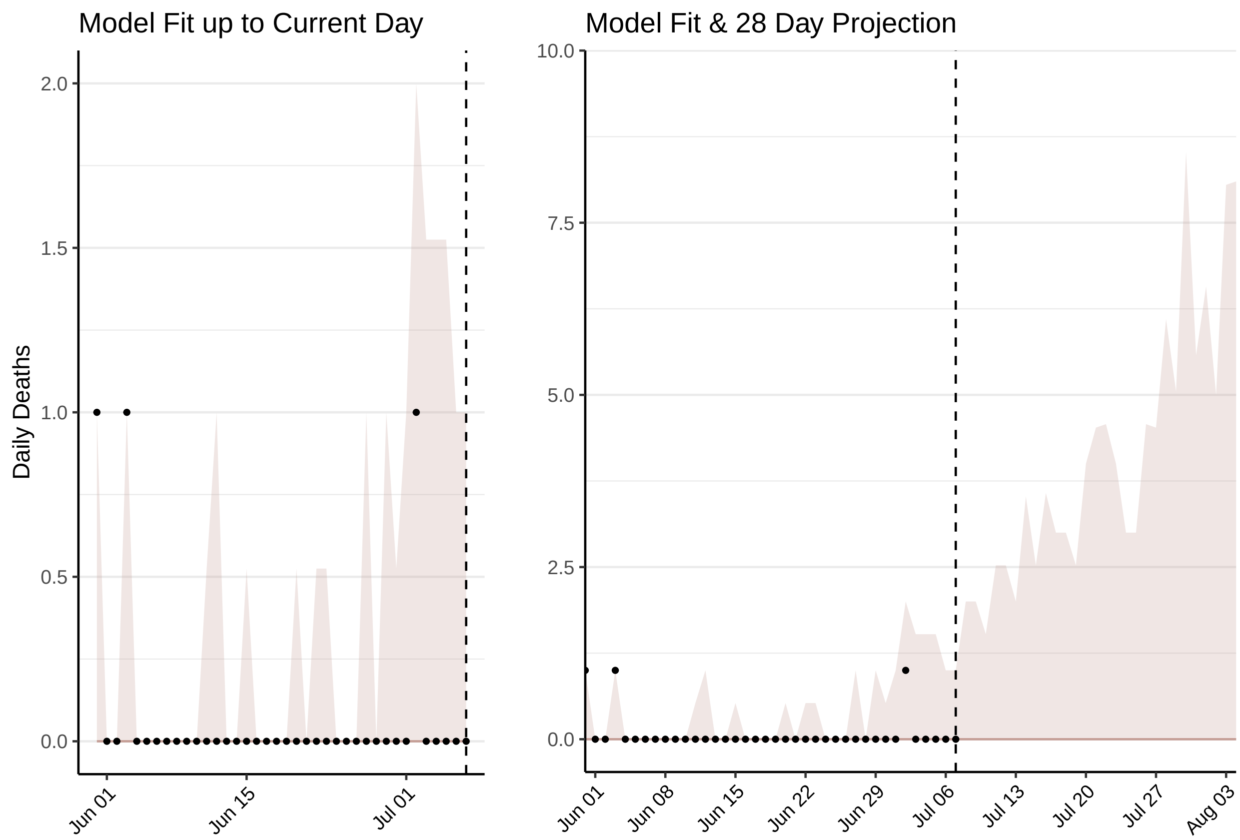

Figure 4: **Estimated daily deaths.** Projected deaths assuming the current level of interventions are maintained are shown in red (median and 95% quantile). Reported deaths are plotted in black. The plot on the left is focussed on the model fit prior to today, while the plot on the right forecasts the next 28 days.

Short-term Epidemic Scenarios

We make the following short-term projections of healthcare demand and new infections under the following three scenarios:

- **Scenario 1.** The epidemic continues to grow at the current rate.
- **Scenario 2.** Countries will further scale up interventions (either increasing current strategies or implementing new interventions) leading to a further 50% reduction in transmission.
- **Scenario 3.** Countries will relax current interventions by 50%

N.B. These scenarios currently assume that the impact of mobility on transmission will remain the same in the future as it has in the past. We are working to extend methods to estimate the impact of increases in mobility on transmission as lockdown and interventions are reversed. Consequently, projection are likely to represent an upper estimate of the healthcare demand and case load for each scenario

We estimate that over the next 4 weeks demand for hospital beds will change from 12 (95% CI: 7-16) patients requiring treatment with high-pressure oxygen at the current date to 76 (95% CI: 25-128) hospital beds being required on 2020-08-04 if no further interventions are introduced (Scenario 1). Similarly, we estimate that over the next 4 weeks demand for critical care (ICU) beds will change from 3 (95% CI: 2-5) patients requiring treatment with mechanical ventilation at the current date to 19 (95% CI: 8-29) by 2020-08-04. These projections assume that approximately 5% of all infections will require treatment with high-pressure oxygen and that approximately 30% of hospitalised cases will require treatment with mechanical ventilation (based on analysis of ongoing epidemics in Europe). **N.B. These scenarios are unlikely to show significant differences for the first week since there is a delay of approximately 10 days between infection and hospital admission. Consequently, the effectiveness of a change in policy is likely to be better captured by hospital admission data approximately 2 weeks after the policy change is implemented.**

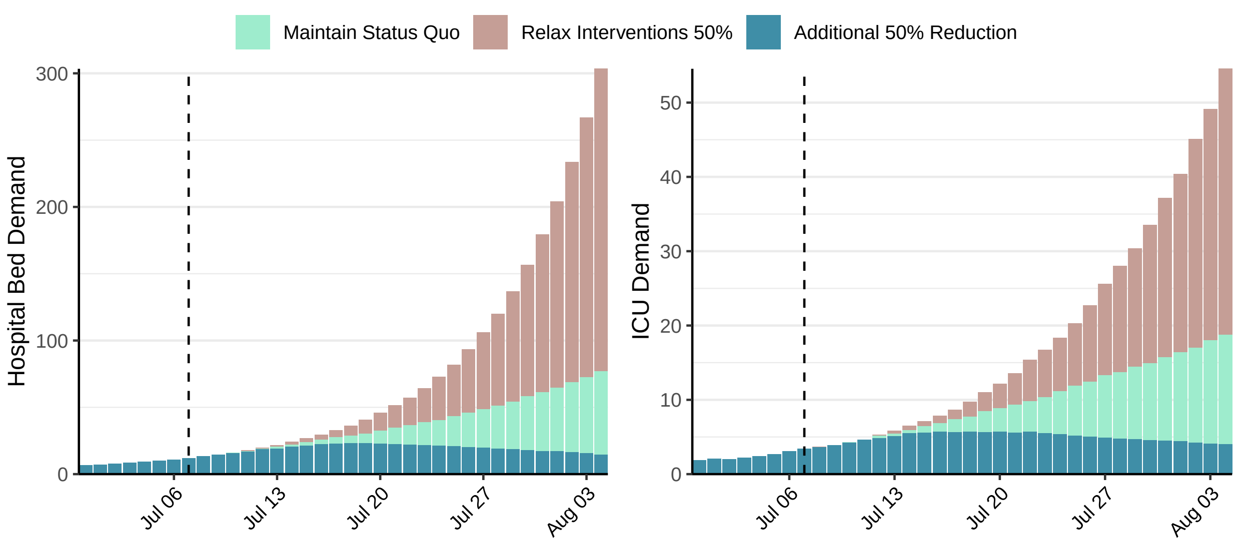

Figure 5: **Healthcare demands in the next 28 days.** Individuals needing an ICU bed are assumed to need mechanical ventilation. Projected demand for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

The impact of each scenario has a more immediate effect on the daily number of infections. The figure below shows the impact of each scenario on the estimated daily incidence of new infections. If interventions are scaled up (Scenario 2), the daily number of infections will change from 194 (95% CI: 109-279) at the current date to 55 (95% CI: 15-96) by 2020-08-04. If current interventions were relaxed by 50%, we estimate the daily number of infections will change from 194 (95% CI: 109-279) at the current date to 6,422 (95% CI: 1,891-10,953) by 2020-08-04.

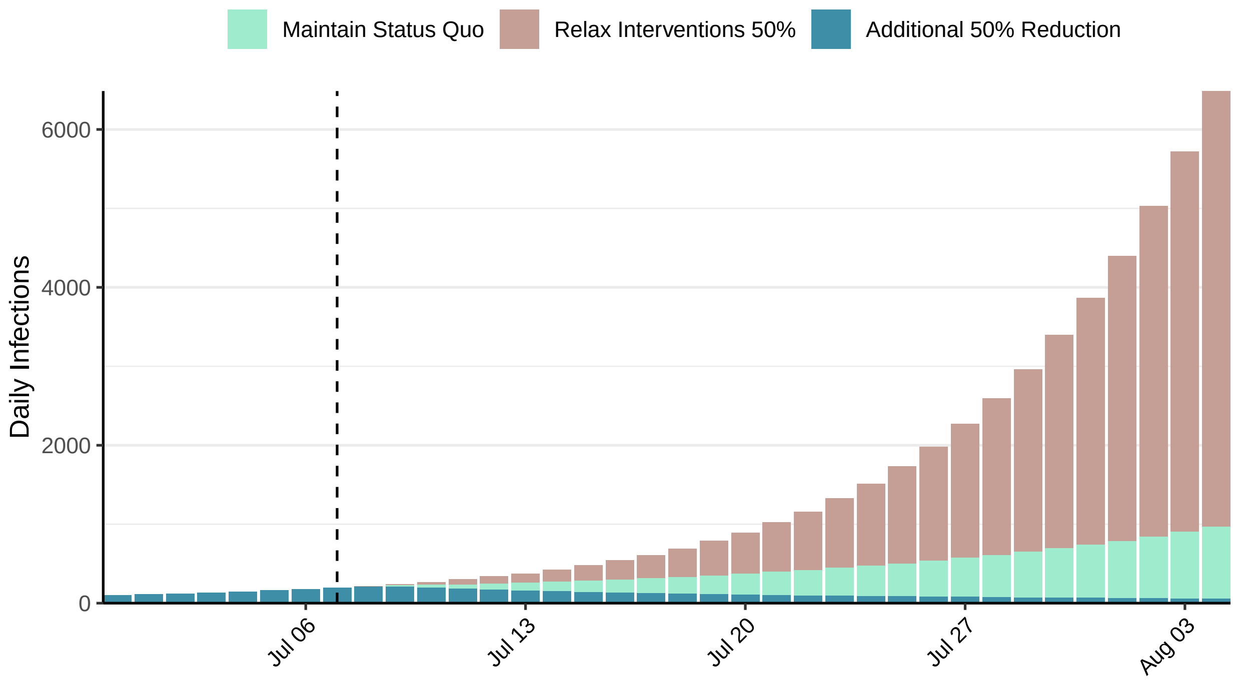

Figure 6: **Daily number of infections estimated by fitting to deaths.** Projected infections for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

To explore different scenarios, we recommend using our COVID-19 Scenario Analysis Tool - https://covidsim.org/, which can be used to simulate different intervention scenarios and explore the long term impact on healthcare demand.

Situation Report for COVID-19: Sudan, 2020-07-07

Download the report for Sudan, 2020-07-07 here. This report uses data from the European Centre for Disease Control. These data are updated daily and whilst there may be a short delay, they are generally consistent with Ministry reports. These data are then used to back-calculate an 'inferred number of COVID-19 infections' using mathematical modelling techniques (see Report 12 for further details) to estimate the number of people that have been infected and to make short-term projections for future healthcare needs.

Epidemiological Situation

Total Reported Cases	New Reported Cases	Total Reported Deaths	New Reported Deaths	Estimated R_t
9,767	0	608	0	0.87 (95% CI: 0.8-0.94)

The figure below shows the cumulative reported deaths as a function of the time since the 10th death was reported. Dashed lines show the expected trajectory for different doubling times of the epidemic. For example, with a doubling time of 3 days, if there are currently a total of 20 deaths reported, we would expect there to be 40 deaths in total reported in 3 days-time, 80 deaths in 6 days-time, 160 deaths in 9 days-time etc. For most epidemics, in the absence of interventions, we expect a doubling time of 3-4 days for this disease.

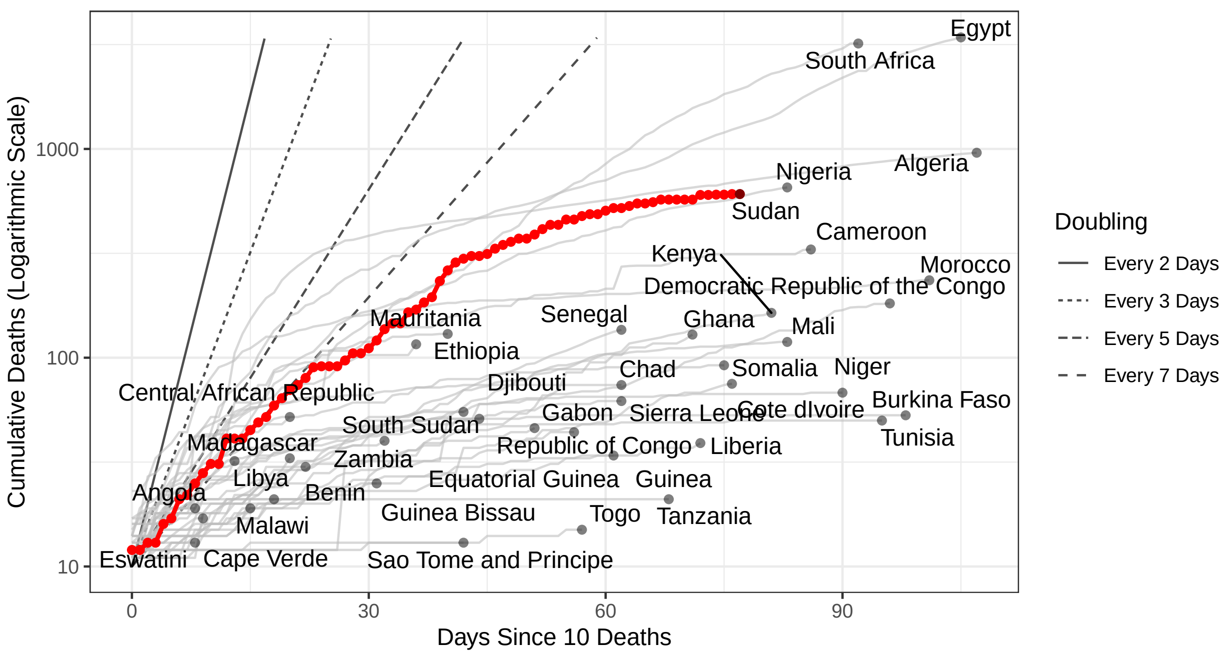

Figure 1: **Cumulative Deaths since 10 deaths.** Country not shown if fewer than 10 deaths.

COVID-19 Transmission Modelling

We assume that the deaths reported to date provide the best indication of the stage of the epidemic, as deaths are more consistently and accurately reported. Our current working estimate is that 1 death indicates that approximately 100 people will have been infected with the other 99 recovering (based on an infection fatality ratio of ~1%). These infections will have happened approximately 21 days previously – capturing a 5-day period from infection to onset of symptoms (the incubation period), 4 days from onset of symptoms to hospitalisation, and 12 days in hospital before death. With a 3-day doubling time, 100 infections that occurred 15 days ago will have generated 200 infections 12 days ago, 400 infections 9 days ago, 800 infections 6 days ago and 1,600 infections 3 days ago resulting in approximately 3,200 infections at the time the first death is observed.

To explore this, we fit our age-structured SEIR model (see Methods) to the time series of deaths in a country, in order to estimate the start date of the epidemic and the baseline R0. We assume that 100% of COVID-19 related deaths have been reported. We have also included the impact of interventions that have been put in place and their effect on human mobility and transmission based on the Google COVID-19 Community Mobility Reports. Using our mathematical model that formalises this approach, we estimate that there has been a total of 62,154 (95% CI: 53,913-70,396) infections over the past 4 weeks.

The figure below shows the estimated number of people infected over the past 4 weeks. The bar charts show, for comparison, the number of reported cases. The right-hand plot shows these data on a different scale as the estimated infections are likely to be much larger than the reported cases. **Importantly**, the estimated infections includes both asymptomatic and mild cases that would not necessarily be identified through surveillance. Consequently, the estimated infections are likely to be significantly higher than the reported cases (see our FAQ for further explanation of these differences and why the reported cases and estimated infections are unlikely to match).

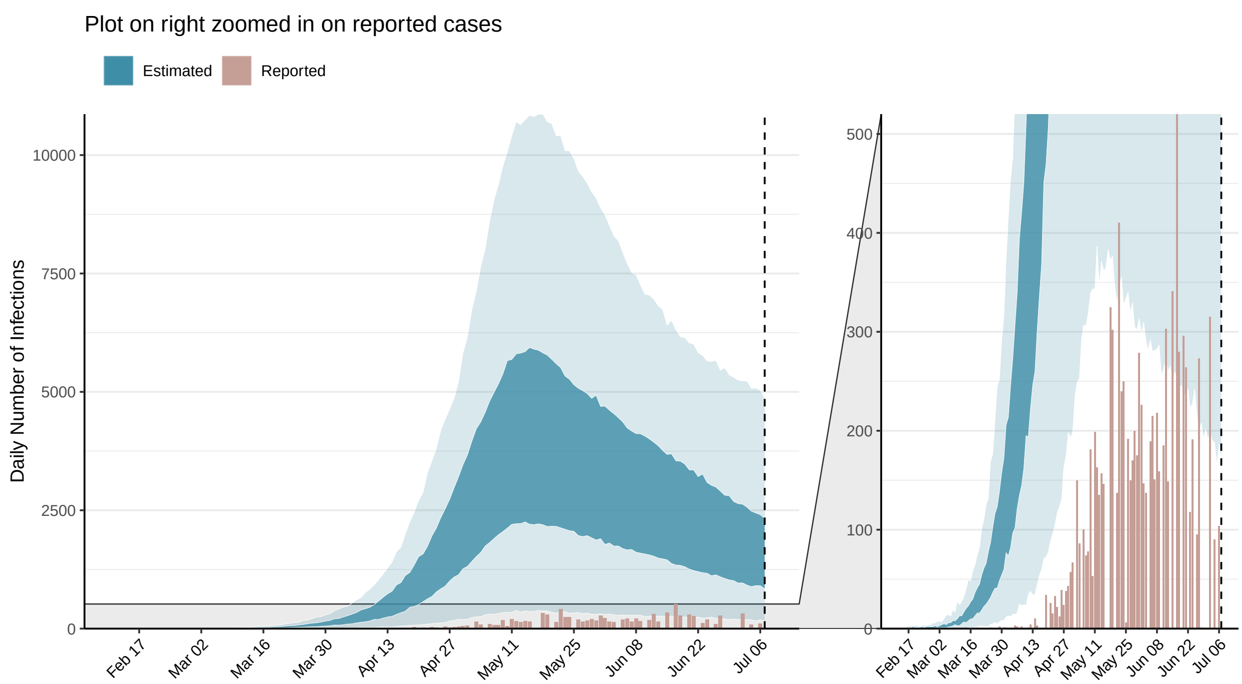

Figure 2: **Daily number of infections estimated by fitting to the current total of deaths.** Reported cases are shown in red. Model estimated infections are shown in blue (dark blue 50% interquartile range, light blue 95% quantile). The dashed line shows the current day.

By fitting to the time series of deaths, we are able to estimate a time-varying reproduction number, R_t. R_t is the the average number of secondary infections caused by a single infected person at a given time. If R_t is above 1, the rate of transmission is increasing and the number of new infections is increasing. R_t is assumed to change in relation to mobility fall in proportion. When fitting our model we assume that 100% of COVID-19 related deaths have been reported (please see our FAQ section for more information about this assumption). We also assume a fixed date at which the impact of mobility on transmission changes from pre-lockdown levels to post-lockdown levels, which may cause large changes in Rt. We are working to refine how this switch occurs and to formally calculate its shape.

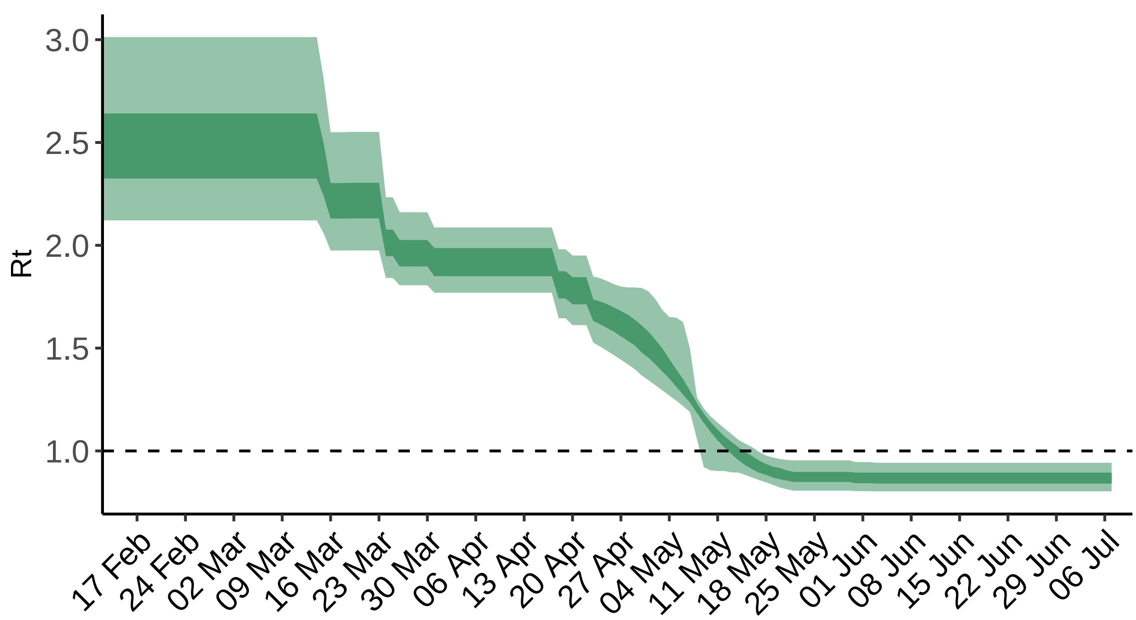

Figure 3: **Time-varying reproduction number, R_t.** R_t is the average number of secondary infections caused by a single infected person at time equal to t. $R_t < 1$ indicates a slowing epidemic in which new infections are not increasing. $R_t > 1$ indicates a growing epidemic in which new infections are increasing over time. Dark green shows the 50% CI and light green shows the 95% CI.

Using the model fit, we can forecast the expected trajectory for cumulative deaths, which is shown in the figure below. This assumes a severity pattern by age that is consistent with that observed in China, Europe and the U.S to date. This projection assumes that transmission is maintained at the current level of transmission as estimated by the final R_t value.

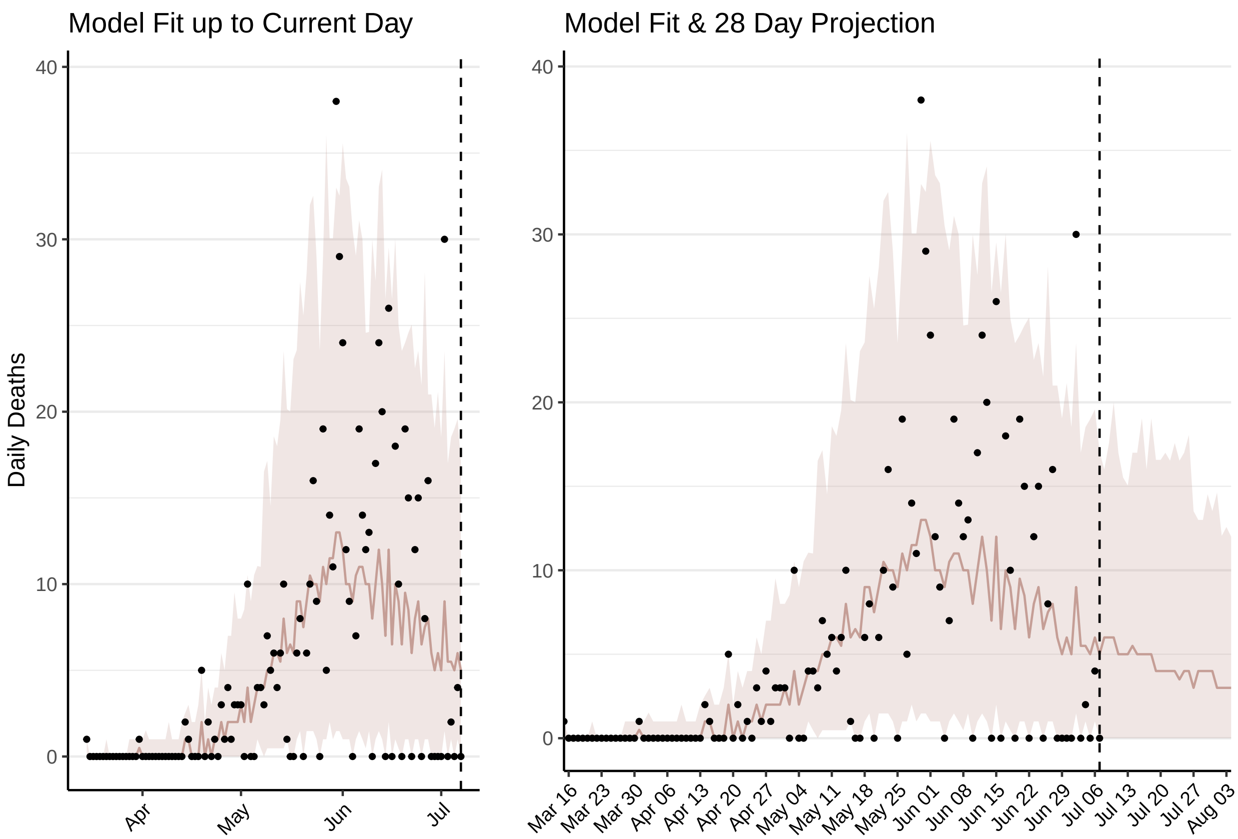

Figure 4: **Estimated daily deaths.** Projected deaths assuming the current level of interventions are maintained are shown in red (median and 95% quantile). Reported deaths are plotted in black. The plot on the left is focussed on the model fit prior to today, while the plot on the right forecasts the next 28 days.

Short-term Epidemic Scenarios

We make the following short-term projections of healthcare demand and new infections under the following three scenarios:

- **Scenario 1.** The epidemic continues to grow at the current rate.
- **Scenario 2.** Countries will further scale up interventions (either increasing current strategies or implementing new interventions) leading to a further 50% reduction in transmission.
- **Scenario 3.** Countries will relax current interventions by 50%

N.B. These scenarios currently assume that the impact of mobility on transmission will remain the same in the future as it has in the past. We are working to extend methods to estimate the impact of increases in mobility on transmission as lockdown and interventions are reversed. Consequently, projection are likely to represent an upper estimate of the healthcare demand and case load for each scenario

We estimate that over the next 4 weeks demand for hospital beds will change from 324 (95% CI: 280-367) patients requiring treatment with high-pressure oxygen at the current date to 194 (95% CI: 165-222) hospital beds being required on 2020-08-04 if no further interventions are introduced (Scenario 1). Similarly, we estimate that over the next 4 weeks demand for critical care (ICU) beds will change from 95 (95% CI: 83-108) patients requiring treatment with mechanical ventilation at the current date to 55 (95% CI: 47-63) by 2020-08-04. These projections assume that approximately 5% of all infections will require treatment with high-pressure oxygen and that approximately 30% of hospitalised cases will require treatment with mechanical ventilation (based on analysis of ongoing epidemics in Europe). **N.B. These scenarios are unlikely to show significant differences for the first week since there is a delay of approximately 10 days between infection and hospital admission. Consequently, the effectiveness of a change in policy is likely to be better captured by hospital admission data approximately 2 weeks after the policy change is implemented.**

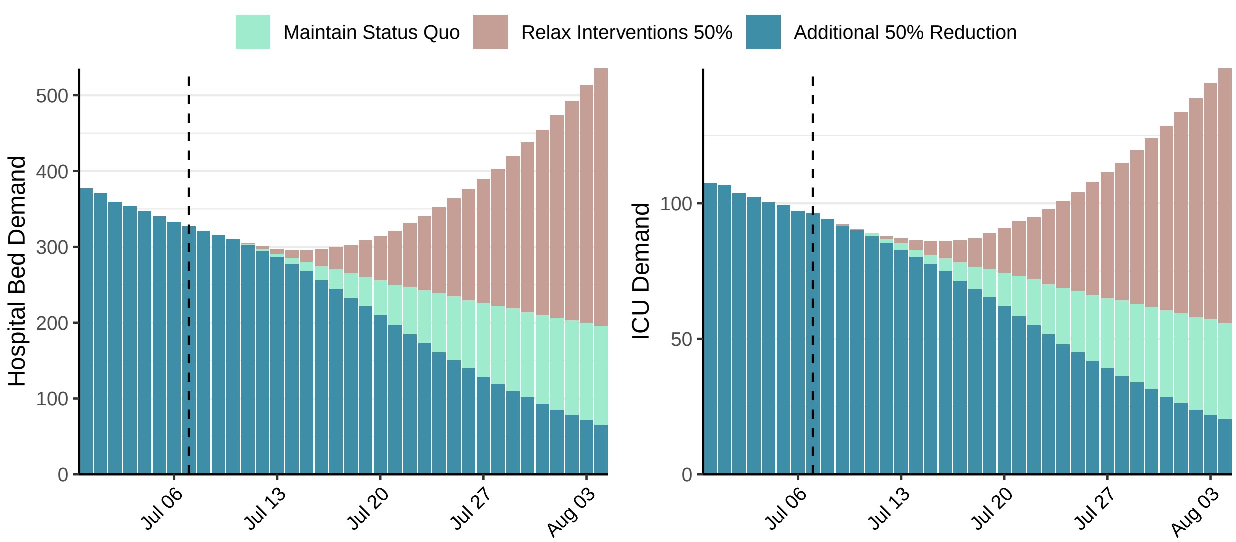

Figure 5: **Healthcare demands in the next 28 days.** Individuals needing an ICU bed are assumed to need mechanical ventilation. Projected demand for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

The impact of each scenario has a more immediate effect on the daily number of infections. The figure below shows the impact of each scenario on the estimated daily incidence of new infections. If interventions are scaled up (Scenario 2), the daily number of infections will change from 1,686 (95% CI: 1,452-1,919) at the current date to 96 (95% CI: 81-111) by 2020-08-04. If current interventions were relaxed by 50%, we estimate the daily number of infections will change from 1,686 (95% CI: 1,452-1,919) at the current date to 5,371 (95% CI: 4,506-6,235) by 2020-08-04.

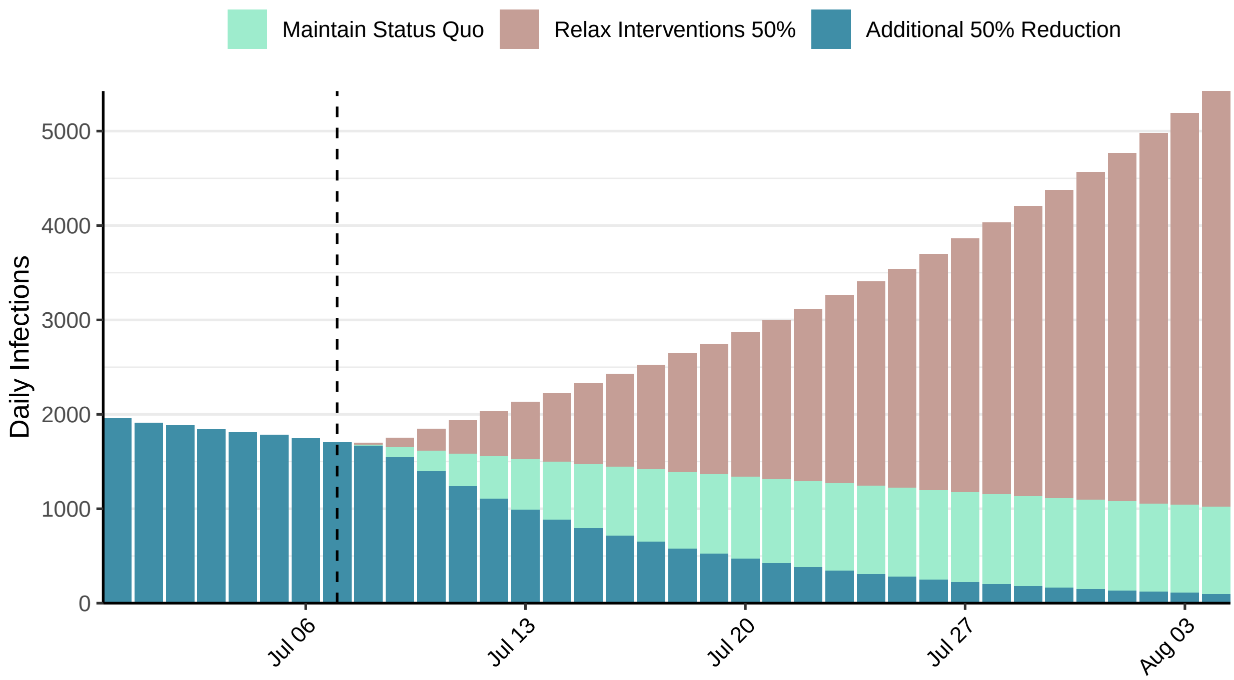

Figure 6: **Daily number of infections estimated by fitting to deaths.** Projected infections for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

To explore different scenarios, we recommend using our COVID-19 Scenario Analysis Tool - https://covidsim.org/, which can be used to simulate different intervention scenarios and explore the long term impact on healthcare demand.

Situation Report for COVID-19: Senegal, 2020-07-07

Download the report for Senegal, 2020-07-07 here. This report uses data from the European Centre for Disease Control. These data are updated daily and whilst there may be a short delay, they are generally consistent with Ministry reports. These data are then used to back-calculate an 'inferred number of COVID-19 infections' using mathematical modelling techniques (see Report 12 for further details) to estimate the number of people that have been infected and to make short-term projections for future healthcare needs.

Epidemiological Situation

Total Reported Cases	New Reported Cases	Total Reported Deaths	New Reported Deaths	Estimated R_t
7,478	78	136	3	1.31 (95% CI: 1.18-1.44)

The figure below shows the cumulative reported deaths as a function of the time since the 10th death was reported. Dashed lines show the expected trajectory for different doubling times of the epidemic. For example, with a doubling time of 3 days, if there are currently a total of 20 deaths reported, we would expect there to be 40 deaths in total reported in 3 days-time, 80 deaths in 6 days-time, 160 deaths in 9 days-time etc. For most epidemics, in the absence of interventions, we expect a doubling time of 3-4 days for this disease.

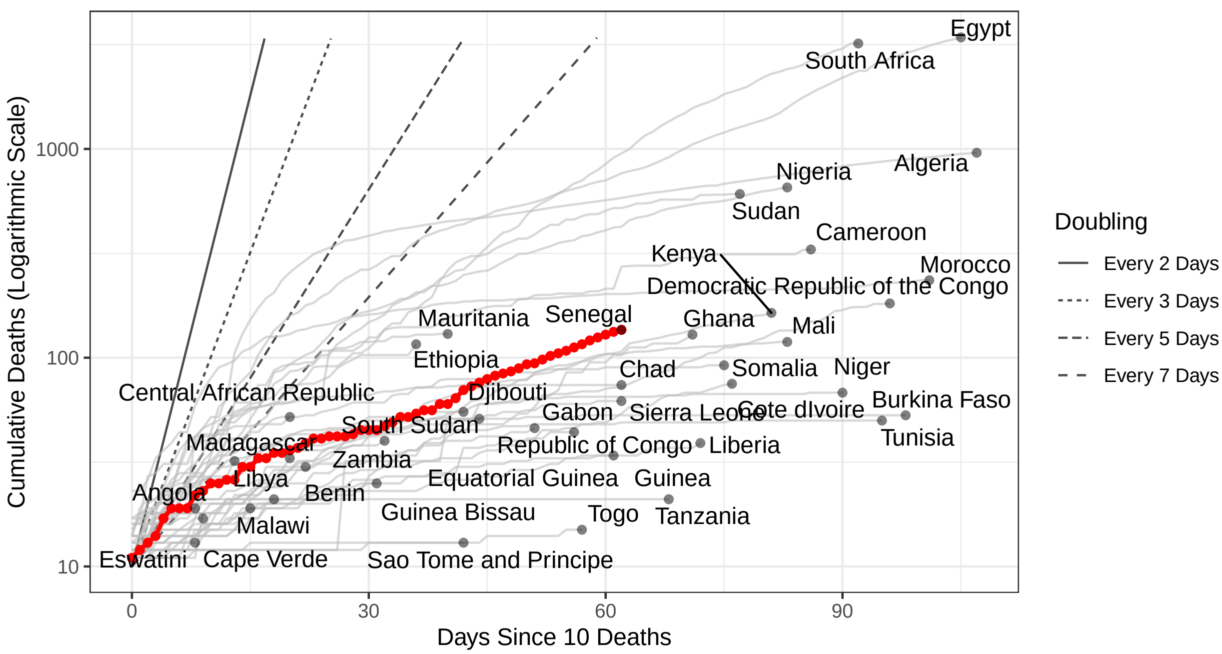

Figure 1: **Cumulative Deaths since 10 deaths.** Country not shown if fewer than 10 deaths.

COVID-19 Transmission Modelling

We assume that the deaths reported to date provide the best indication of the stage of the epidemic, as deaths are more consistently and accurately reported. Our current working estimate is that 1 death indicates that approximately 100 people will have been infected with the other 99 recovering (based on an infection fatality ratio of ~1%). These infections will have happened approximately 21 days previously – capturing a 5-day period from infection to onset of symptoms (the incubation period), 4 days from onset of symptoms to hospitalisation, and 12 days in hospital before death. With a 3-day doubling time, 100 infections that occurred 15 days ago will have generated 200 infections 12 days ago, 400 infections 9 days ago, 800 infections 6 days ago and 1,600 infections 3 days ago resulting in approximately 3,200 infections at the time the first death is observed.

To explore this, we fit our age-structured SEIR model (see Methods) to the time series of deaths in a country, in order to estimate the start date of the epidemic and the baseline R0. We assume that 100% of COVID-19 related deaths have been reported. We have also included the impact of interventions that have been put in place and their effect on human mobility and transmission based on the Google COVID-19 Community Mobility Reports. Using our mathematical model that formalises this approach, we estimate that there has been a total of 81,209 (95% CI: 71,517-90,900) infections over the past 4 weeks.

The figure below shows the estimated number of people infected over the past 4 weeks. The bar charts show, for comparison, the number of reported cases. The right-hand plot shows these data on a different scale as the estimated infections are likely to be much larger than the reported cases. **Importantly**, the estimated infections includes both asymptomatic and mild cases that would not necessarily be identified through surveillance. Consequently, the estimated infections are likely to be significantly higher than the reported cases (see our FAQ for further explanation of these differences and why the reported cases and estimated infections are unlikely to match).

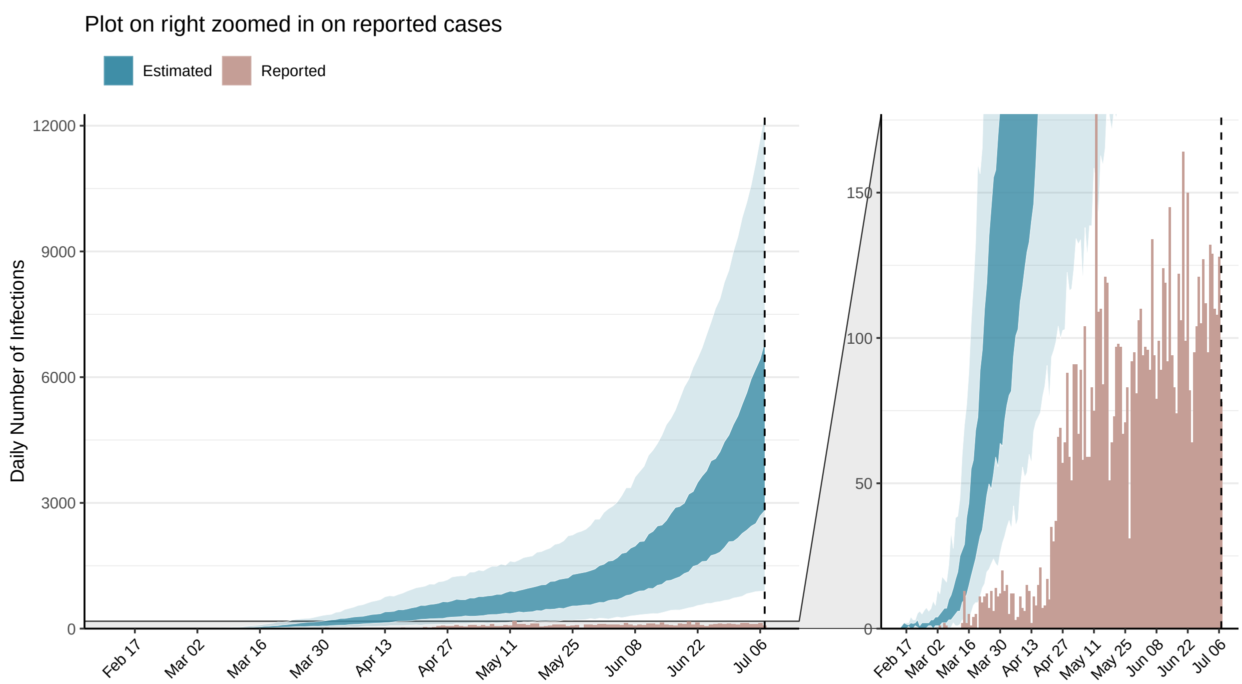

Figure 2: **Daily number of infections estimated by fitting to the current total of deaths.** Reported cases are shown in red. Model estimated infections are shown in blue (dark blue 50% interquartile range, light blue 95% quantile). The dashed line shows the current day.

By fitting to the time series of deaths, we are able to estimate a time-varying reproduction number, R_t. R_t is the the average number of secondary infections caused by a single infected person at a given time. If R_t is above 1, the rate of transmission is increasing and the number of new infections is increasing. R_t is assumed to change in relation to mobility fall in proportion. When fitting our model we assume that 100% of COVID-19 related deaths have been reported (please see our FAQ section for more information about this assumption). We also assume a fixed date at which the impact of mobility on transmission changes from pre-lockdown levels to post-lockdown levels, which may cause large changes in Rt. We are working to refine how this switch occurs and to formally calculate its shape.

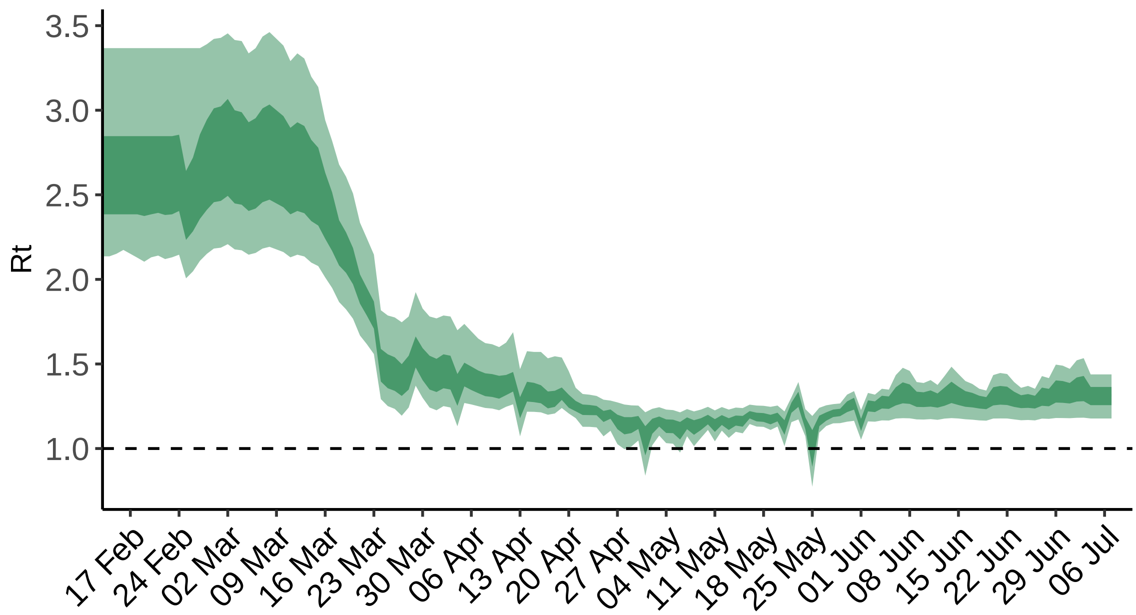

Figure 3: **Time-varying reproduction number, R_t.** R_t is the average number of secondary infections caused by a single infected person at time equal to t. $R_t < 1$ indicates a slowing epidemic in which new infections are not increasing. $R_t > 1$ indicates a growing epidemic in which new infections are increasing over time. Dark green shows the 50% CI and light green shows the 95% CI.

Using the model fit, we can forecast the expected trajectory for cumulative deaths, which is shown in the figure below. This assumes a severity pattern by age that is consistent with that observed in China, Europe and the U.S to date. This projection assumes that transmission is maintained at the current level of transmission as estimated by the final R_t value.

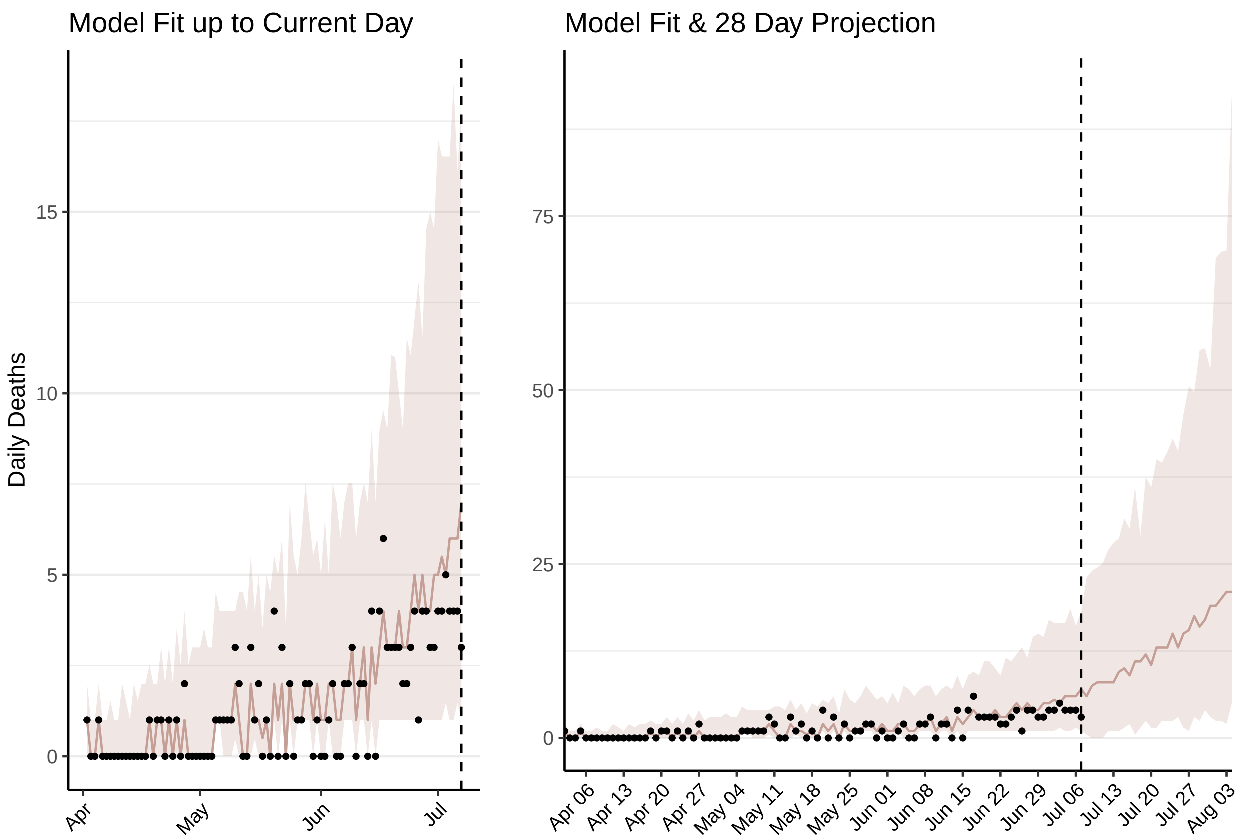

Figure 4: **Estimated daily deaths.** Projected deaths assuming the current level of interventions are maintained are shown in red (median and 95% quantile). Reported deaths are plotted in black. The plot on the left is focussed on the model fit prior to today, while the plot on the right forecasts the next 28 days.

Short-term Epidemic Scenarios

We make the following short-term projections of healthcare demand and new infections under the following three scenarios:

- **Scenario 1.** The epidemic continues to grow at the current rate.
- **Scenario 2.** Countries will further scale up interventions (either increasing current strategies or implementing new interventions) leading to a further 50% reduction in transmission.
- **Scenario 3.** Countries will relax current interventions by 50%

N.B. These scenarios currently assume that the impact of mobility on transmission will remain the same in the future as it has in the past. We are working to extend methods to estimate the impact of increases in mobility on transmission as lockdown and interventions are reversed. Consequently, projection are likely to represent an upper estimate of the healthcare demand and case load for each scenario

We estimate that over the next 4 weeks demand for hospital beds will change from 454 (95% CI: 399-509) patients requiring treatment with high-pressure oxygen at the current date to 1,520 (95% CI: 1,321-1,719) hospital beds being required on 2020-08-04 if no further interventions are introduced (Scenario 1). Similarly, we estimate that over the next 4 weeks demand for critical care (ICU) beds will change from 122 (95% CI: 107-138) patients requiring treatment with mechanical ventilation at the current date to 406 (95% CI: 354-458) by 2020-08-04. These projections assume that approximately 5% of all infections will require treatment with high-pressure oxygen and that approximately 30% of hospitalised cases will require treatment with mechanical ventilation (based on analysis of ongoing epidemics in Europe). **N.B. These scenarios are unlikely to show significant differences for the first week since there is a delay of approximately 10 days between infection and hospital admission. Consequently, the effectiveness of a change in policy is likely to be better captured by hospital admission data approximately 2 weeks after the policy change is implemented.**

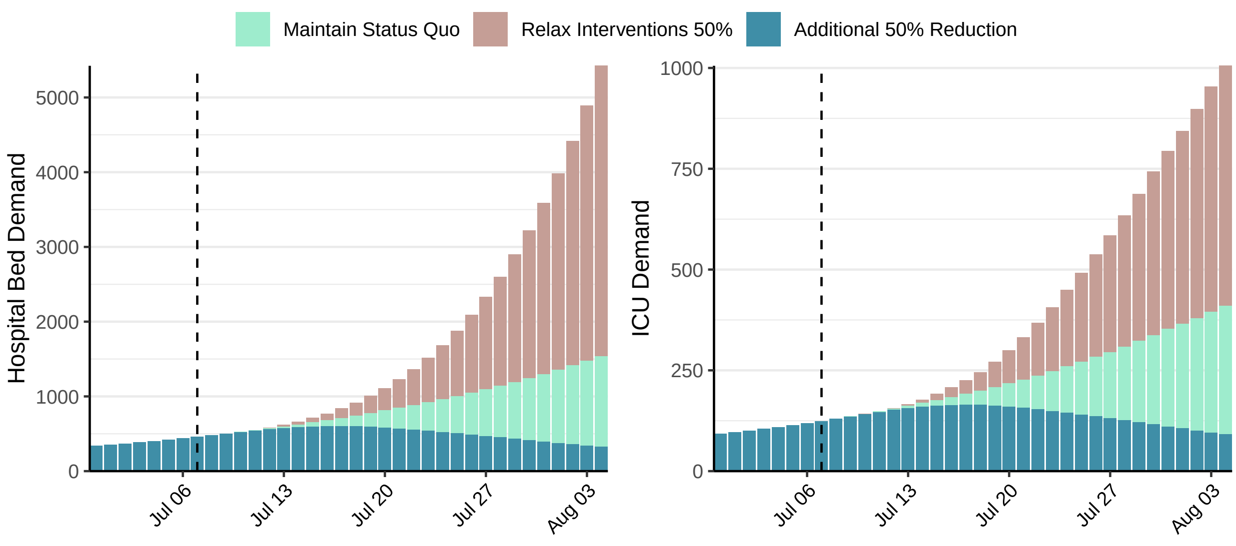

Figure 5: **Healthcare demands in the next 28 days.** Individuals needing an ICU bed are assumed to need mechanical ventilation. Projected demand for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

The impact of each scenario has a more immediate effect on the daily number of infections. The figure below shows the impact of each scenario on the estimated daily incidence of new infections. If interventions are scaled up (Scenario 2), the daily number of infections will change from 4,914 (95% CI: 4,308-5,519) at the current date to 1,097 (95% CI: 947-1,248) by 2020-08-04. If current interventions were relaxed by 50%, we estimate the daily number of infections will change from 4,914 (95% CI: 4,308-5,519) at the current date to 95,202 (95% CI: 83,267-107,137) by 2020-08-04.

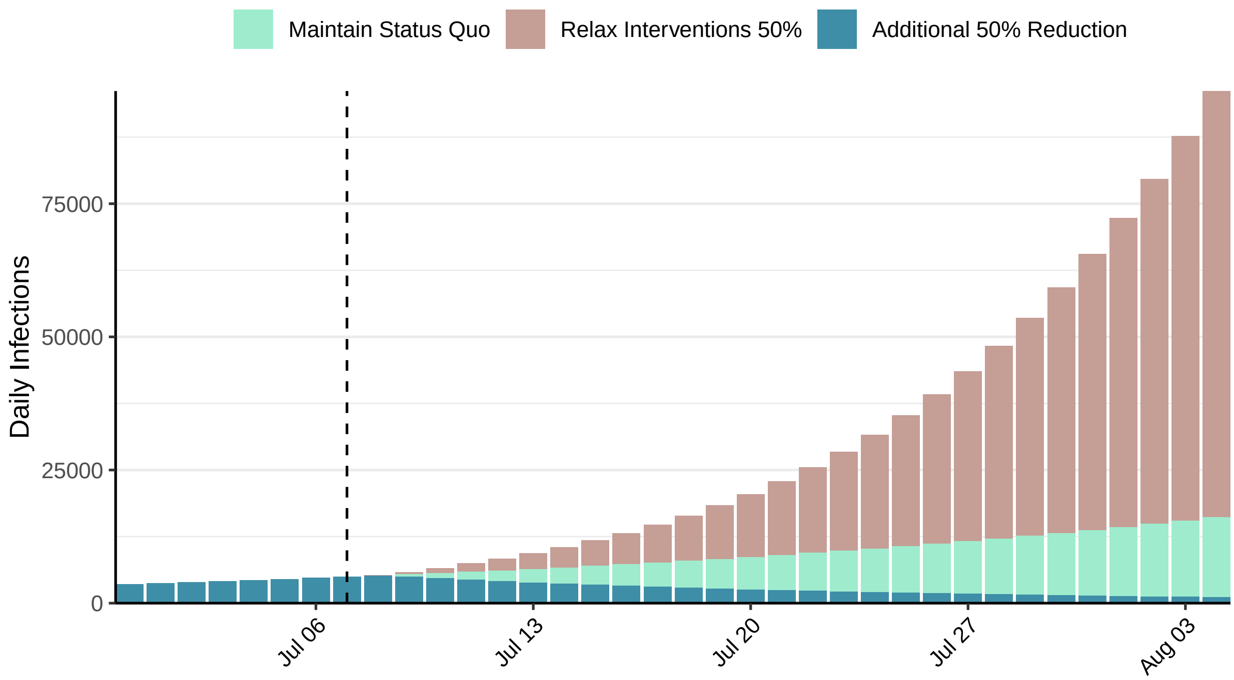

Figure 6: **Daily number of infections estimated by fitting to deaths.** Projected infections for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

To explore different scenarios, we recommend using our COVID-19 Scenario Analysis Tool - https://covidsim.org/, which can be used to simulate different intervention scenarios and explore the long term impact on healthcare demand.

Situation Report for COVID-19: Sierra Leone, 2020-07-07

Download the report for Sierra Leone, 2020-07-07 here. This report uses data from the European Centre for Disease Control. These data are updated daily and whilst there may be a short delay, they are generally consistent with Ministry reports. These data are then used to back-calculate an 'inferred number of COVID-19 infections' using mathematical modelling techniques (see Report 12 for further details) to estimate the number of people that have been infected and to make short-term projections for future healthcare needs.

Epidemiological Situation

Total Reported Cases	New Reported Cases	Total Reported Deaths	New Reported Deaths	Estimated R_t
1,542	0	62	0	0.97 (95% CI: 0.76-1.21)

The figure below shows the cumulative reported deaths as a function of the time since the 10th death was reported. Dashed lines show the expected trajectory for different doubling times of the epidemic. For example, with a doubling time of 3 days, if there are currently a total of 20 deaths reported, we would expect there to be 40 deaths in total reported in 3 days-time, 80 deaths in 6 days-time, 160 deaths in 9 days-time etc. For most epidemics, in the absence of interventions, we expect a doubling time of 3-4 days for this disease.

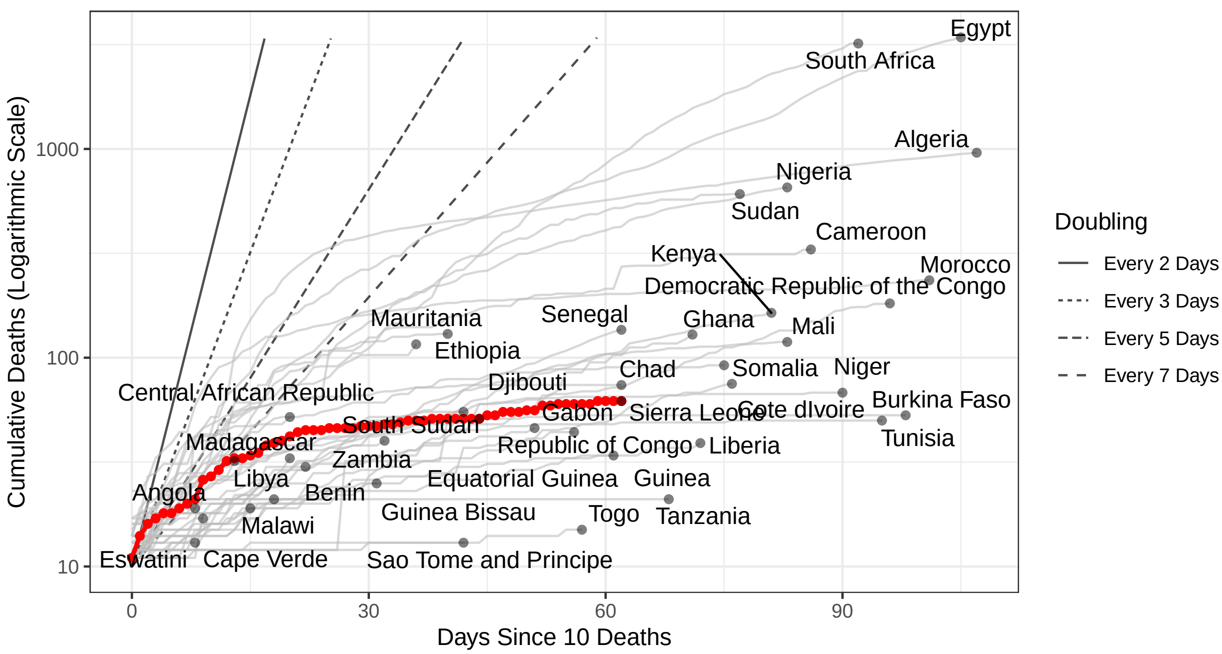

Figure 1: **Cumulative Deaths since 10 deaths.** Country not shown if fewer than 10 deaths.

COVID-19 Transmission Modelling

We assume that the deaths reported to date provide the best indication of the stage of the epidemic, as deaths are more consistently and accurately reported. Our current working estimate is that 1 death indicates that approximately 100 people will have been infected with the other 99 recovering (based on an infection fatality ratio of ~1%). These infections will have happened approximately 21 days previously – capturing a 5-day period from infection to onset of symptoms (the incubation period), 4 days from onset of symptoms to hospitalisation, and 12 days in hospital before death. With a 3-day doubling time, 100 infections that occurred 15 days ago will have generated 200 infections 12 days ago, 400 infections 9 days ago, 800 infections 6 days ago and 1,600 infections 3 days ago resulting in approximately 3,200 infections at the time the first death is observed.

To explore this, we fit our age-structured SEIR model (see Methods) to the time series of deaths in a country, in order to estimate the start date of the epidemic and the baseline R0. We assume that 100% of COVID-19 related deaths have been reported. We have also included the impact of interventions that have been put in place and their effect on human mobility and transmission based on the Google COVID-19 Community Mobility Reports. Using our mathematical model that formalises this approach, we estimate that there has been a total of 5,486 (95% CI: 4,870-6,102) infections over the past 4 weeks.

The figure below shows the estimated number of people infected over the past 4 weeks. The bar charts show, for comparison, the number of reported cases. The right-hand plot shows these data on a different scale as the estimated infections are likely to be much larger than the reported cases. **Importantly**, the estimated infections includes both asymptomatic and mild cases that would not necessarily be identified through surveillance. Consequently, the estimated infections are likely to be significantly higher than the reported cases (see our FAQ for further explanation of these differences and why the reported cases and estimated infections are unlikely to match).

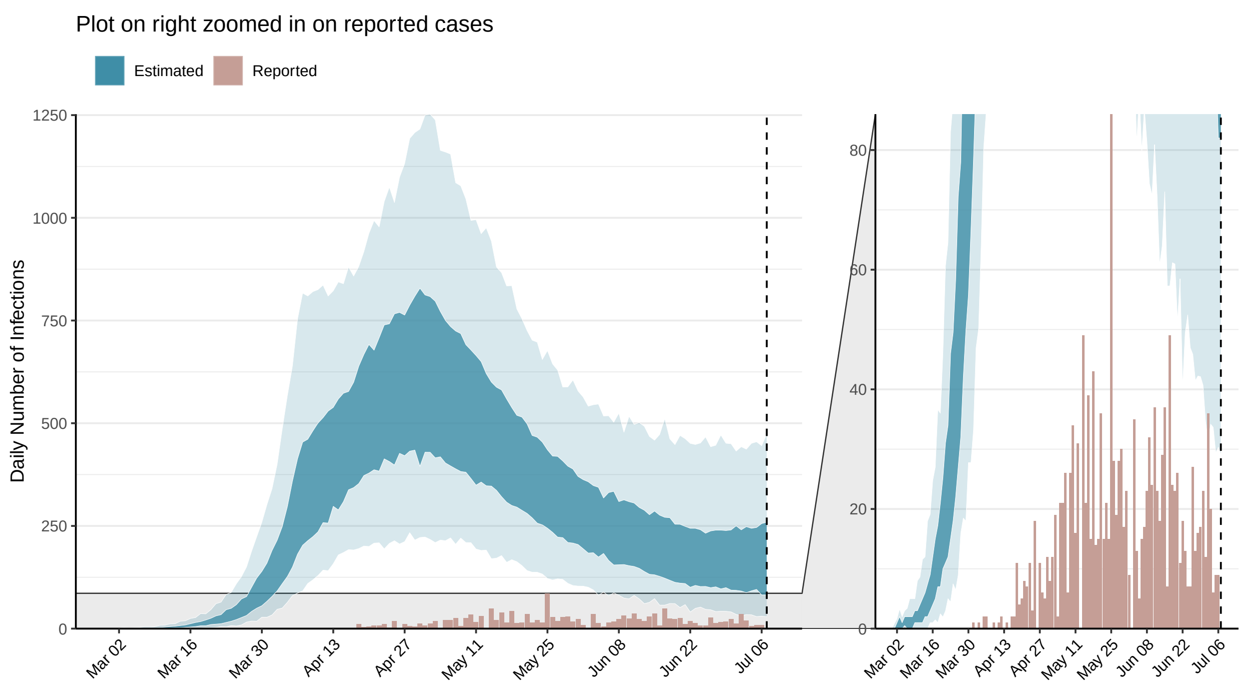

Figure 2: **Daily number of infections estimated by fitting to the current total of deaths.** Reported cases are shown in red. Model estimated infections are shown in blue (dark blue 50% interquartile range, light blue 95% quantile). The dashed line shows the current day.

By fitting to the time series of deaths, we are able to estimate a time-varying reproduction number, R_t. R_t is the the average number of secondary infections caused by a single infected person at a given time. If R_t is above 1, the rate of transmission is increasing and the number of new infections is increasing. R_t is assumed to change in relation to mobility fall in proportion. When fitting our model we assume that 100% of COVID-19 related deaths have been reported (please see our FAQ section for more information about this assumption). We also assume a fixed date at which the impact of mobility on transmission changes from pre-lockdown levels to post-lockdown levels, which may cause large changes in Rt. We are working to refine how this switch occurs and to formally calculate its shape.

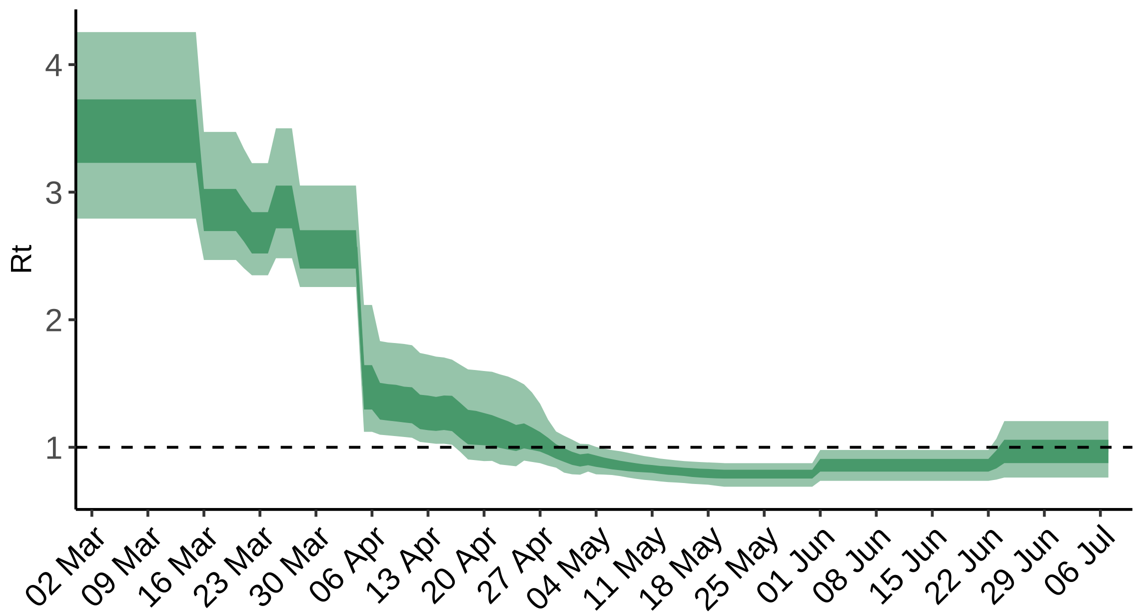

Figure 3: **Time-varying reproduction number, R_t.** R_t is the average number of secondary infections caused by a single infected person at time equal to t. $R_t < 1$ indicates a slowing epidemic in which new infections are not increasing. $R_t > 1$ indicates a growing epidemic in which new infections are increasing over time. Dark green shows the 50% CI and light green shows the 95% CI.

Using the model fit, we can forecast the expected trajectory for cumulative deaths, which is shown in the figure below. This assumes a severity pattern by age that is consistent with that observed in China, Europe and the U.S to date. This projection assumes that transmission is maintained at the current level of transmission as estimated by the final R_t value.

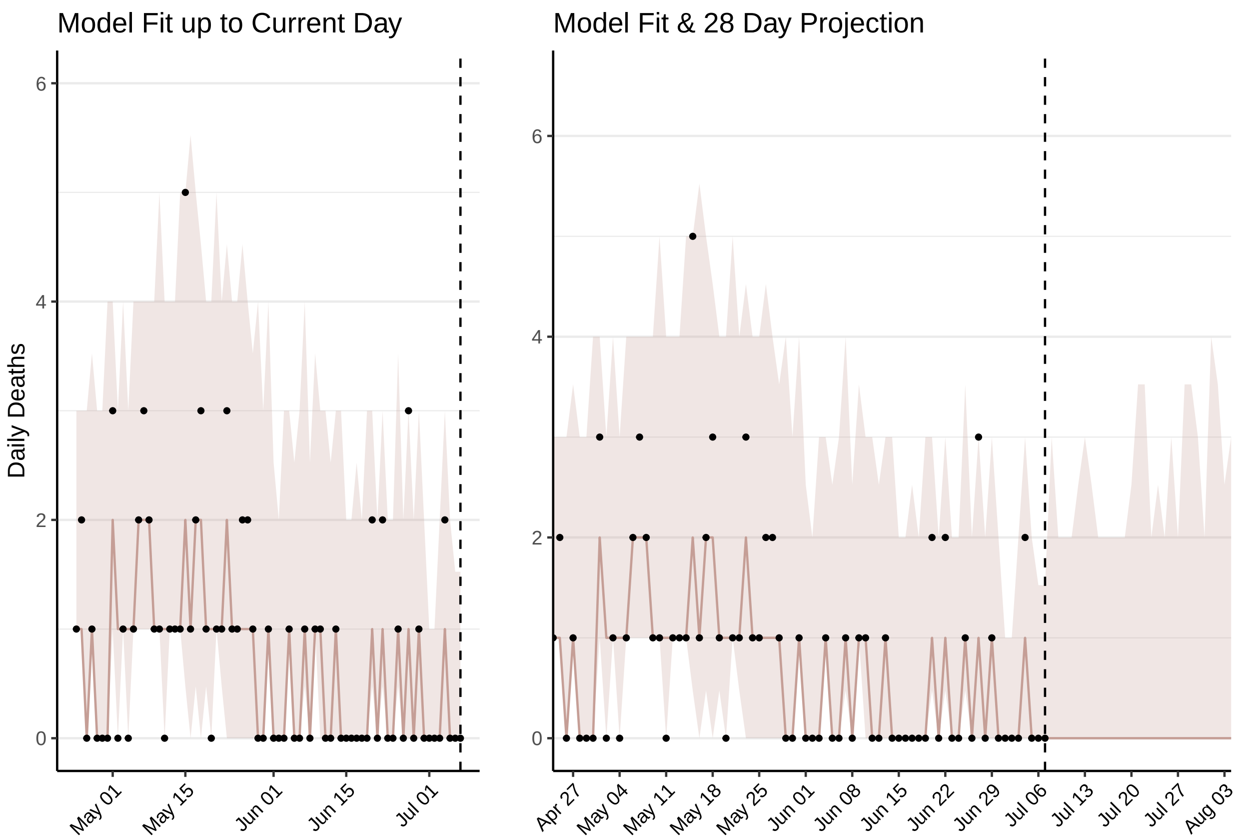

Figure 4: **Estimated daily deaths.** Projected deaths assuming the current level of interventions are maintained are shown in red (median and 95% quantile). Reported deaths are plotted in black. The plot on the left is focussed on the model fit prior to today, while the plot on the right forecasts the next 28 days.

Short-term Epidemic Scenarios

We make the following short-term projections of healthcare demand and new infections under the following three scenarios:

- **Scenario 1.** The epidemic continues to grow at the current rate.
- **Scenario 2.** Countries will further scale up interventions (either increasing current strategies or implementing new interventions) leading to a further 50% reduction in transmission.
- **Scenario 3.** Countries will relax current interventions by 50%

N.B. These scenarios currently assume that the impact of mobility on transmission will remain the same in the future as it has in the past. We are working to extend methods to estimate the impact of increases in mobility on transmission as lockdown and interventions are reversed. Consequently, projection are likely to represent an upper estimate of the healthcare demand and case load for each scenario

We estimate that over the next 4 weeks demand for hospital beds will change from 28 (95% CI: 25-32) patients requiring treatment with high-pressure oxygen at the current date to 32 (95% CI: 26-38) hospital beds being required on 2020-08-04 if no further interventions are introduced (Scenario 1). Similarly, we estimate that over the next 4 weeks demand for critical care (ICU) beds will change from 8 (95% CI: 7-9) patients requiring treatment with mechanical ventilation at the current date to 8 (95% CI: 6-10) by 2020-08-04. These projections assume that approximately 5% of all infections will require treatment with high-pressure oxygen and that approximately 30% of hospitalised cases will require treatment with mechanical ventilation (based on analysis of ongoing epidemics in Europe). **N.B. These scenarios are unlikely to show significant differences for the first week since there is a delay of approximately 10 days between infection and hospital admission. Consequently, the effectiveness of a change in policy is likely to be better captured by hospital admission data approximately 2 weeks after the policy change is implemented.**

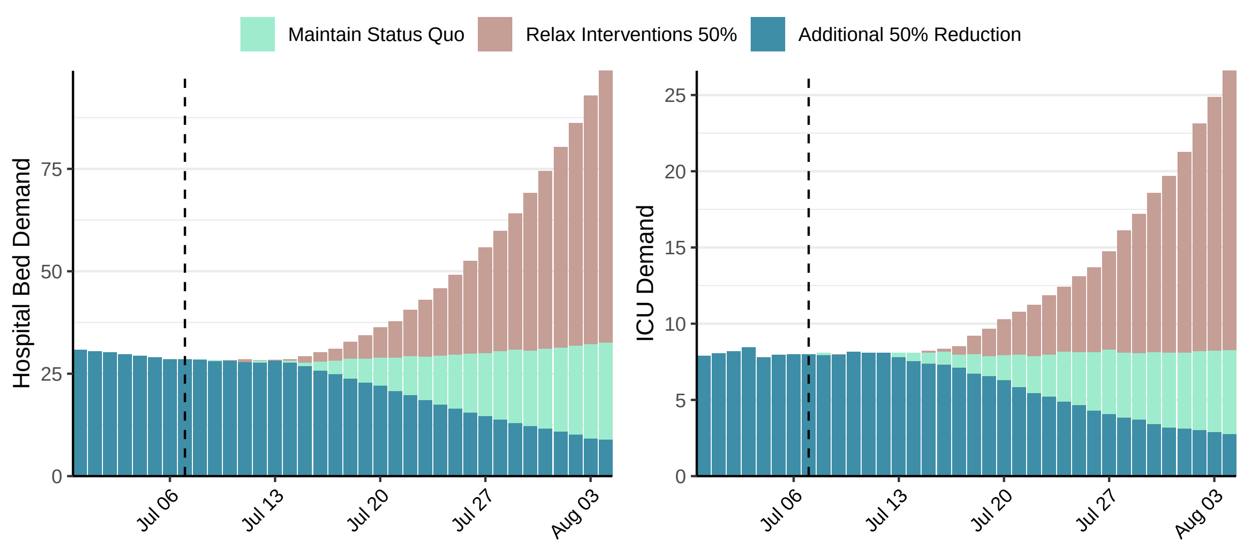

Figure 5: **Healthcare demands in the next 28 days.** Individuals needing an ICU bed are assumed to need mechanical ventilation. Projected demand for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

The impact of each scenario has a more immediate effect on the daily number of infections. The figure below shows the impact of each scenario on the estimated daily incidence of new infections. If interventions are scaled up (Scenario 2), the daily number of infections will change from 187 (95% CI: 161-214) at the current date to 20 (95% CI: 15-24) by 2020-08-04. If current interventions were relaxed by 50%, we estimate the daily number of infections will change from 187 (95% CI: 161-214) at the current date to 1,441 (95% CI: 1,077-1,806) by 2020-08-04.

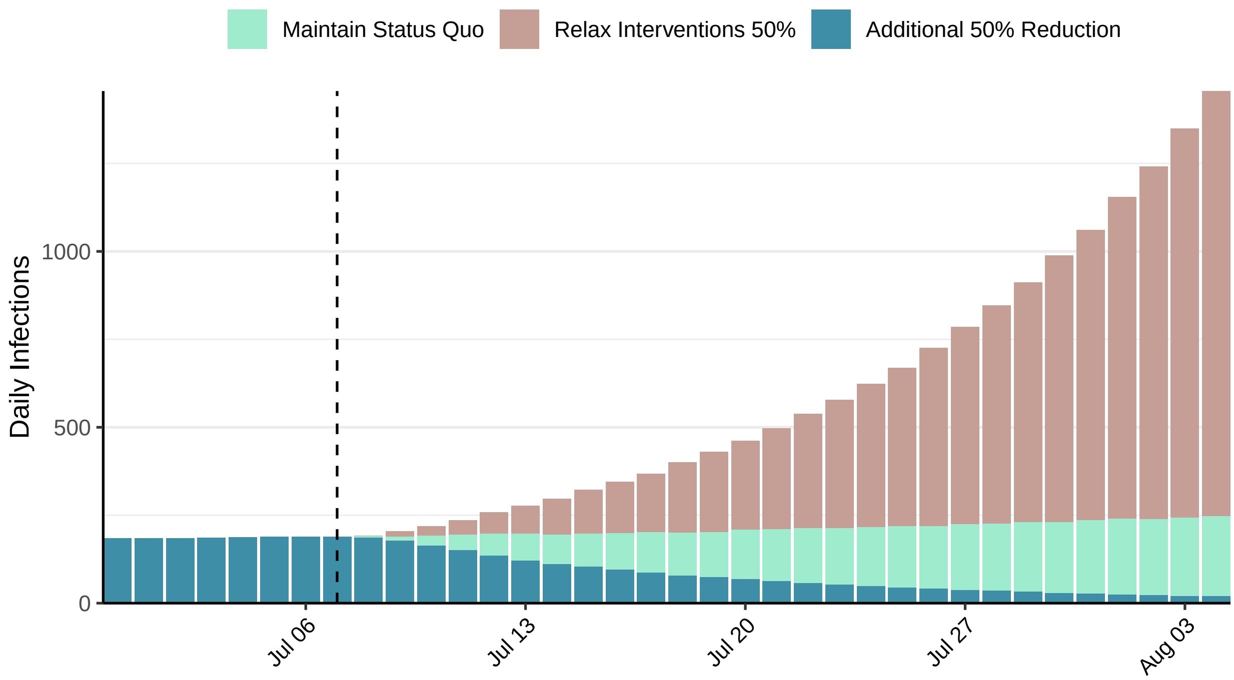

Figure 6: **Daily number of infections estimated by fitting to deaths.** Projected infections for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

To explore different scenarios, we recommend using our COVID-19 Scenario Analysis Tool - https://covidsim.org/, which can be used to simulate different intervention scenarios and explore the long term impact on healthcare demand.

Situation Report for COVID-19: El Salvador, 2020-07-07

Download the report for El Salvador, 2020-07-07 here. This report uses data from the European Centre for Disease Control. These data are updated daily and whilst there may be a short delay, they are generally consistent with Ministry reports. These data are then used to back-calculate an 'inferred number of COVID-19 infections' using mathematical modelling techniques (see Report 12 for further details) to estimate the number of people that have been infected and to make short-term projections for future healthcare needs.

Epidemiological Situation

Total Reported Cases	New Reported Cases	Total Reported Deaths	New Reported Deaths	Estimated R_t
8,027	250	223	6	1.44 (95% CI: 1.26-1.61)

The figure below shows the cumulative reported deaths as a function of the time since the 10th death was reported. Dashed lines show the expected trajectory for different doubling times of the epidemic. For example, with a doubling time of 3 days, if there are currently a total of 20 deaths reported, we would expect there to be 40 deaths in total reported in 3 days-time, 80 deaths in 6 days-time, 160 deaths in 9 days-time etc. For most epidemics, in the absence of interventions, we expect a doubling time of 3-4 days for this disease.

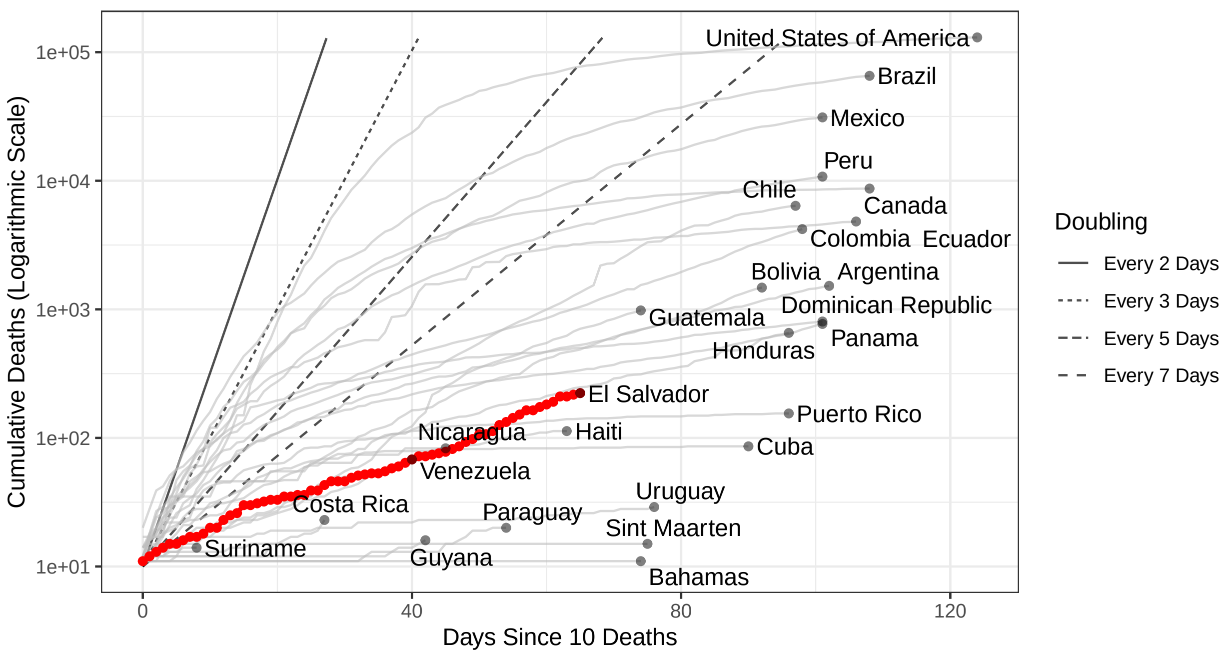

Figure 1: **Cumulative Deaths since 10 deaths.** Country not shown if fewer than 10 deaths.

COVID-19 Transmission Modelling

We assume that the deaths reported to date provide the best indication of the stage of the epidemic, as deaths are more consistently and accurately reported. Our current working estimate is that 1 death indicates that approximately 100 people will have been infected with the other 99 recovering (based on an infection fatality ratio of ~1%). These infections will have happened approximately 21 days previously – capturing a 5-day period from infection to onset of symptoms (the incubation period), 4 days from onset of symptoms to hospitalisation, and 12 days in hospital before death. With a 3-day doubling time, 100 infections that occurred 15 days ago will have generated 200 infections 12 days ago, 400 infections 9 days ago, 800 infections 6 days ago and 1,600 infections 3 days ago resulting in approximately 3,200 infections at the time the first death is observed.

To explore this, we fit our age-structured SEIR model (see Methods) to the time series of deaths in a country, in order to estimate the start date of the epidemic and the baseline R0. We assume that 100% of COVID-19 related deaths have been reported. We have also included the impact of interventions that have been put in place and their effect on human mobility and transmission based on the Google COVID-19 Community Mobility Reports. Using our mathematical model that formalises this approach, we estimate that there has been a total of 160,544 (95% CI: 143,778-177,309) infections over the past 4 weeks.

The figure below shows the estimated number of people infected over the past 4 weeks. The bar charts show, for comparison, the number of reported cases. The right-hand plot shows these data on a different scale as the estimated infections are likely to be much larger than the reported cases. **Importantly**, the estimated infections includes both asymptomatic and mild cases that would not necessarily be identified through surveillance. Consequently, the estimated infections are likely to be significantly higher than the reported cases (see our FAQ for further explanation of these differences and why the reported cases and estimated infections are unlikely to match).

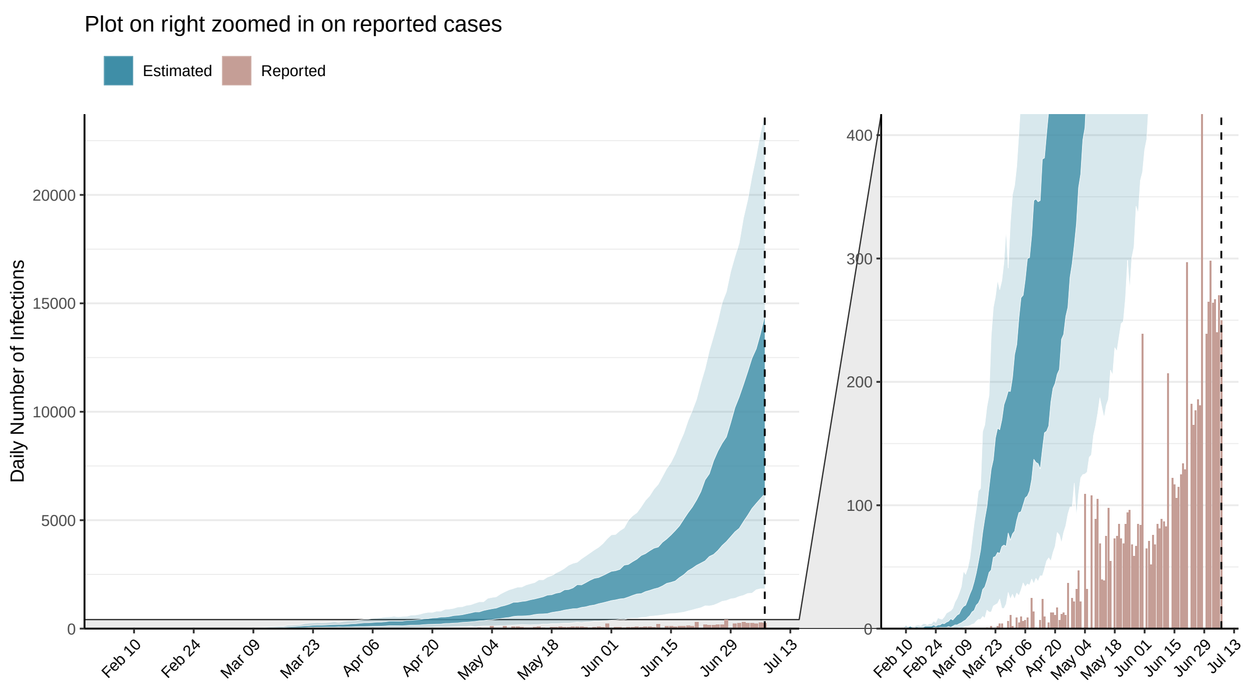

Figure 2: **Daily number of infections estimated by fitting to the current total of deaths.** Reported cases are shown in red. Model estimated infections are shown in blue (dark blue 50% interquartile range, light blue 95% quantile). The dashed line shows the current day.

By fitting to the time series of deaths, we are able to estimate a time-varying reproduction number, R_t. R_t is the the average number of secondary infections caused by a single infected person at a given time. If R_t is above 1, the rate of transmission is increasing and the number of new infections is increasing. R_t is assumed to change in relation to mobility fall in proportion. When fitting our model we assume that 100% of COVID-19 related deaths have been reported (please see our FAQ section for more information about this assumption). We also assume a fixed date at which the impact of mobility on transmission changes from pre-lockdown levels to post-lockdown levels, which may cause large changes in Rt. We are working to refine how this switch occurs and to formally calculate its shape.

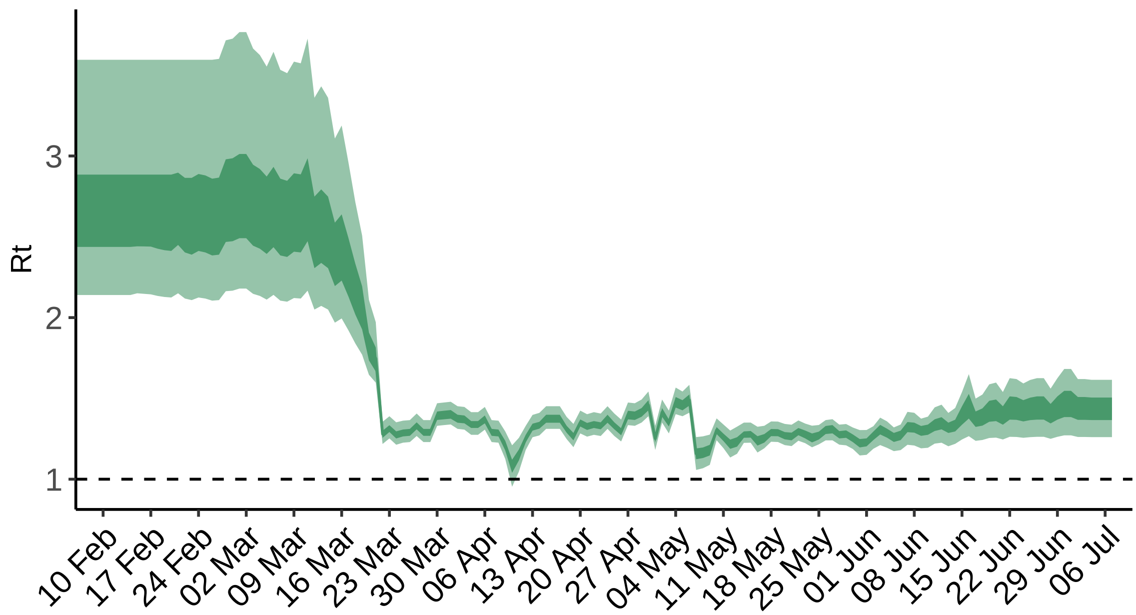

Figure 3: **Time-varying reproduction number, R_t.** R_t is the average number of secondary infections caused by a single infected person at time equal to t. $R_t < 1$ indicates a slowing epidemic in which new infections are not increasing. $R_t > 1$ indicates a growing epidemic in which new infections are increasing over time. Dark green shows the 50% CI and light green shows the 95% CI.

Using the model fit, we can forecast the expected trajectory for cumulative deaths, which is shown in the figure below. This assumes a severity pattern by age that is consistent with that observed in China, Europe and the U.S to date. This projection assumes that transmission is maintained at the current level of transmission as estimated by the final R_t value. **N.B. El Salvador is forecast to be close to or surpassing our best estimates for healthcare capacity in the next 28 days.** Estimates of deaths in the next 28 days may be inaccurate due to our working assumptions for mortality in individuals who do not receive appropriate treatment. See our methods for more information.

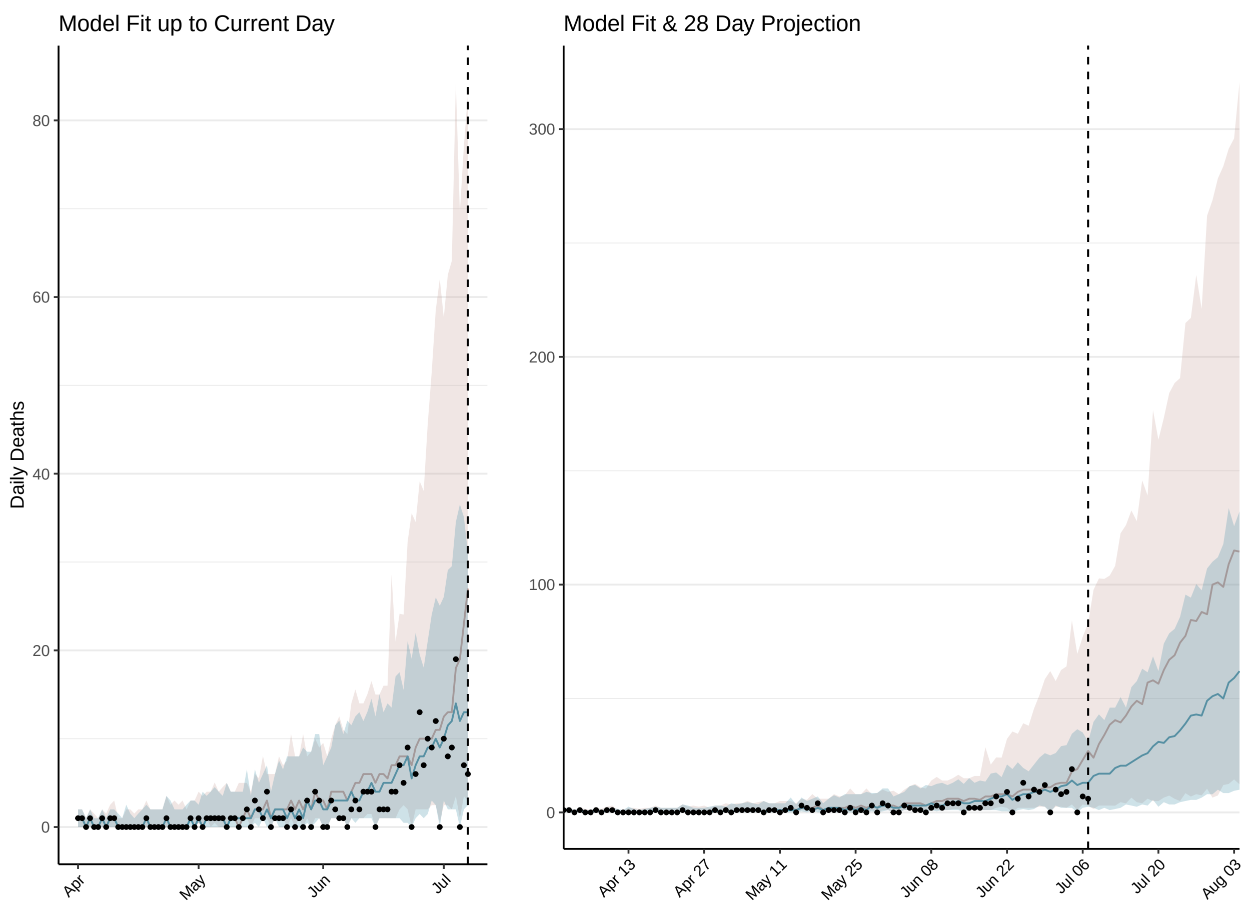

Figure 4: **Estimated daily deaths.** Projected deaths assuming the current level of interventions are maintained are shown in red (median and 95% quantile). Reported deaths are plotted in black. The plot on the left is focussed on the model fit prior to today, while the plot on the right forecasts the next 28 days. The forecasted deaths in blue assumes healthcare capacity has been surged to ensure sufficient supply of ICU and hospital beds. The red curve assumes no surging in healthcare capacity and subsequently projects increased deaths.

Short-term Epidemic Scenarios

We make the following short-term projections of healthcare demand and new infections under the following three scenarios:

- **Scenario 1.** The epidemic continues to grow at the current rate.
- **Scenario 2.** Countries will further scale up interventions (either increasing current strategies or implementing new interventions) leading to a further 50% reduction in transmission.
- **Scenario 3.** Countries will relax current interventions by 50%

N.B. These scenarios currently assume that the impact of mobility on transmission will remain the same in the future as it has in the past. We are working to extend methods to estimate the impact of increases in mobility on transmission as lockdown and interventions are reversed. Consequently, projection are likely to represent an upper estimate of the healthcare demand and case load for each scenario

We estimate that over the next 4 weeks demand for hospital beds will change from 907 (95% CI: 811-1,003) patients requiring treatment with high-pressure oxygen at the current date to 3,258 (95% CI: 2,893-3,622) hospital beds being required on 2020-08-04 if no further interventions are introduced (Scenario 1). Similarly, we estimate that over the next 4 weeks demand for critical care (ICU) beds will change from 215 (95% CI: 201-229) patients requiring treatment with mechanical ventilation at the current date to 356 (95% CI: 335-377) by 2020-08-04. These projections assume that approximately 5% of all infections will require treatment with high-pressure oxygen and that approximately 30% of hospitalised cases will require treatment with mechanical ventilation (based on analysis of ongoing epidemics in Europe). **N.B. These scenarios are unlikely to show significant differences for the first week since there is a delay of approximately 10 days between infection and hospital admission. Consequently, the effectiveness of a change in policy is likely to be better captured by hospital admission data approximately 2 weeks after the policy change is implemented.**

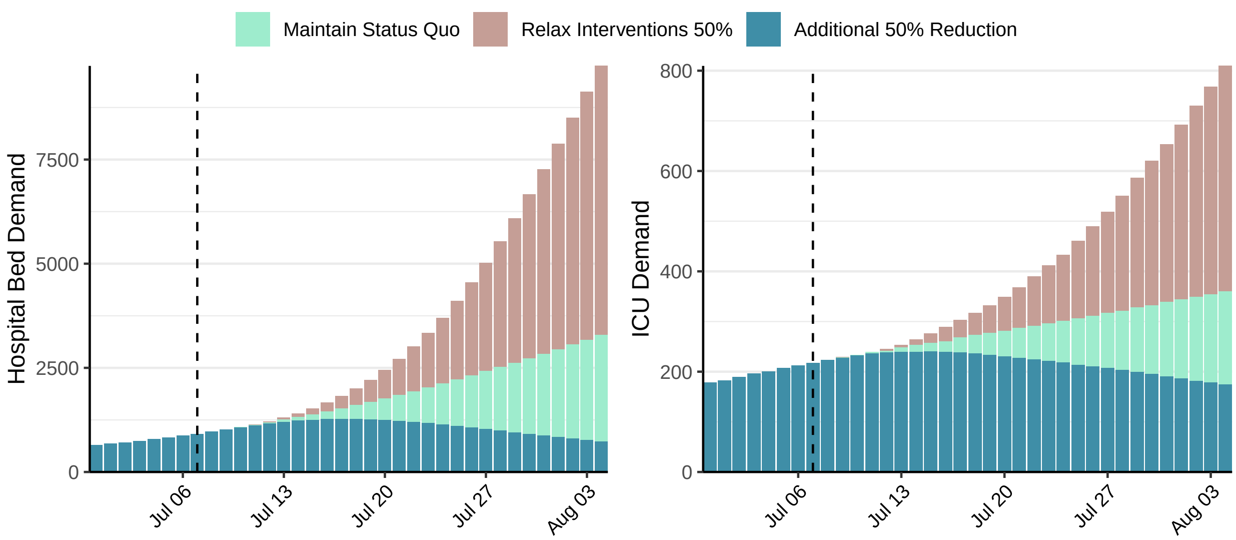

Figure 5: **Healthcare demands in the next 28 days.** Individuals needing an ICU bed are assumed to need mechanical ventilation. Projected demand for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

The impact of each scenario has a more immediate effect on the daily number of infections. The figure below shows the impact of each scenario on the estimated daily incidence of new infections. If interventions are scaled up (Scenario 2), the daily number of infections will change from 10,497 (95% CI: 9,365-11,630) at the current date to 2,433 (95% CI: 2,144-2,722) by 2020-08-04. If current interventions were relaxed by 50%, we estimate the daily number of infections will change from 10,497 (95% CI: 9,365-11,630) at the current date to 107,095 (95% CI: 100,220-113,970) by 2020-08-04.

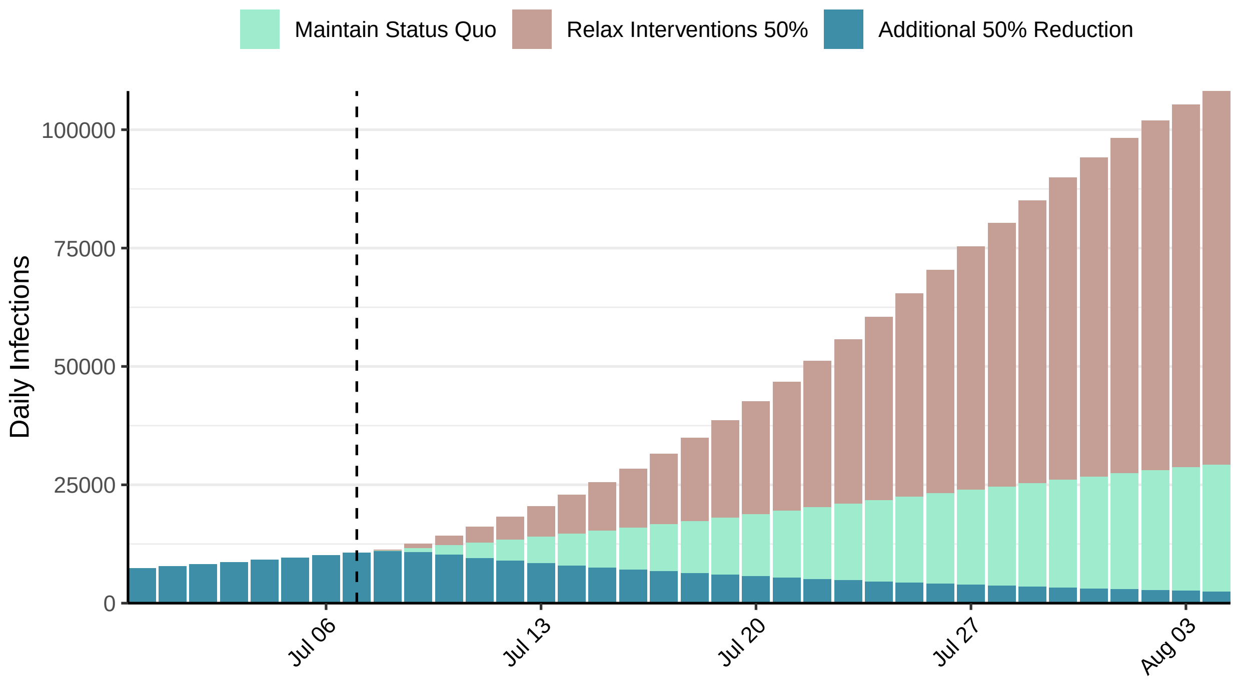

Figure 6: **Daily number of infections estimated by fitting to deaths.** Projected infections for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

To explore different scenarios, we recommend using our COVID-19 Scenario Analysis Tool - https://covidsim.org/, which can be used to simulate different intervention scenarios and explore the long term impact on healthcare demand.

Situation Report for COVID-19: Somalia, 2020-07-07

Download the report for Somalia, 2020-07-07 here. This report uses data from the European Centre for Disease Control. These data are updated daily and whilst there may be a short delay, they are generally consistent with Ministry reports. These data are then used to back-calculate an 'inferred number of COVID-19 infections' using mathematical modelling techniques (see Report 12 for further details) to estimate the number of people that have been infected and to make short-term projections for future healthcare needs.

Epidemiological Situation

Total Reported Cases	New Reported Cases	Total Reported Deaths	New Reported Deaths	Estimated R_t
3,006	9	92	0	0.6 (95% CI: 0.46-0.75)

The figure below shows the cumulative reported deaths as a function of the time since the 10th death was reported. Dashed lines show the expected trajectory for different doubling times of the epidemic. For example, with a doubling time of 3 days, if there are currently a total of 20 deaths reported, we would expect there to be 40 deaths in total reported in 3 days-time, 80 deaths in 6 days-time, 160 deaths in 9 days-time etc. For most epidemics, in the absence of interventions, we expect a doubling time of 3-4 days for this disease.

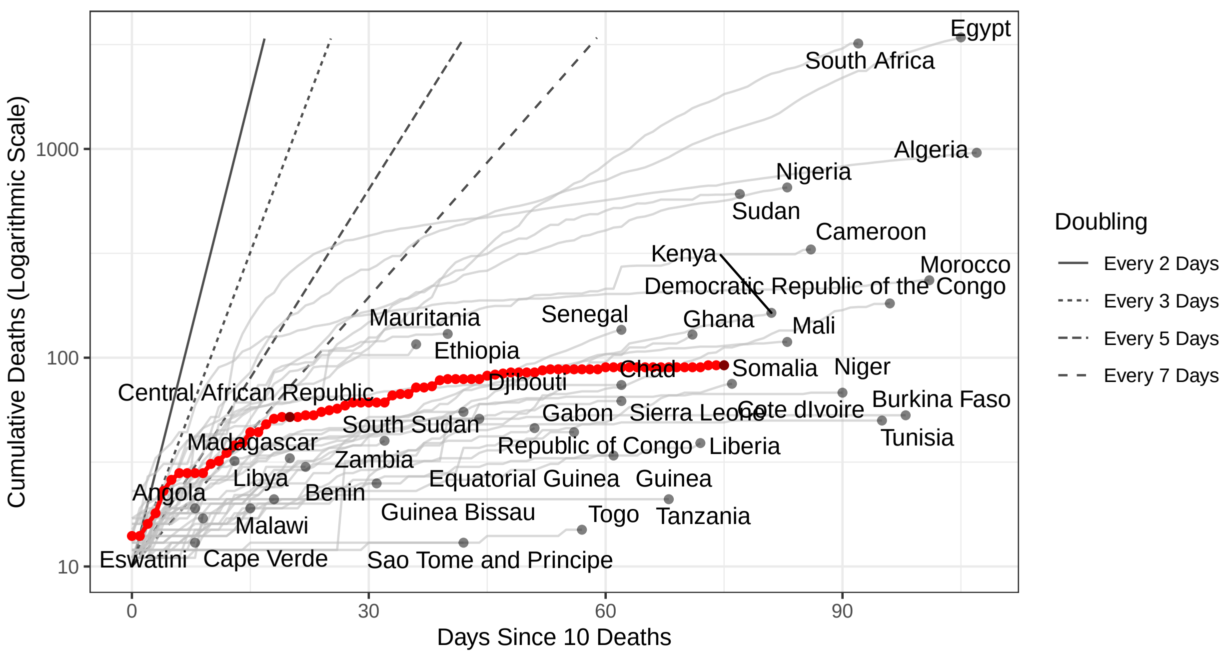

Figure 1: **Cumulative Deaths since 10 deaths.** Country not shown if fewer than 10 deaths.

COVID-19 Transmission Modelling

We assume that the deaths reported to date provide the best indication of the stage of the epidemic, as deaths are more consistently and accurately reported. Our current working estimate is that 1 death indicates that approximately 100 people will have been infected with the other 99 recovering (based on an infection fatality ratio of ~1%). These infections will have happened approximately 21 days previously – capturing a 5-day period from infection to onset of symptoms (the incubation period), 4 days from onset of symptoms to hospitalisation, and 12 days in hospital before death. With a 3-day doubling time, 100 infections that occurred 15 days ago will have generated 200 infections 12 days ago, 400 infections 9 days ago, 800 infections 6 days ago and 1,600 infections 3 days ago resulting in approximately 3,200 infections at the time the first death is observed.

To explore this, we fit our age-structured SEIR model (see Methods) to the time series of deaths in a country, in order to estimate the start date of the epidemic and the baseline R0. We assume that 100% of COVID-19 related deaths have been reported. We have also included the impact of interventions that have been put in place and their effect on human mobility and transmission based on the Google COVID-19 Community Mobility Reports. Using our mathematical model that formalises this approach, we estimate that there has been a total of 2,030 (95% CI: 1,742-2,319) infections over the past 4 weeks.

The figure below shows the estimated number of people infected over the past 4 weeks. The bar charts show, for comparison, the number of reported cases. The right-hand plot shows these data on a different scale as the estimated infections are likely to be much larger than the reported cases. **Importantly**, the estimated infections includes both asymptomatic and mild cases that would not necessarily be identified through surveillance. Consequently, the estimated infections are likely to be significantly higher than the reported cases (see our FAQ for further explanation of these differences and why the reported cases and estimated infections are unlikely to match).

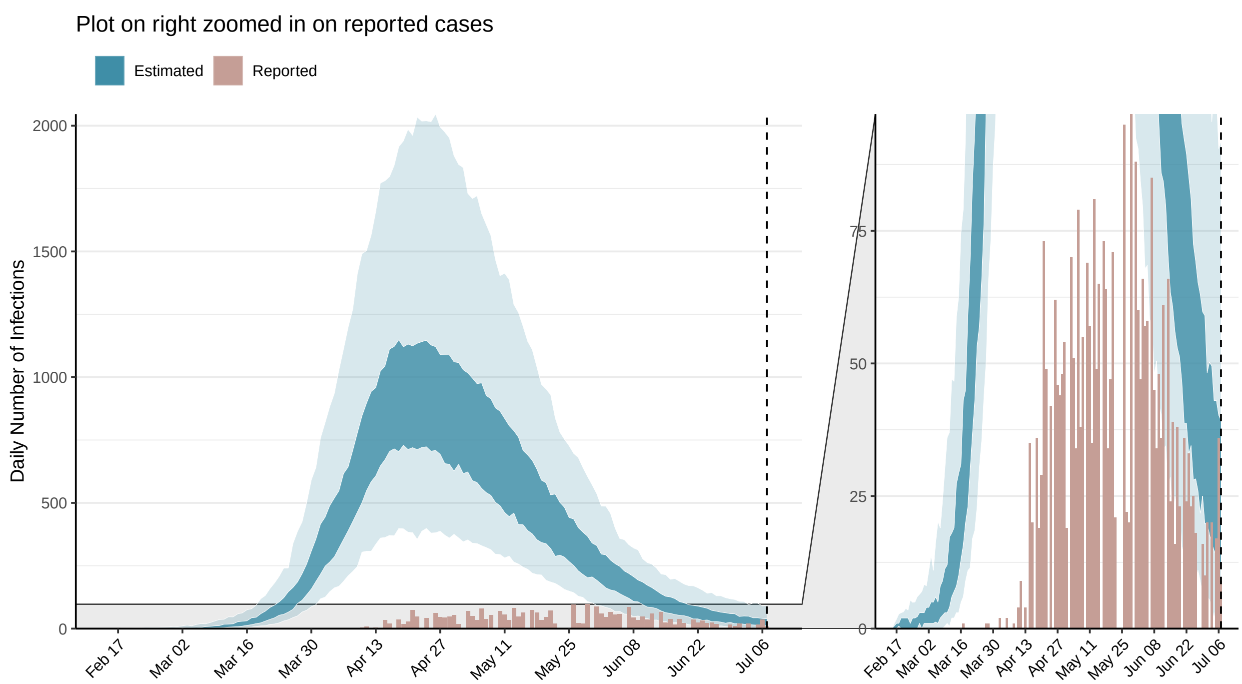

Figure 2: **Daily number of infections estimated by fitting to the current total of deaths.** Reported cases are shown in red. Model estimated infections are shown in blue (dark blue 50% interquartile range, light blue 95% quantile). The dashed line shows the current day.

By fitting to the time series of deaths, we are able to estimate a time-varying reproduction number, R_t. R_t is the the average number of secondary infections caused by a single infected person at a given time. If R_t is above 1, the rate of transmission is increasing and the number of new infections is increasing. R_t is assumed to change in relation to mobility fall in proportion. When fitting our model we assume that 100% of COVID-19 related deaths have been reported (please see our FAQ section for more information about this assumption). We also assume a fixed date at which the impact of mobility on transmission changes from pre-lockdown levels to post-lockdown levels, which may cause large changes in Rt. We are working to refine how this switch occurs and to formally calculate its shape.

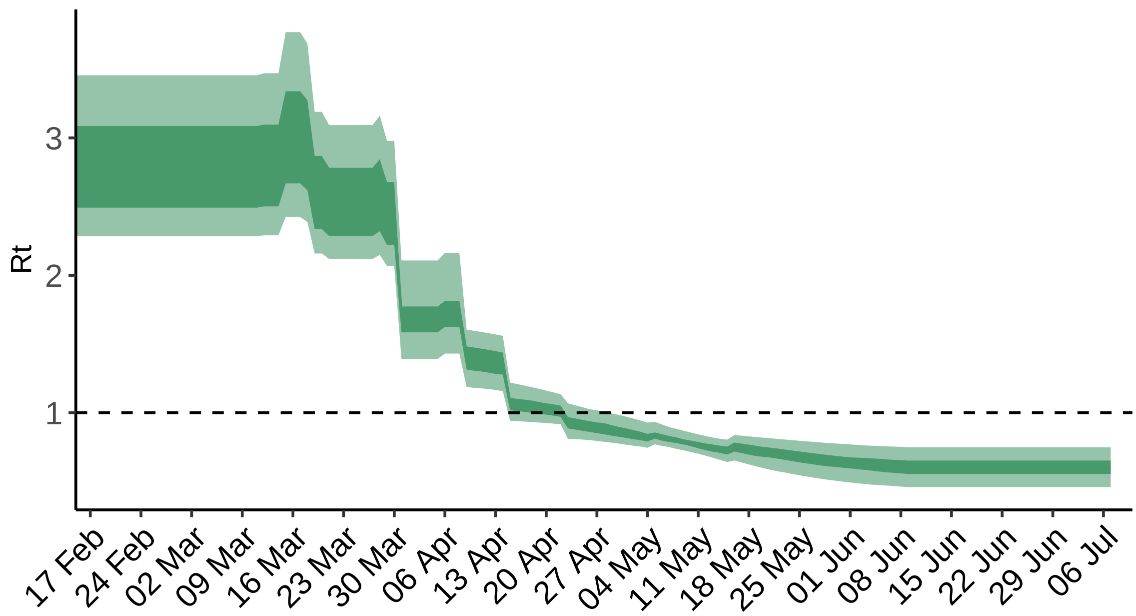

Figure 3: **Time-varying reproduction number, R_t.** R_t is the average number of secondary infections caused by a single infected person at time equal to t. $R_t < 1$ indicates a slowing epidemic in which new infections are not increasing. $R_t > 1$ indicates a growing epidemic in which new infections are increasing over time. Dark green shows the 50% CI and light green shows the 95% CI.

Using the model fit, we can forecast the expected trajectory for cumulative deaths, which is shown in the figure below. This assumes a severity pattern by age that is consistent with that observed in China, Europe and the U.S to date. This projection assumes that transmission is maintained at the current level of transmission as estimated by the final R_t value.

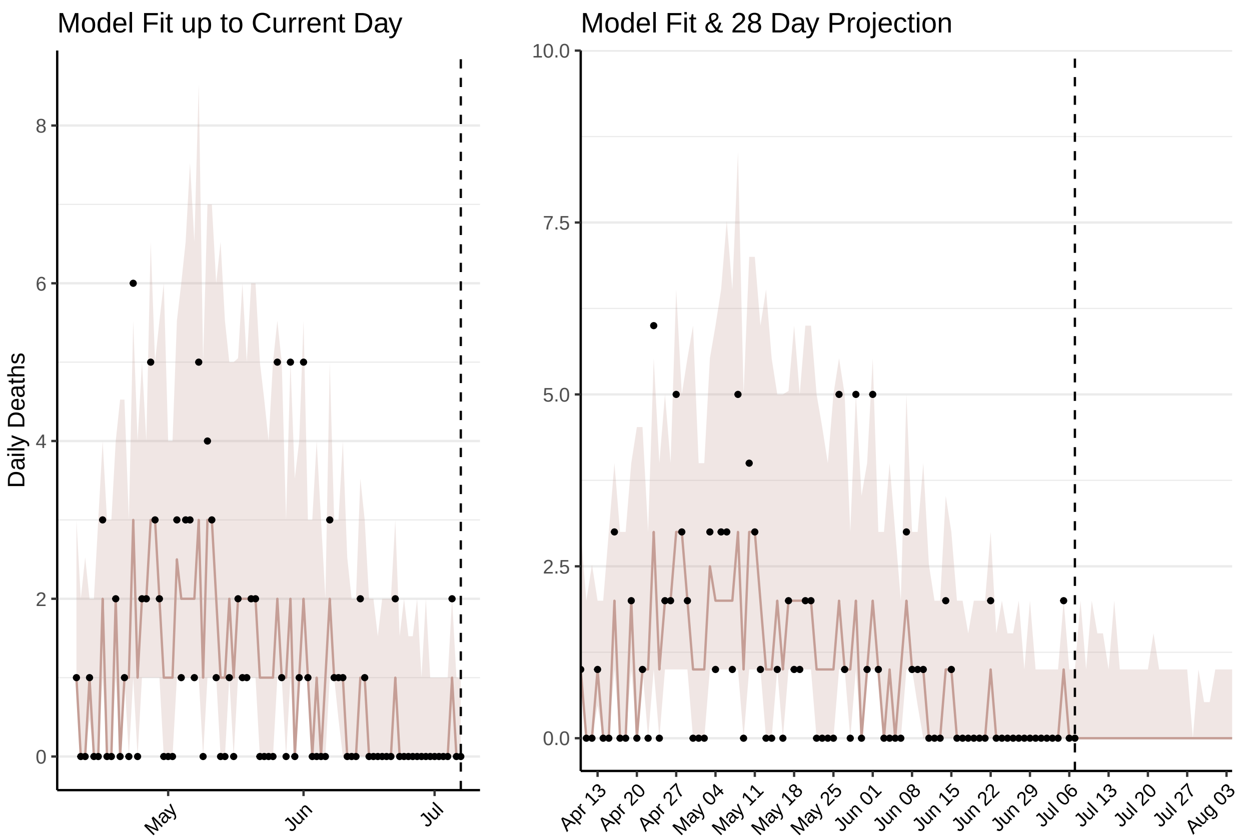

Figure 4: **Estimated daily deaths.** Projected deaths assuming the current level of interventions are maintained are shown in red (median and 95% quantile). Reported deaths are plotted in black. The plot on the left is focussed on the model fit prior to today, while the plot on the right forecasts the next 28 days.

Short-term Epidemic Scenarios

We make the following short-term projections of healthcare demand and new infections under the following three scenarios:

- **Scenario 1.** The epidemic continues to grow at the current rate.
- **Scenario 2.** Countries will further scale up interventions (either increasing current strategies or implementing new interventions) leading to a further 50% reduction in transmission.
- **Scenario 3.** Countries will relax current interventions by 50%

N.B. These scenarios currently assume that the impact of mobility on transmission will remain the same in the future as it has in the past. We are working to extend methods to estimate the impact of increases in mobility on transmission as lockdown and interventions are reversed. Consequently, projection are likely to represent an upper estimate of the healthcare demand and case load for each scenario

We estimate that over the next 4 weeks demand for hospital beds will change from 8 (95% CI: 7-10) patients requiring treatment with high-pressure oxygen at the current date to 2 (95% CI: 1-2) hospital beds being required on 2020-08-04 if no further interventions are introduced (Scenario 1). Similarly, we estimate that over the next 4 weeks demand for critical care (ICU) beds will change from 3 (95% CI: 2-3) patients requiring treatment with mechanical ventilation at the current date to 0 (95% CI: 0-1) by 2020-08-04. These projections assume that approximately 5% of all infections will require treatment with high-pressure oxygen and that approximately 30% of hospitalised cases will require treatment with mechanical ventilation (based on analysis of ongoing epidemics in Europe). **N.B. These scenarios are unlikely to show significant differences for the first week since there is a delay of approximately 10 days between infection and hospital admission. Consequently, the effectiveness of a change in policy is likely to be better captured by hospital admission data approximately 2 weeks after the policy change is implemented.**

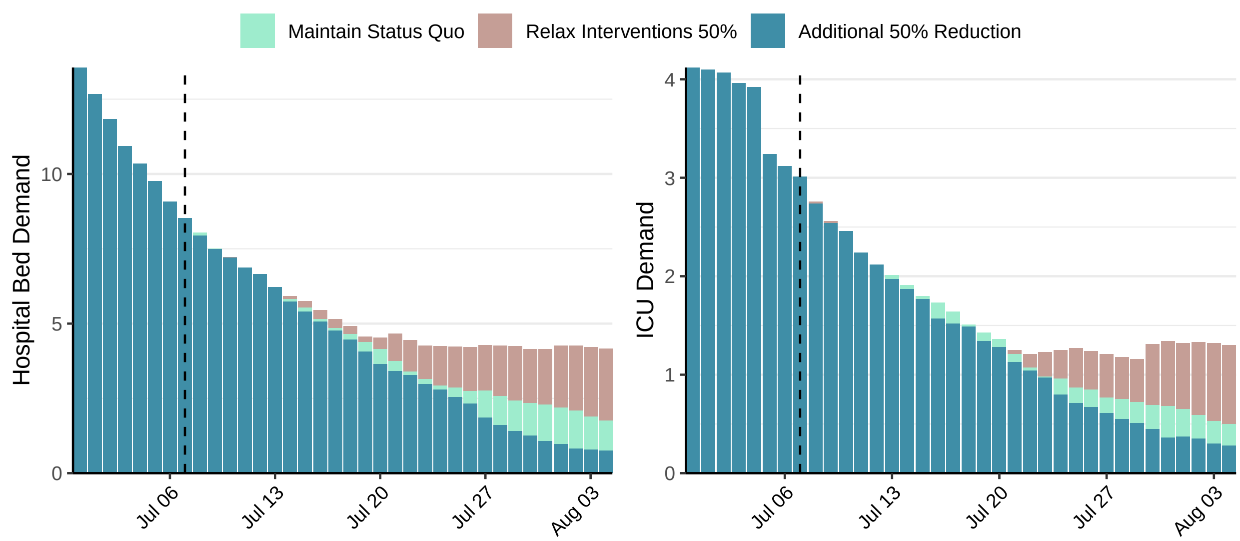

Figure 5: **Healthcare demands in the next 28 days.** Individuals needing an ICU bed are assumed to need mechanical ventilation. Projected demand for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

The impact of each scenario has a more immediate effect on the daily number of infections. The figure below shows the impact of each scenario on the estimated daily incidence of new infections. If interventions are scaled up (Scenario 2), the daily number of infections will change from 29 (95% CI: 23-34) at the current date to 1 (95% CI: 0-1) by 2020-08-04. If current interventions were relaxed by 50%, we estimate the daily number of infections will change from 29 (95% CI: 23-34) at the current date to 30 (95% CI: 20-39) by 2020-08-04.

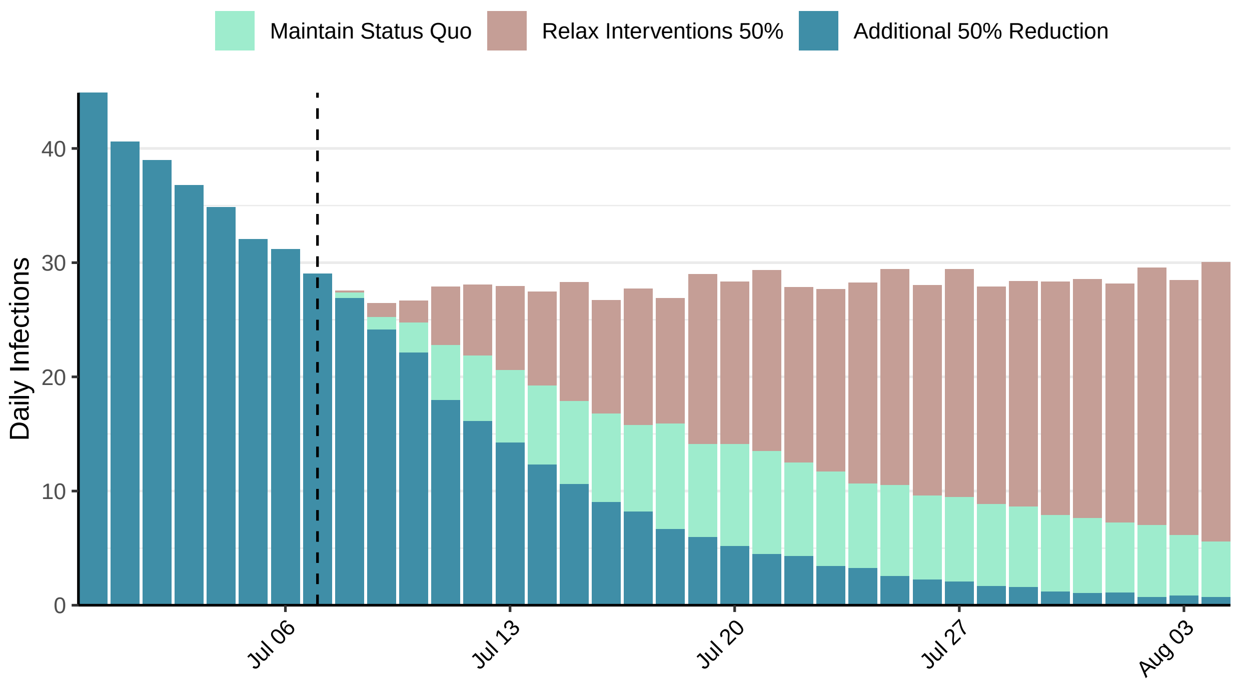

Figure 6: **Daily number of infections estimated by fitting to deaths.** Projected infections for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

To explore different scenarios, we recommend using our COVID-19 Scenario Analysis Tool - https://covidsim.org/, which can be used to simulate different intervention scenarios and explore the long term impact on healthcare demand.

Situation Report for COVID-19: Serbia, 2020-07-07

Download the report for Serbia, 2020-07-07 here. This report uses data from the European Centre for Disease Control. These data are updated daily and whilst there may be a short delay, they are generally consistent with Ministry reports. These data are then used to back-calculate an 'inferred number of COVID-19 infections' using mathematical modelling techniques (see Report 12 for further details) to estimate the number of people that have been infected and to make short-term projections for future healthcare needs.

Epidemiological Situation

Total Reported Cases	New Reported Cases	Total Reported Deaths	New Reported Deaths	Estimated R_t
16,420	289	317	6	1.14 (95% CI: 1.07-1.2)

The figure below shows the cumulative reported deaths as a function of the time since the 10th death was reported. Dashed lines show the expected trajectory for different doubling times of the epidemic. For example, with a doubling time of 3 days, if there are currently a total of 20 deaths reported, we would expect there to be 40 deaths in total reported in 3 days-time, 80 deaths in 6 days-time, 160 deaths in 9 days-time etc. For most epidemics, in the absence of interventions, we expect a doubling time of 3-4 days for this disease.

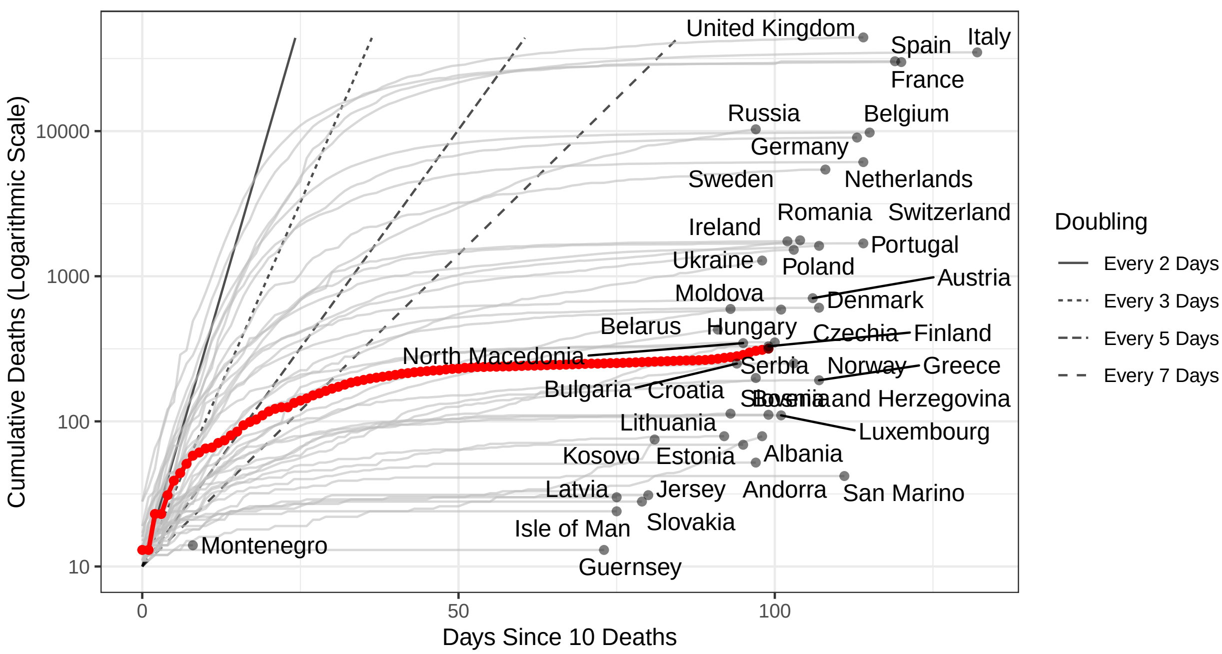

Figure 1: **Cumulative Deaths since 10 deaths.** Country not shown if fewer than 10 deaths.

COVID-19 Transmission Modelling

We assume that the deaths reported to date provide the best indication of the stage of the epidemic, as deaths are more consistently and accurately reported. Our current working estimate is that 1 death indicates that approximately 100 people will have been infected with the other 99 recovering (based on an infection fatality ratio of ~1%). These infections will have happened approximately 21 days previously – capturing a 5-day period from infection to onset of symptoms (the incubation period), 4 days from onset of symptoms to hospitalisation, and 12 days in hospital before death. With a 3-day doubling time, 100 infections that occurred 15 days ago will have generated 200 infections 12 days ago, 400 infections 9 days ago, 800 infections 6 days ago and 1,600 infections 3 days ago resulting in approximately 3,200 infections at the time the first death is observed.

To explore this, we fit our age-structured SEIR model (see Methods) to the time series of deaths in a country, in order to estimate the start date of the epidemic and the baseline R0. We assume that 100% of COVID-19 related deaths have been reported. We have also included the impact of interventions that have been put in place and their effect on human mobility and transmission based on the Google COVID-19 Community Mobility Reports. Using our mathematical model that formalises this approach, we estimate that there has been a total of 18,799 (95% CI: 17,033-20,565) infections over the past 4 weeks.

The figure below shows the estimated number of people infected over the past 4 weeks. The bar charts show, for comparison, the number of reported cases. The right-hand plot shows these data on a different scale as the estimated infections are likely to be much larger than the reported cases. **Importantly**, the estimated infections includes both asymptomatic and mild cases that would not necessarily be identified through surveillance. Consequently, the estimated infections are likely to be significantly higher than the reported cases (see our FAQ for further explanation of these differences and why the reported cases and estimated infections are unlikely to match).

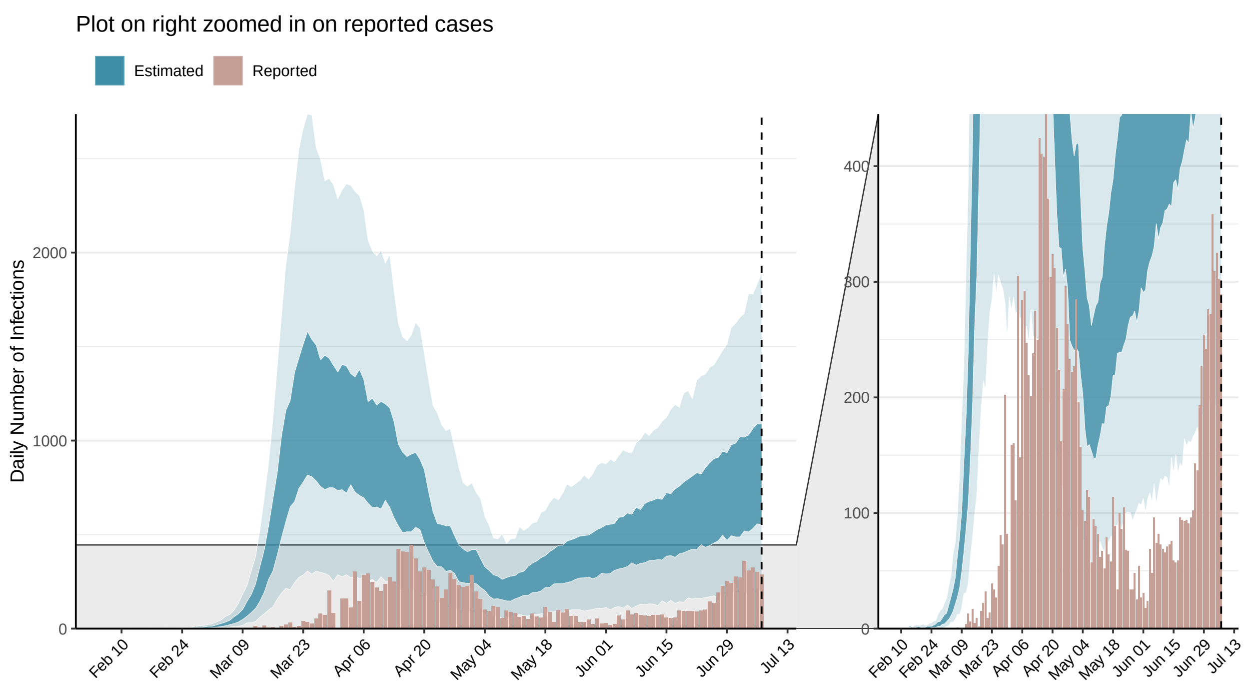

Figure 2: **Daily number of infections estimated by fitting to the current total of deaths.** Reported cases are shown in red. Model estimated infections are shown in blue (dark blue 50% interquartile range, light blue 95% quantile). The dashed line shows the current day.

By fitting to the time series of deaths, we are able to estimate a time-varying reproduction number, R_t. R_t is the the average number of secondary infections caused by a single infected person at a given time. If R_t is above 1, the rate of transmission is increasing and the number of new infections is increasing. R_t is assumed to change in relation to mobility fall in proportion. When fitting our model we assume that 100% of COVID-19 related deaths have been reported (please see our FAQ section for more information about this assumption). We also assume a fixed date at which the impact of mobility on transmission changes from pre-lockdown levels to post-lockdown levels, which may cause large changes in Rt. We are working to refine how this switch occurs and to formally calculate its shape.

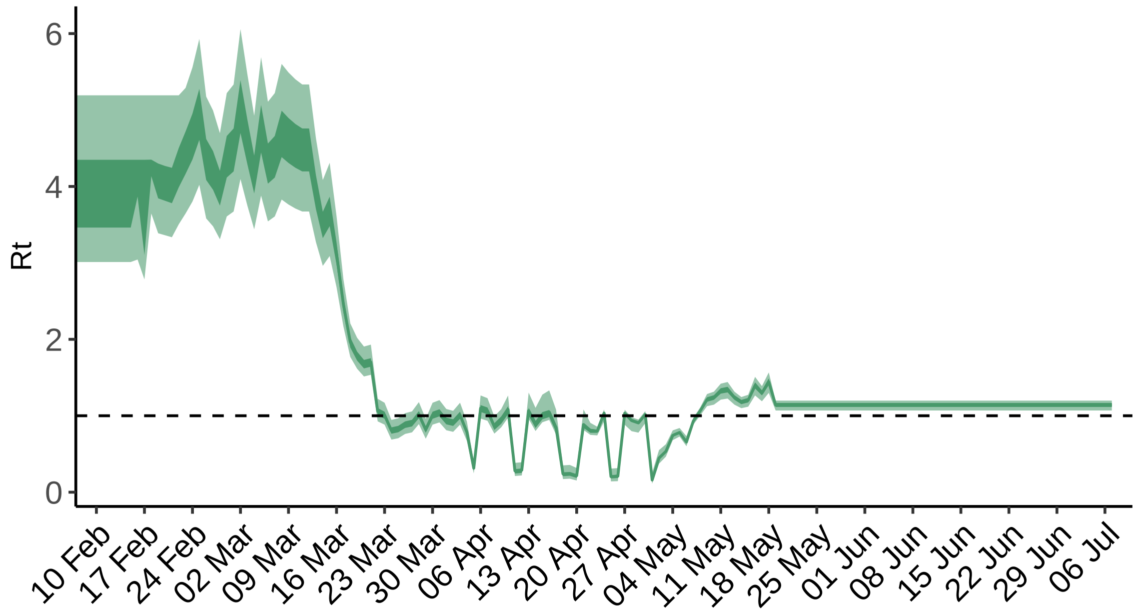

Figure 3: **Time-varying reproduction number, R_t.** R_t is the average number of secondary infections caused by a single infected person at time equal to t. $R_t < 1$ indicates a slowing epidemic in which new infections are not increasing. $R_t > 1$ indicates a growing epidemic in which new infections are increasing over time. Dark green shows the 50% CI and light green shows the 95% CI.

Using the model fit, we can forecast the expected trajectory for cumulative deaths, which is shown in the figure below. This assumes a severity pattern by age that is consistent with that observed in China, Europe and the U.S to date. This projection assumes that transmission is maintained at the current level of transmission as estimated by the final R_t value.

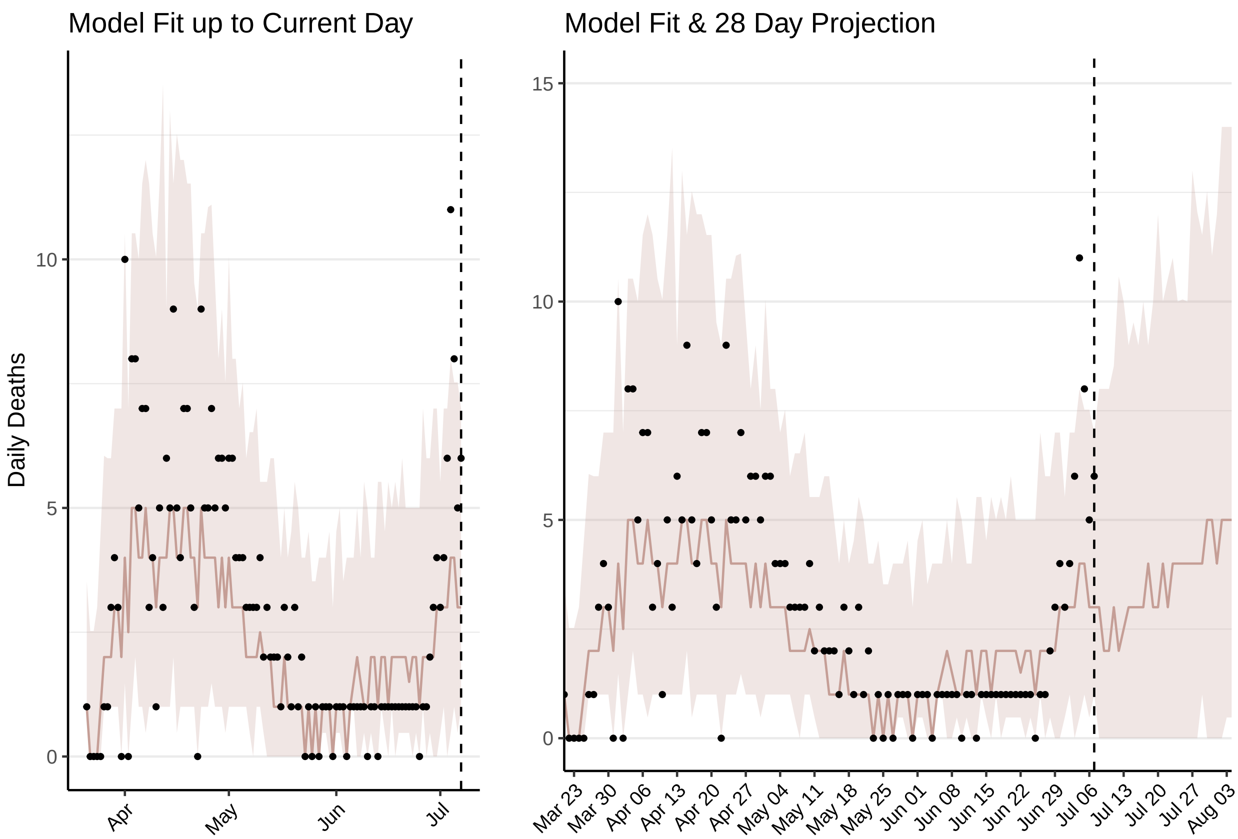

Figure 4: **Estimated daily deaths.** Projected deaths assuming the current level of interventions are maintained are shown in red (median and 95% quantile). Reported deaths are plotted in black. The plot on the left is focussed on the model fit prior to today, while the plot on the right forecasts the next 28 days.

Short-term Epidemic Scenarios

We make the following short-term projections of healthcare demand and new infections under the following three scenarios:

- **Scenario 1.** The epidemic continues to grow at the current rate.
- **Scenario 2.** Countries will further scale up interventions (either increasing current strategies or implementing new interventions) leading to a further 50% reduction in transmission.
- **Scenario 3.** Countries will relax current interventions by 50%

N.B. These scenarios currently assume that the impact of mobility on transmission will remain the same in the future as it has in the past. We are working to extend methods to estimate the impact of increases in mobility on transmission as lockdown and interventions are reversed. Consequently, projection are likely to represent an upper estimate of the healthcare demand and case load for each scenario

We estimate that over the next 4 weeks demand for hospital beds will change from 148 (95% CI: 134-162) patients requiring treatment with high-pressure oxygen at the current date to 259 (95% CI: 231-286) hospital beds being required on 2020-08-04 if no further interventions are introduced (Scenario 1). Similarly, we estimate that over the next 4 weeks demand for critical care (ICU) beds will change from 45 (95% CI: 40-50) patients requiring treatment with mechanical ventilation at the current date to 79 (95% CI: 71-87) by 2020-08-04. These projections assume that approximately 5% of all infections will require treatment with high-pressure oxygen and that approximately 30% of hospitalised cases will require treatment with mechanical ventilation (based on analysis of ongoing epidemics in Europe). **N.B. These scenarios are unlikely to show significant differences for the first week since there is a delay of approximately 10 days between infection and hospital admission. Consequently, the effectiveness of a change in policy is likely to be better captured by hospital admission data approximately 2 weeks after the policy change is implemented.**

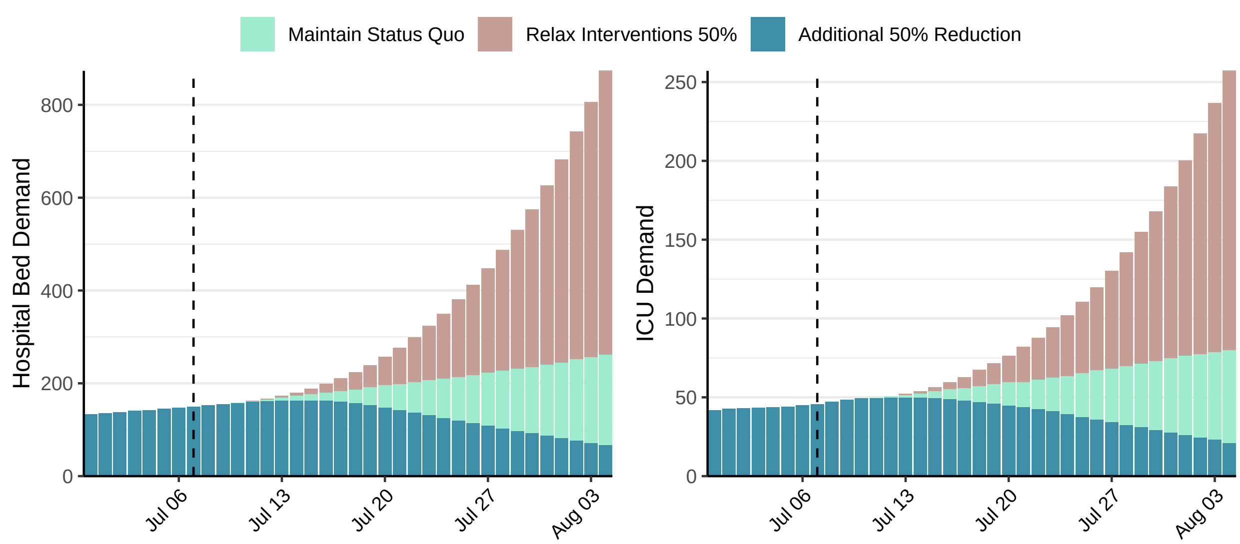

Figure 5: **Healthcare demands in the next 28 days.** Individuals needing an ICU bed are assumed to need mechanical ventilation. Projected demand for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

The impact of each scenario has a more immediate effect on the daily number of infections. The figure below shows the impact of each scenario on the estimated daily incidence of new infections. If interventions are scaled up (Scenario 2), the daily number of infections will change from 863 (95% CI: 778-948) at the current date to 114 (95% CI: 102-126) by 2020-08-04. If current interventions were relaxed by 50%, we estimate the daily number of infections will change from 863 (95% CI: 778-948) at the current date to 8,991 (95% CI: 8,019-9,963) by 2020-08-04.

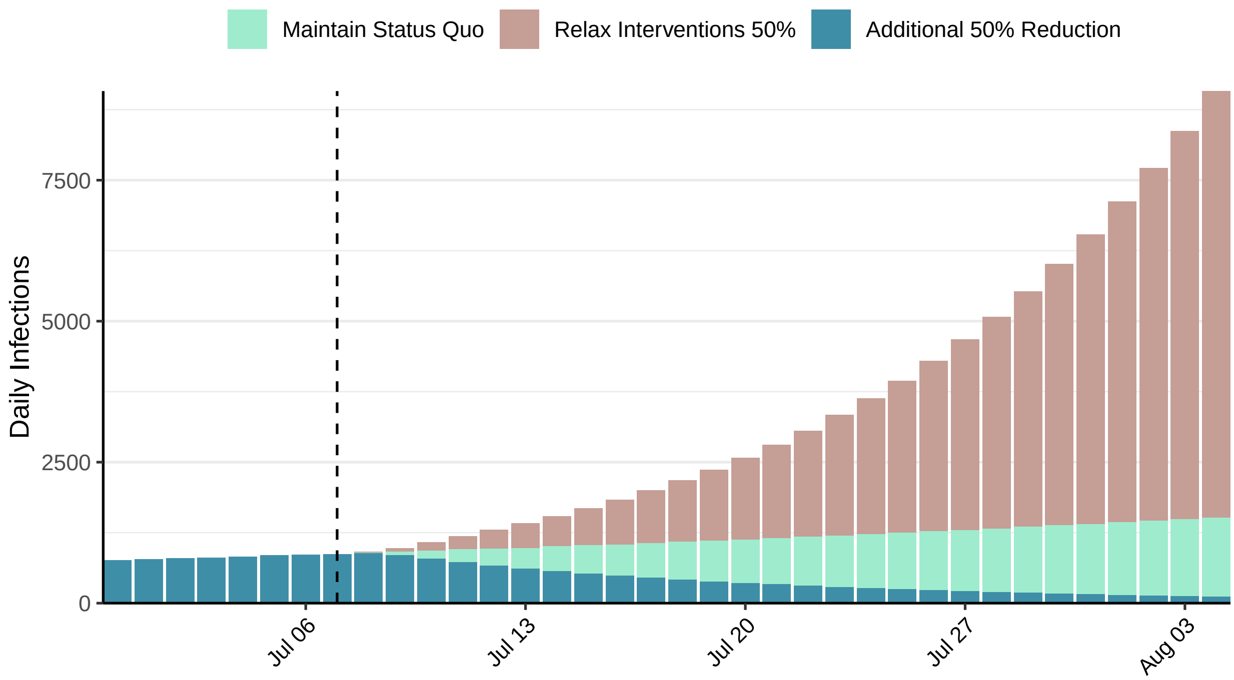

Figure 6: **Daily number of infections estimated by fitting to deaths.** Projected infections for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

To explore different scenarios, we recommend using our COVID-19 Scenario Analysis Tool - https://covidsim.org/, which can be used to simulate different intervention scenarios and explore the long term impact on healthcare demand.

Situation Report for COVID-19: South Sudan, 2020-07-07

Download the report for South Sudan, 2020-07-07 here. This report uses data from the European Centre for Disease Control. These data are updated daily and whilst there may be a short delay, they are generally consistent with Ministry reports. These data are then used to back-calculate an 'inferred number of COVID-19 infections' using mathematical modelling techniques (see Report 12 for further details) to estimate the number of people that have been infected and to make short-term projections for future healthcare needs.

Epidemiological Situation

Total Reported Cases	New Reported Cases	Total Reported Deaths	New Reported Deaths	Estimated R_t
2,093	57	40	2	1.04 (95% CI: 0.91-1.16)

The figure below shows the cumulative reported deaths as a function of the time since the 10th death was reported. Dashed lines show the expected trajectory for different doubling times of the epidemic. For example, with a doubling time of 3 days, if there are currently a total of 20 deaths reported, we would expect there to be 40 deaths in total reported in 3 days-time, 80 deaths in 6 days-time, 160 deaths in 9 days-time etc. For most epidemics, in the absence of interventions, we expect a doubling time of 3-4 days for this disease.

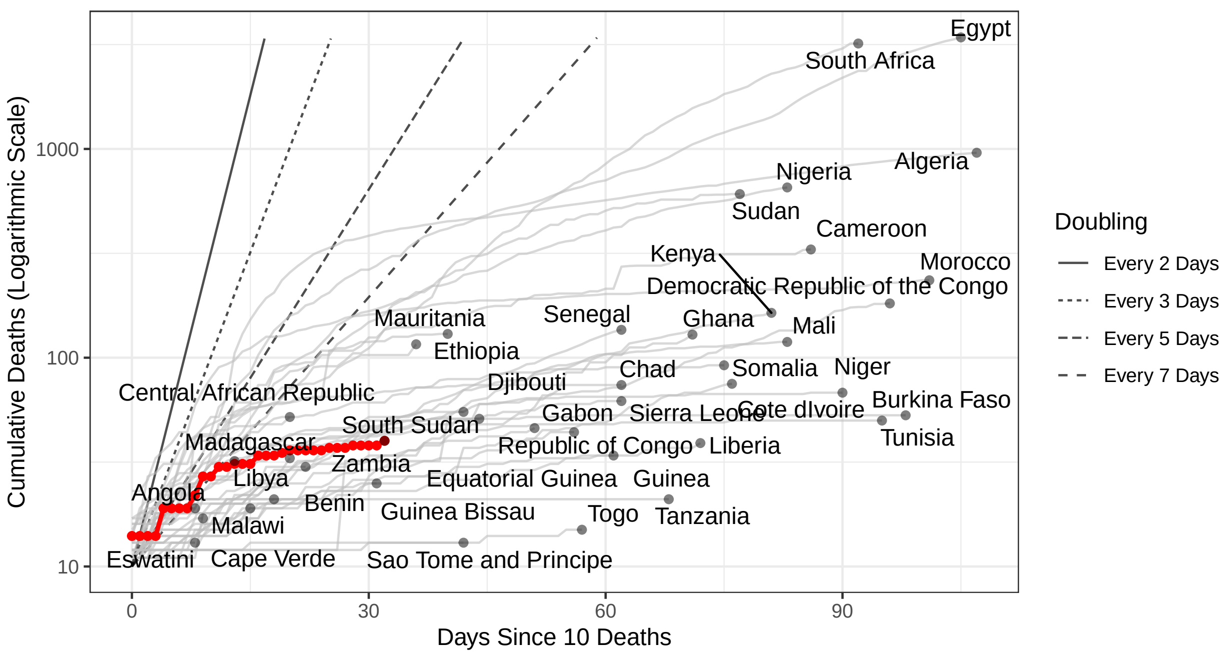

Figure 1: **Cumulative Deaths since 10 deaths.** Country not shown if fewer than 10 deaths.

COVID-19 Transmission Modelling

We assume that the deaths reported to date provide the best indication of the stage of the epidemic, as deaths are more consistently and accurately reported. Our current working estimate is that 1 death indicates that approximately 100 people will have been infected with the other 99 recovering (based on an infection fatality ratio of ~1%). These infections will have happened approximately 21 days previously – capturing a 5-day period from infection to onset of symptoms (the incubation period), 4 days from onset of symptoms to hospitalisation, and 12 days in hospital before death. With a 3-day doubling time, 100 infections that occurred 15 days ago will have generated 200 infections 12 days ago, 400 infections 9 days ago, 800 infections 6 days ago and 1,600 infections 3 days ago resulting in approximately 3,200 infections at the time the first death is observed.

To explore this, we fit our age-structured SEIR model (see Methods) to the time series of deaths in a country, in order to estimate the start date of the epidemic and the baseline R0. We assume that 100% of COVID-19 related deaths have been reported. We have also included the impact of interventions that have been put in place and their effect on human mobility and transmission based on the Google COVID-19 Community Mobility Reports. Using our mathematical model that formalises this approach, we estimate that there has been a total of 10,085 (95% CI: 8,941-11,230) infections over the past 4 weeks.

The figure below shows the estimated number of people infected over the past 4 weeks. The bar charts show, for comparison, the number of reported cases. The right-hand plot shows these data on a different scale as the estimated infections are likely to be much larger than the reported cases. **Importantly**, the estimated infections includes both asymptomatic and mild cases that would not necessarily be identified through surveillance. Consequently, the estimated infections are likely to be significantly higher than the reported cases (see our FAQ for further explanation of these differences and why the reported cases and estimated infections are unlikely to match).

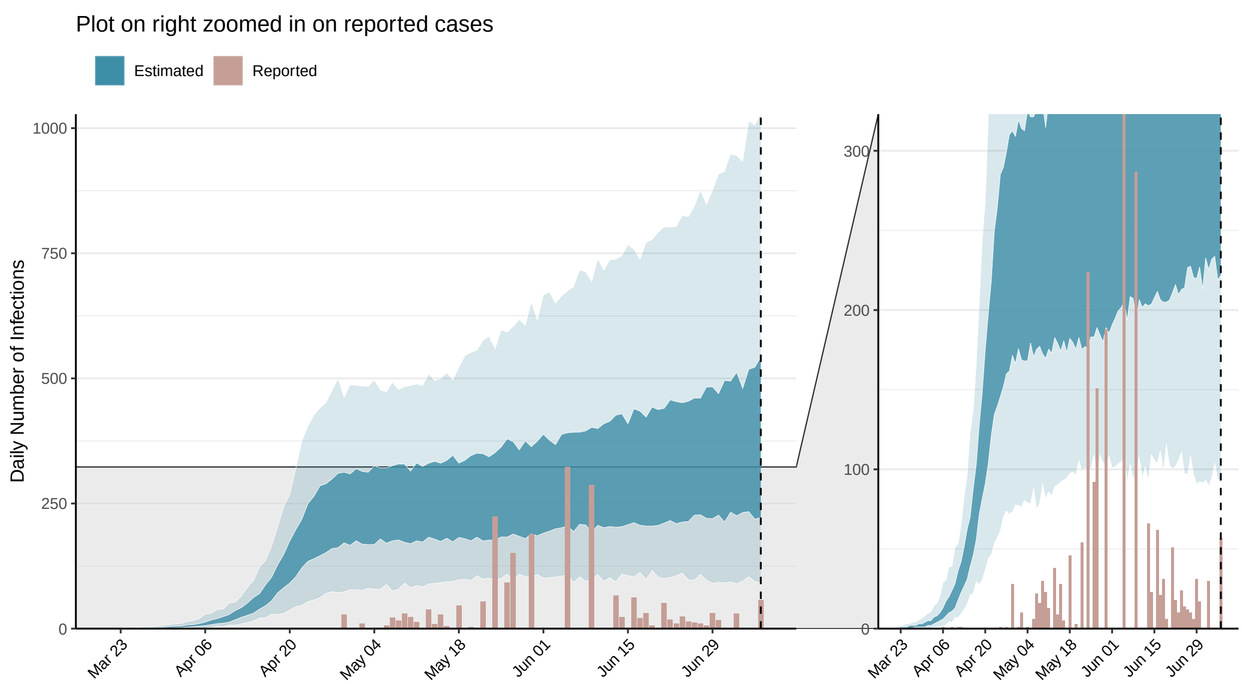

Figure 2: **Daily number of infections estimated by fitting to the current total of deaths.** Reported cases are shown in red. Model estimated infections are shown in blue (dark blue 50% interquartile range, light blue 95% quantile). The dashed line shows the current day.

By fitting to the time series of deaths, we are able to estimate a time-varying reproduction number, R_t. R_t is the the average number of secondary infections caused by a single infected person at a given time. If R_t is above 1, the rate of transmission is increasing and the number of new infections is increasing. R_t is assumed to change in relation to mobility fall in proportion. When fitting our model we assume that 100% of COVID-19 related deaths have been reported (please see our FAQ section for more information about this assumption). We also assume a fixed date at which the impact of mobility on transmission changes from pre-lockdown levels to post-lockdown levels, which may cause large changes in Rt. We are working to refine how this switch occurs and to formally calculate its shape.

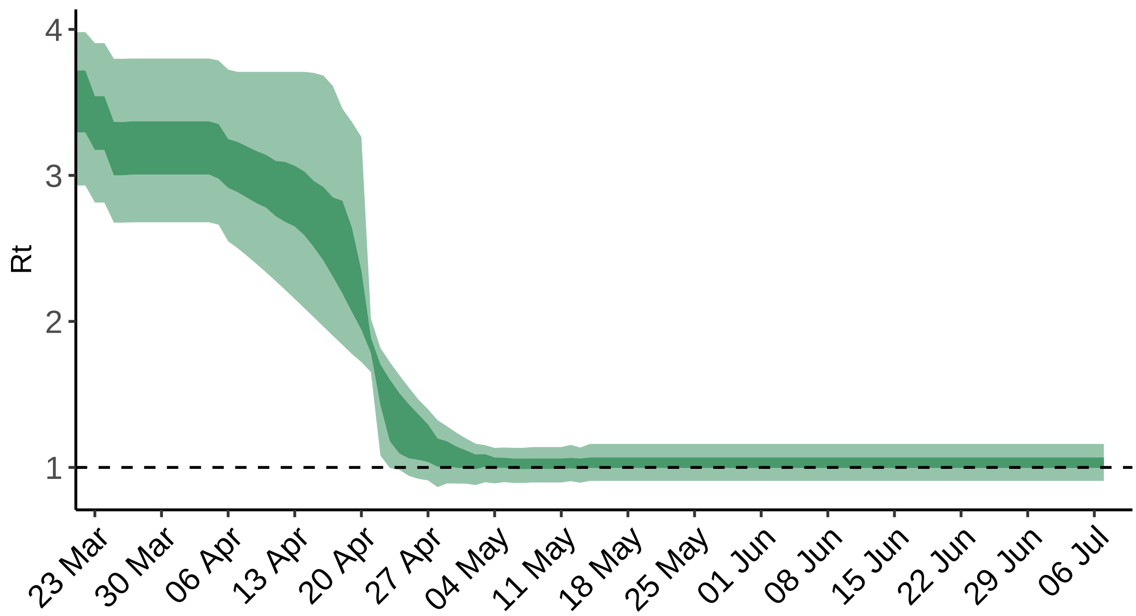

Figure 3: **Time-varying reproduction number, R_t.** R_t is the average number of secondary infections caused by a single infected person at time equal to t. $R_t < 1$ indicates a slowing epidemic in which new infections are not increasing. $R_t > 1$ indicates a growing epidemic in which new infections are increasing over time. Dark green shows the 50% CI and light green shows the 95% CI.

Using the model fit, we can forecast the expected trajectory for cumulative deaths, which is shown in the figure below. This assumes a severity pattern by age that is consistent with that observed in China, Europe and the U.S to date. This projection assumes that transmission is maintained at the current level of transmission as estimated by the final R_t value.

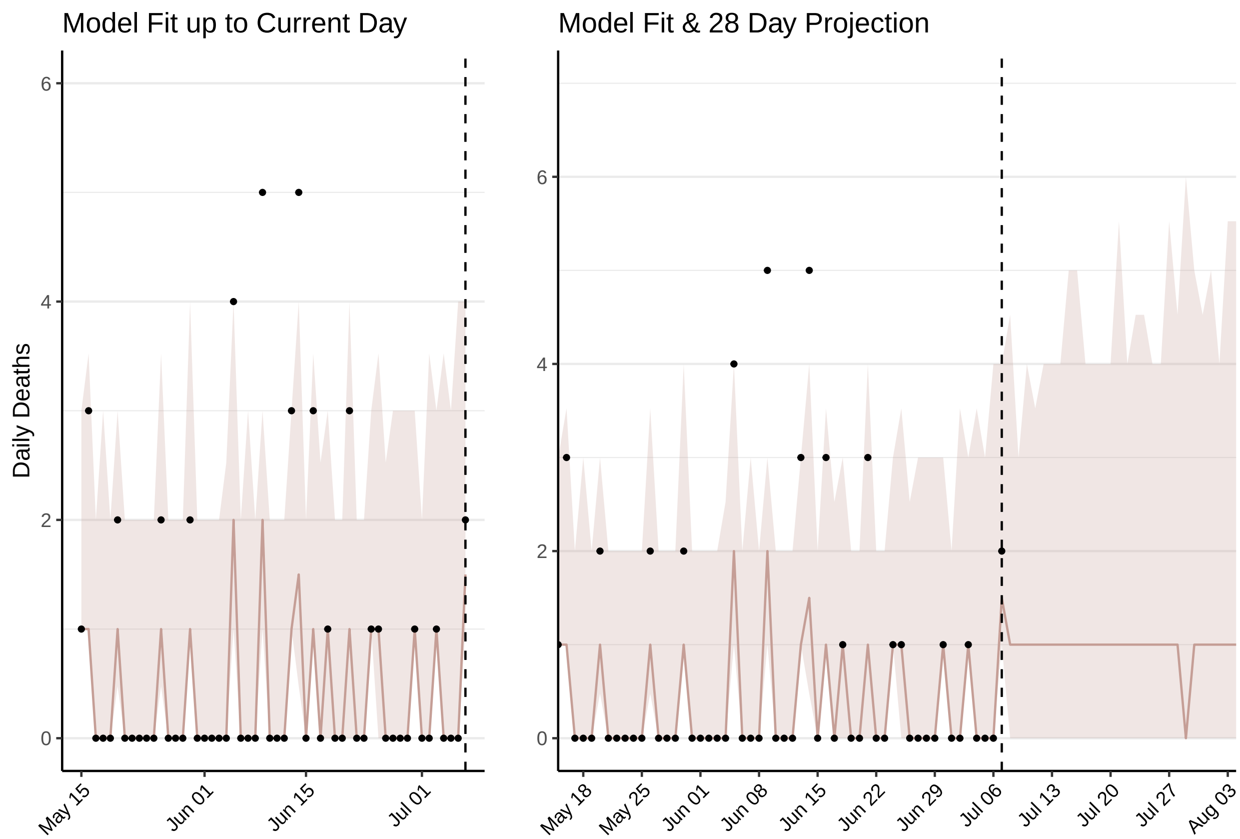

Figure 4: **Estimated daily deaths.** Projected deaths assuming the current level of interventions are maintained are shown in red (median and 95% quantile). Reported deaths are plotted in black. The plot on the left is focussed on the model fit prior to today, while the plot on the right forecasts the next 28 days.

Short-term Epidemic Scenarios

We make the following short-term projections of healthcare demand and new infections under the following three scenarios:

- **Scenario 1.** The epidemic continues to grow at the current rate.
- **Scenario 2.** Countries will further scale up interventions (either increasing current strategies or implementing new interventions) leading to a further 50% reduction in transmission.
- **Scenario 3.** Countries will relax current interventions by 50%

N.B. These scenarios currently assume that the impact of mobility on transmission will remain the same in the future as it has in the past. We are working to extend methods to estimate the impact of increases in mobility on transmission as lockdown and interventions are reversed. Consequently, projection are likely to represent an upper estimate of the healthcare demand and case load for each scenario

We estimate that over the next 4 weeks demand for hospital beds will change from 55 (95% CI: 48-62) patients requiring treatment with high-pressure oxygen at the current date to 73 (95% CI: 62-84) hospital beds being required on 2020-08-04 if no further interventions are introduced (Scenario 1). Similarly, we estimate that over the next 4 weeks demand for critical care (ICU) beds will change from 16 (95% CI: 13-18) patients requiring treatment with mechanical ventilation at the current date to 20 (95% CI: 17-23) by 2020-08-04. These projections assume that approximately 5% of all infections will require treatment with high-pressure oxygen and that approximately 30% of hospitalised cases will require treatment with mechanical ventilation (based on analysis of ongoing epidemics in Europe). **N.B. These scenarios are unlikely to show significant differences for the first week since there is a delay of approximately 10 days between infection and hospital admission. Consequently, the effectiveness of a change in policy is likely to be better captured by hospital admission data approximately 2 weeks after the policy change is implemented.**

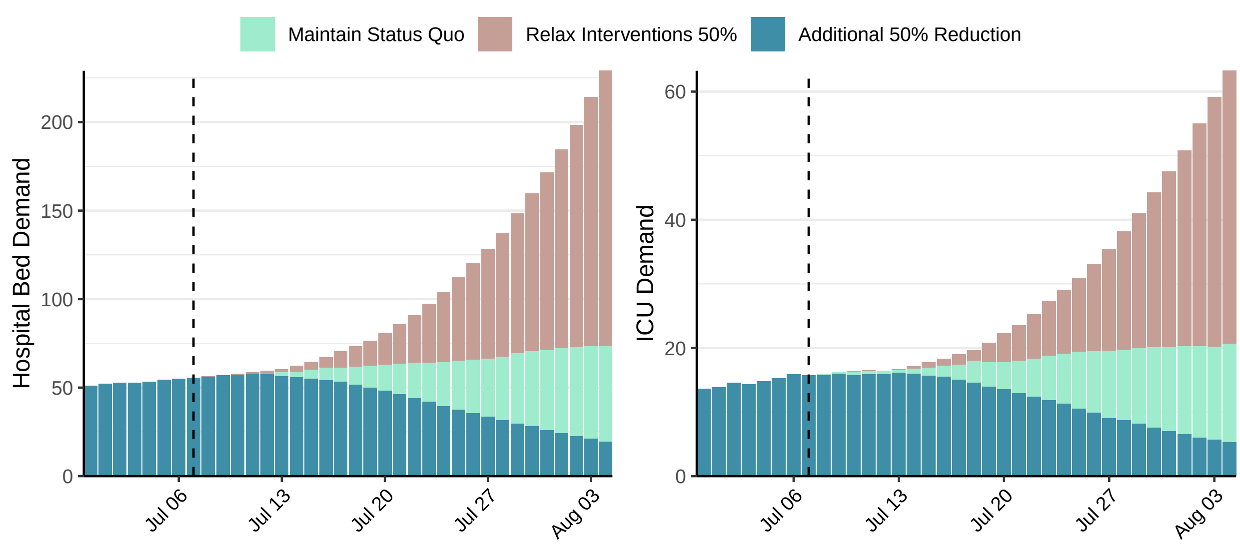

Figure 5: **Healthcare demands in the next 28 days.** Individuals needing an ICU bed are assumed to need mechanical ventilation. Projected demand for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

The impact of each scenario has a more immediate effect on the daily number of infections. The figure below shows the impact of each scenario on the estimated daily incidence of new infections. If interventions are scaled up (Scenario 2), the daily number of infections will change from 408 (95% CI: 354-461) at the current date to 43 (95% CI: 36-50) by 2020-08-04. If current interventions were relaxed by 50%, we estimate the daily number of infections will change from 408 (95% CI: 354-461) at the current date to 3,228 (95% CI: 2,664-3,791) by 2020-08-04.

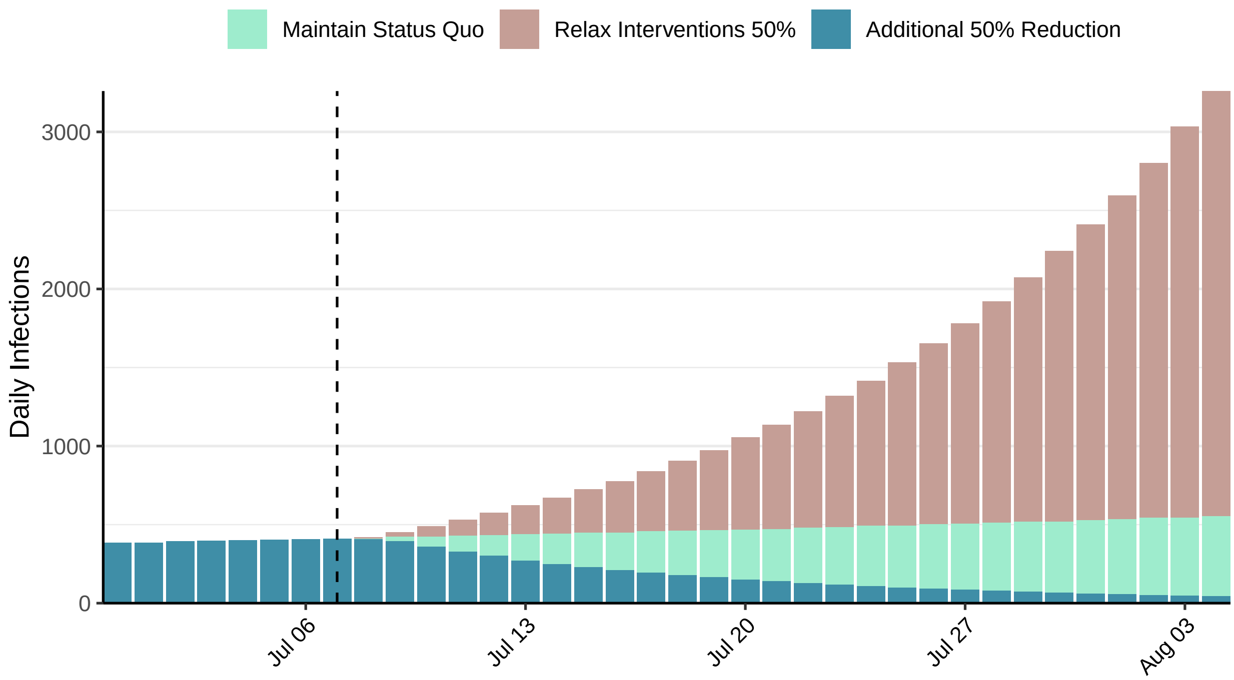

Figure 6: **Daily number of infections estimated by fitting to deaths.** Projected infections for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

To explore different scenarios, we recommend using our COVID-19 Scenario Analysis Tool - https://covidsim.org/, which can be used to simulate different intervention scenarios and explore the long term impact on healthcare demand.

Situation Report for COVID-19: Sao Tome and Principe, 2020-07-07

Download the report for Sao Tome and Principe, 2020-07-07 here. This report uses data from the European Centre for Disease Control. These data are updated daily and whilst there may be a short delay, they are generally consistent with Ministry reports. These data are then used to back-calculate an 'inferred number of COVID-19 infections' using mathematical modelling techniques (see Report 12 for further details) to estimate the number of people that have been infected and to make short-term projections for future healthcare needs.

Epidemiological Situation

Total Reported Cases	New Reported Cases	Total Reported Deaths	New Reported Deaths	Estimated R_t
721	1	13	0	0.82 (95% CI: 0.57-1.13)

The figure below shows the cumulative reported deaths as a function of the time since the 10th death was reported. Dashed lines show the expected trajectory for different doubling times of the epidemic. For example, with a doubling time of 3 days, if there are currently a total of 20 deaths reported, we would expect there to be 40 deaths in total reported in 3 days-time, 80 deaths in 6 days-time, 160 deaths in 9 days-time etc. For most epidemics, in the absence of interventions, we expect a doubling time of 3-4 days for this disease.

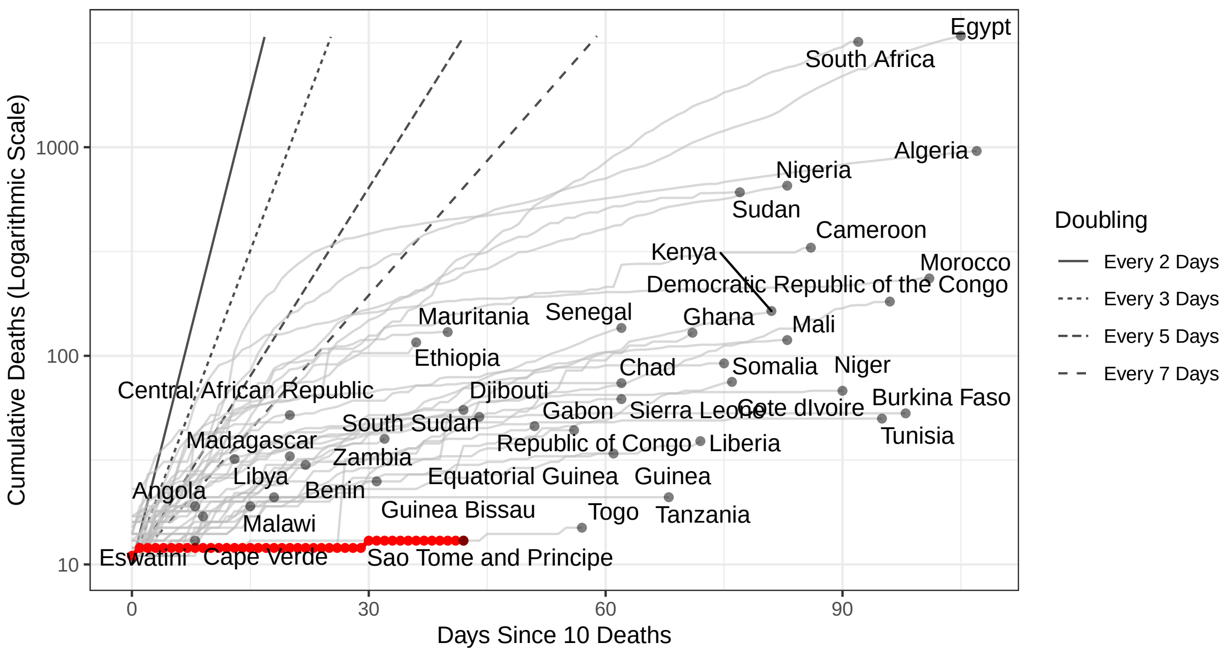

Figure 1: **Cumulative Deaths since 10 deaths.** Country not shown if fewer than 10 deaths.

COVID-19 Transmission Modelling

We assume that the deaths reported to date provide the best indication of the stage of the epidemic, as deaths are more consistently and accurately reported. Our current working estimate is that 1 death indicates that approximately 100 people will have been infected with the other 99 recovering (based on an infection fatality ratio of ~1%). These infections will have happened approximately 21 days previously – capturing a 5-day period from infection to onset of symptoms (the incubation period), 4 days from onset of symptoms to hospitalisation, and 12 days in hospital before death. With a 3-day doubling time, 100 infections that occurred 15 days ago will have generated 200 infections 12 days ago, 400 infections 9 days ago, 800 infections 6 days ago and 1,600 infections 3 days ago resulting in approximately 3,200 infections at the time the first death is observed.

To explore this, we fit our age-structured SEIR model (see Methods) to the time series of deaths in a country, in order to estimate the start date of the epidemic and the baseline R0. We assume that 100% of COVID-19 related deaths have been reported. We have also included the impact of interventions that have been put in place and their effect on human mobility and transmission based on the Google COVID-19 Community Mobility Reports. Using our mathematical model that formalises this approach, we estimate that there has been a total of 230 (95% CI: 180-280) infections over the past 4 weeks.

The figure below shows the estimated number of people infected over the past 4 weeks. The bar charts show, for comparison, the number of reported cases. The right-hand plot shows these data on a different scale as the estimated infections are likely to be much larger than the reported cases. **Importantly**, the estimated infections includes both asymptomatic and mild cases that would not necessarily be identified through surveillance. Consequently, the estimated infections are likely to be significantly higher than the reported cases (see our FAQ for further explanation of these differences and why the reported cases and estimated infections are unlikely to match).

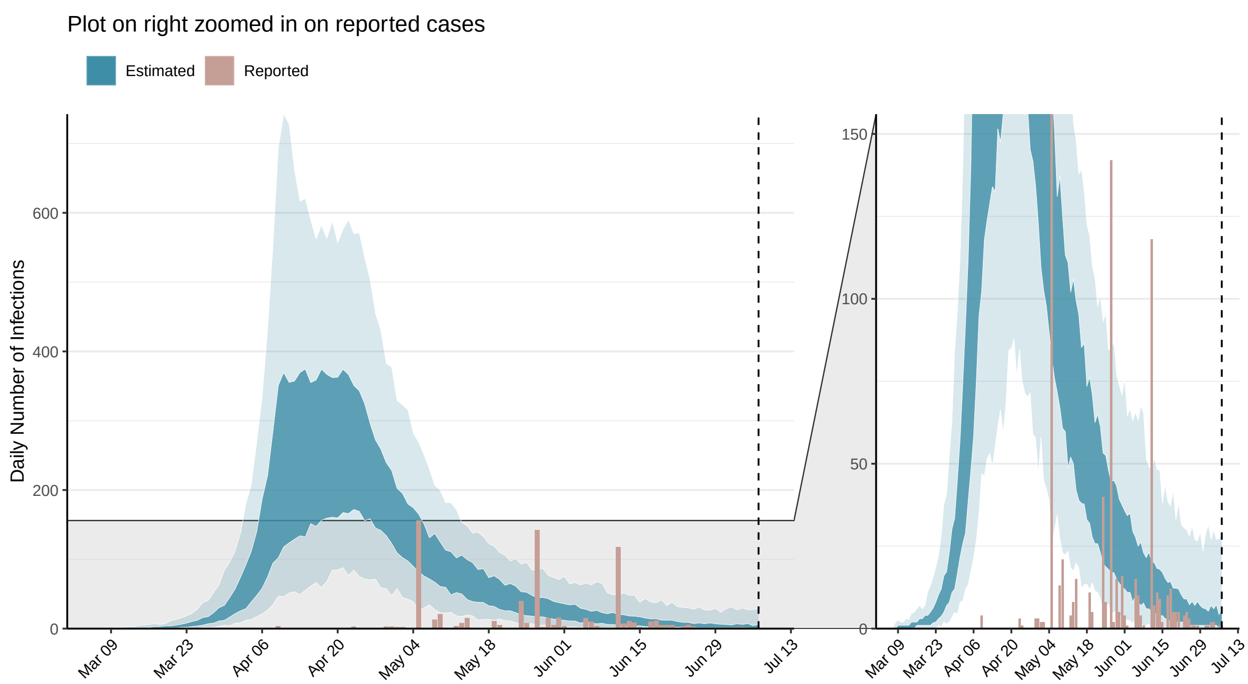

Figure 2: **Daily number of infections estimated by fitting to the current total of deaths.** Reported cases are shown in red. Model estimated infections are shown in blue (dark blue 50% interquartile range, light blue 95% quantile). The dashed line shows the current day.

By fitting to the time series of deaths, we are able to estimate a time-varying reproduction number, R_t. R_t is the the average number of secondary infections caused by a single infected person at a given time. If R_t is above 1, the rate of transmission is increasing and the number of new infections is increasing. R_t is assumed to change in relation to mobility fall in proportion. When fitting our model we assume that 100% of COVID-19 related deaths have been reported (please see our FAQ section for more information about this assumption). We also assume a fixed date at which the impact of mobility on transmission changes from pre-lockdown levels to post-lockdown levels, which may cause large changes in Rt. We are working to refine how this switch occurs and to formally calculate its shape.

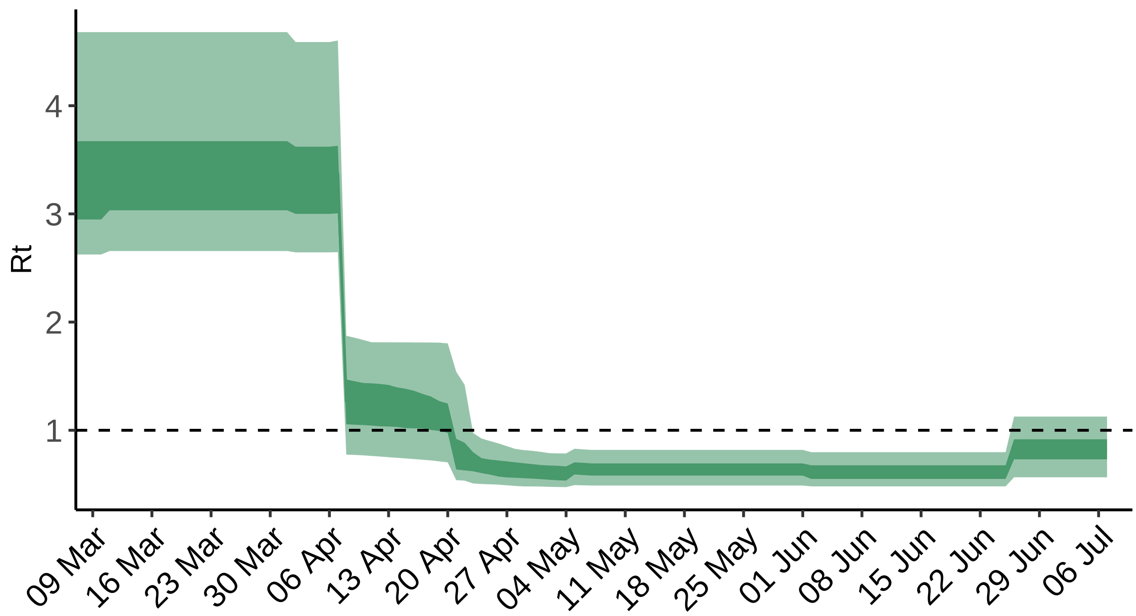

Figure 3: **Time-varying reproduction number, R_t.** R_t is the average number of secondary infections caused by a single infected person at time equal to t. $R_t < 1$ indicates a slowing epidemic in which new infections are not increasing. $R_t > 1$ indicates a growing epidemic in which new infections are increasing over time. Dark green shows the 50% CI and light green shows the 95% CI.

Using the model fit, we can forecast the expected trajectory for cumulative deaths, which is shown in the figure below. This assumes a severity pattern by age that is consistent with that observed in China, Europe and the U.S to date. This projection assumes that transmission is maintained at the current level of transmission as estimated by the final R_t value.

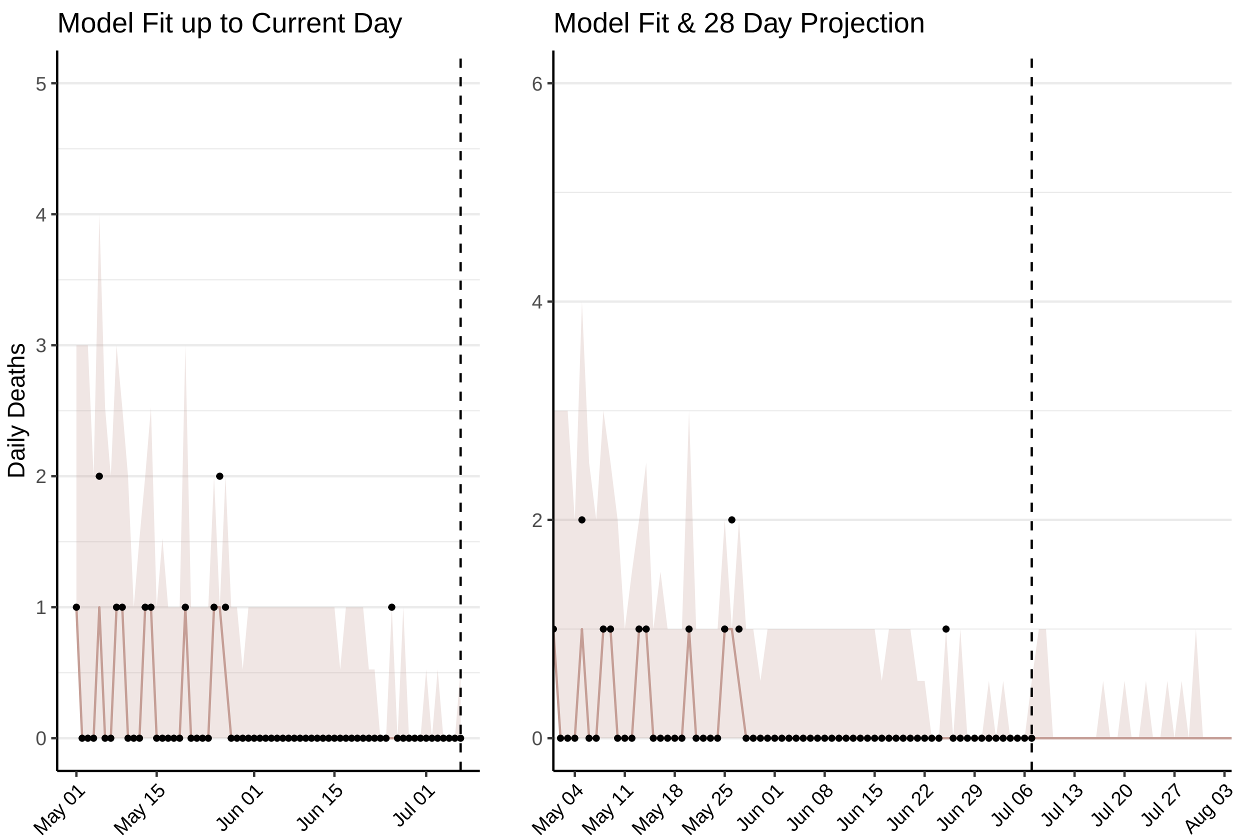

Figure 4: **Estimated daily deaths.** Projected deaths assuming the current level of interventions are maintained are shown in red (median and 95% quantile). Reported deaths are plotted in black. The plot on the left is focussed on the model fit prior to today, while the plot on the right forecasts the next 28 days.

Short-term Epidemic Scenarios

We make the following short-term projections of healthcare demand and new infections under the following three scenarios:

- **Scenario 1.** The epidemic continues to grow at the current rate.
- **Scenario 2.** Countries will further scale up interventions (either increasing current strategies or implementing new interventions) leading to a further 50% reduction in transmission.
- **Scenario 3.** Countries will relax current interventions by 50%

N.B. These scenarios currently assume that the impact of mobility on transmission will remain the same in the future as it has in the past. We are working to extend methods to estimate the impact of increases in mobility on transmission as lockdown and interventions are reversed. Consequently, projection are likely to represent an upper estimate of the healthcare demand and case load for each scenario

We estimate that over the next 4 weeks demand for hospital beds will change from 1 (95% CI: 1-1) patients requiring treatment with high-pressure oxygen at the current date to 1 (95% CI: 0-1) hospital beds being required on 2020-08-04 if no further interventions are introduced (Scenario 1). Similarly, we estimate that over the next 4 weeks demand for critical care (ICU) beds will change from 0 (95% CI: 0-1) patients requiring treatment with mechanical ventilation at the current date to 0 (95% CI: 0-0) by 2020-08-04. These projections assume that approximately 5% of all infections will require treatment with high-pressure oxygen and that approximately 30% of hospitalised cases will require treatment with mechanical ventilation (based on analysis of ongoing epidemics in Europe). **N.B. These scenarios are unlikely to show significant differences for the first week since there is a delay of approximately 10 days between infection and hospital admission. Consequently, the effectiveness of a change in policy is likely to be better captured by hospital admission data approximately 2 weeks after the policy change is implemented.**

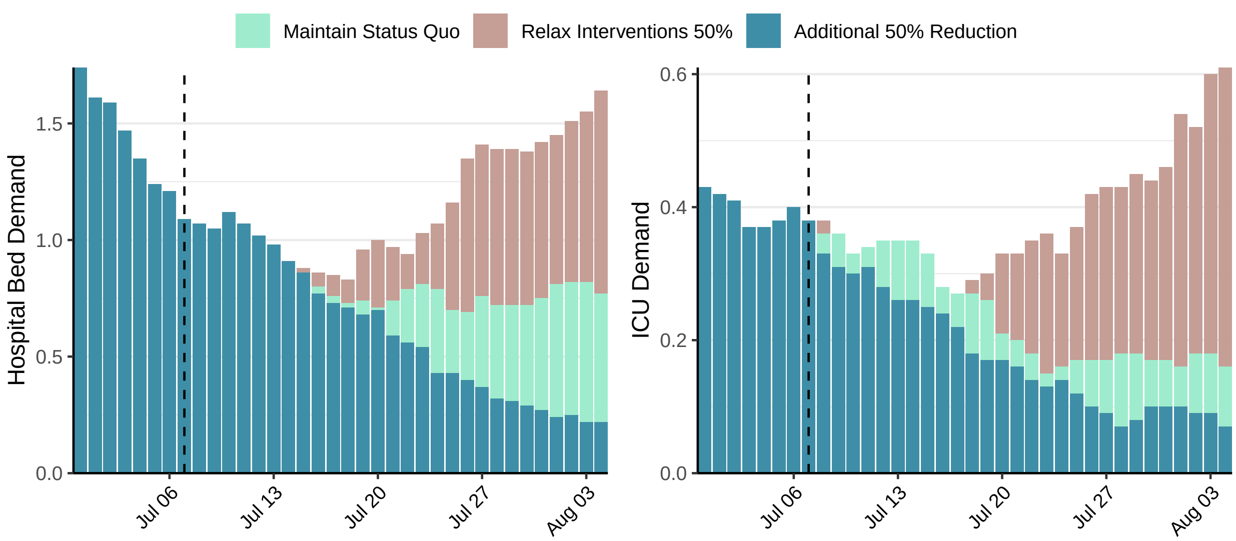

Figure 5: **Healthcare demands in the next 28 days.** Individuals needing an ICU bed are assumed to need mechanical ventilation. Projected demand for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

The impact of each scenario has a more immediate effect on the daily number of infections. The figure below shows the impact of each scenario on the estimated daily incidence of new infections. If interventions are scaled up (Scenario 2), the daily number of infections will change from 5 (95% CI: 3-6) at the current date to 0 (95% CI: 0-1) by 2020-08-04. If current interventions were relaxed by 50%, we estimate the daily number of infections will change from 5 (95% CI: 3-6) at the current date to 21 (95% CI: 11-31) by 2020-08-04.

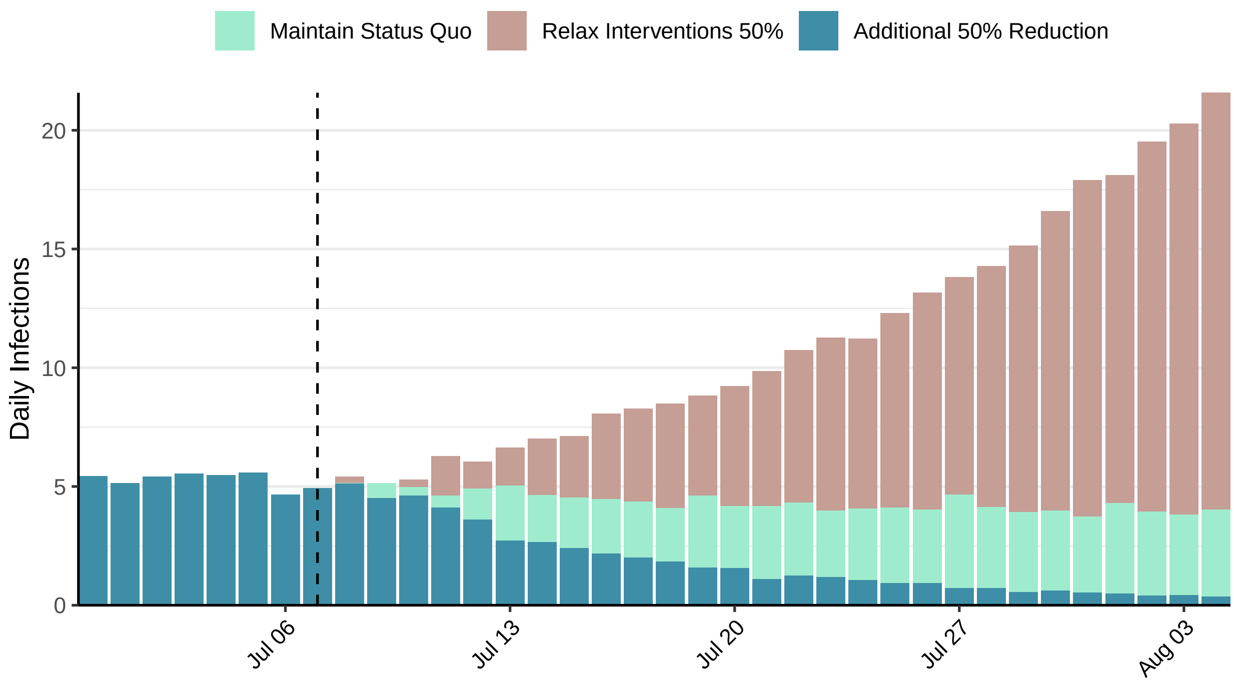

Figure 6: **Daily number of infections estimated by fitting to deaths.** Projected infections for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

To explore different scenarios, we recommend using our COVID-19 Scenario Analysis Tool - https://covidsim.org/, which can be used to simulate different intervention scenarios and explore the long term impact on healthcare demand.

Situation Report for COVID-19: Suriname, 2020-07-07

Download the report for Suriname, 2020-07-07 here. This report uses data from the European Centre for Disease Control. These data are updated daily and whilst there may be a short delay, they are generally consistent with Ministry reports. These data are then used to back-calculate an 'inferred number of COVID-19 infections' using mathematical modelling techniques (see Report 12 for further details) to estimate the number of people that have been infected and to make short-term projections for future healthcare needs.

Epidemiological Situation

Total Reported Cases	New Reported Cases	Total Reported Deaths	New Reported Deaths	Estimated R_t
614	20	14	0	1.93 (95% CI: 1.79-2.14)

The figure below shows the cumulative reported deaths as a function of the time since the 10th death was reported. Dashed lines show the expected trajectory for different doubling times of the epidemic. For example, with a doubling time of 3 days, if there are currently a total of 20 deaths reported, we would expect there to be 40 deaths in total reported in 3 days-time, 80 deaths in 6 days-time, 160 deaths in 9 days-time etc. For most epidemics, in the absence of interventions, we expect a doubling time of 3-4 days for this disease.

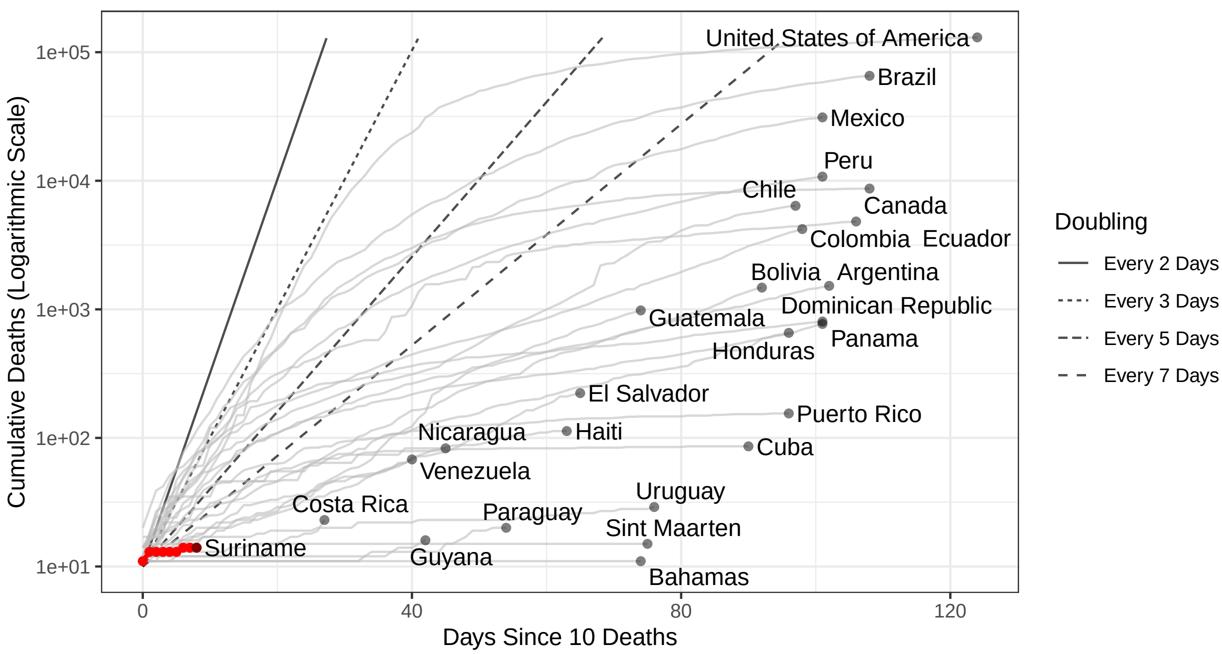

Figure 1: **Cumulative Deaths since 10 deaths.** Country not shown if fewer than 10 deaths.

COVID-19 Transmission Modelling

We assume that the deaths reported to date provide the best indication of the stage of the epidemic, as deaths are more consistently and accurately reported. Our current working estimate is that 1 death indicates that approximately 100 people will have been infected with the other 99 recovering (based on an infection fatality ratio of ~1%). These infections will have happened approximately 21 days previously – capturing a 5-day period from infection to onset of symptoms (the incubation period), 4 days from onset of symptoms to hospitalisation, and 12 days in hospital before death. With a 3-day doubling time, 100 infections that occurred 15 days ago will have generated 200 infections 12 days ago, 400 infections 9 days ago, 800 infections 6 days ago and 1,600 infections 3 days ago resulting in approximately 3,200 infections at the time the first death is observed.

To explore this, we fit our age-structured SEIR model (see Methods) to the time series of deaths in a country, in order to estimate the start date of the epidemic and the baseline R0. We assume that 100% of COVID-19 related deaths have been reported. We have also included the impact of interventions that have been put in place and their effect on human mobility and transmission based on the Google COVID-19 Community Mobility Reports. Using our mathematical model that formalises this approach, we estimate that there has been a total of 25,070 (95% CI: 21,622-28,519) infections over the past 4 weeks.

The figure below shows the estimated number of people infected over the past 4 weeks. The bar charts show, for comparison, the number of reported cases. The right-hand plot shows these data on a different scale as the estimated infections are likely to be much larger than the reported cases. **Importantly**, the estimated infections includes both asymptomatic and mild cases that would not necessarily be identified through surveillance. Consequently, the estimated infections are likely to be significantly higher than the reported cases (see our FAQ for further explanation of these differences and why the reported cases and estimated infections are unlikely to match).

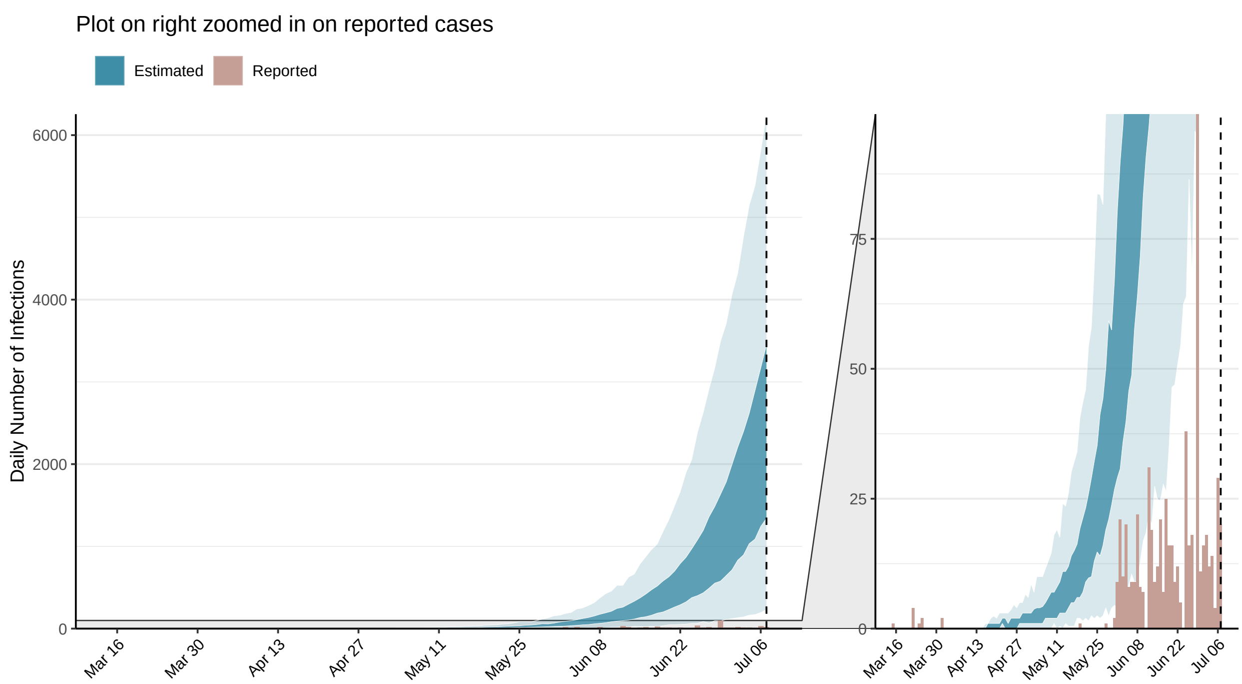

Figure 2: **Daily number of infections estimated by fitting to the current total of deaths.** Reported cases are shown in red. Model estimated infections are shown in blue (dark blue 50% interquartile range, light blue 95% quantile). The dashed line shows the current day.

By fitting to the time series of deaths, we are able to estimate a time-varying reproduction number, R_t. R_t is the the average number of secondary infections caused by a single infected person at a given time. If R_t is above 1, the rate of transmission is increasing and the number of new infections is increasing. R_t is assumed to change in relation to mobility fall in proportion. When fitting our model we assume that 100% of COVID-19 related deaths have been reported (please see our FAQ section for more information about this assumption). We also assume a fixed date at which the impact of mobility on transmission changes from pre-lockdown levels to post-lockdown levels, which may cause large changes in Rt. We are working to refine how this switch occurs and to formally calculate its shape.

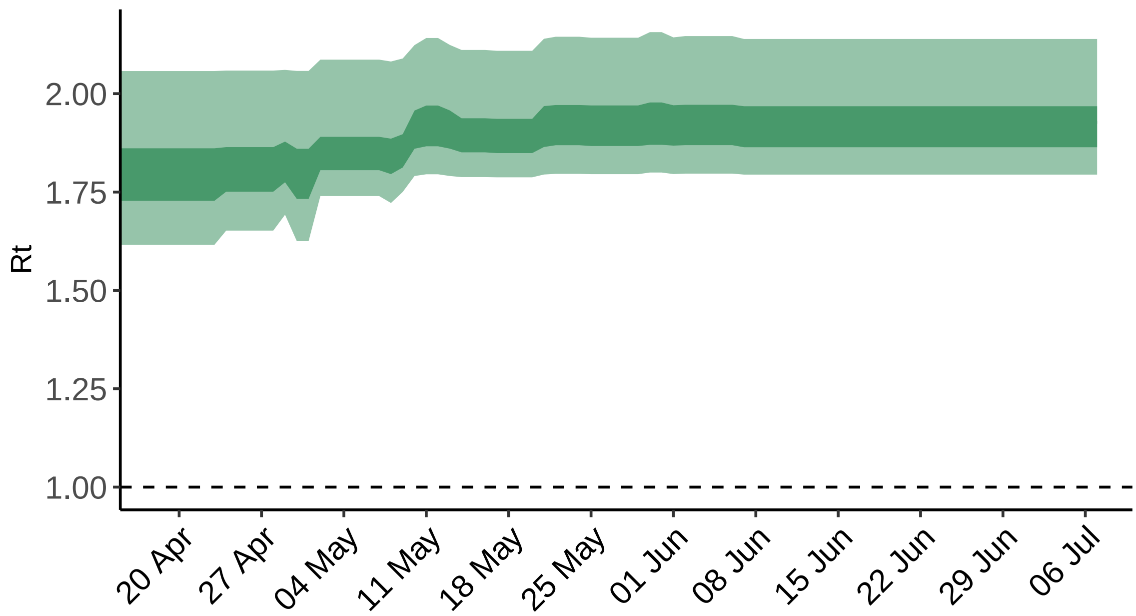

Figure 3: **Time-varying reproduction number, R_t.** R_t is the average number of secondary infections caused by a single infected person at time equal to t. $R_t < 1$ indicates a slowing epidemic in which new infections are not increasing. $R_t > 1$ indicates a growing epidemic in which new infections are increasing over time. Dark green shows the 50% CI and light green shows the 95% CI.

Using the model fit, we can forecast the expected trajectory for cumulative deaths, which is shown in the figure below. This assumes a severity pattern by age that is consistent with that observed in China, Europe and the U.S to date. This projection assumes that transmission is maintained at the current level of transmission as estimated by the final R_t value. **N.B. Suriname is forecast to be close to or surpassing our best estimates for healthcare capacity in the next 28 days.** Estimates of deaths in the next 28 days may be inaccurate due to our working assumptions for mortality in individuals who do not receive appropriate treatment. See our methods for more information.

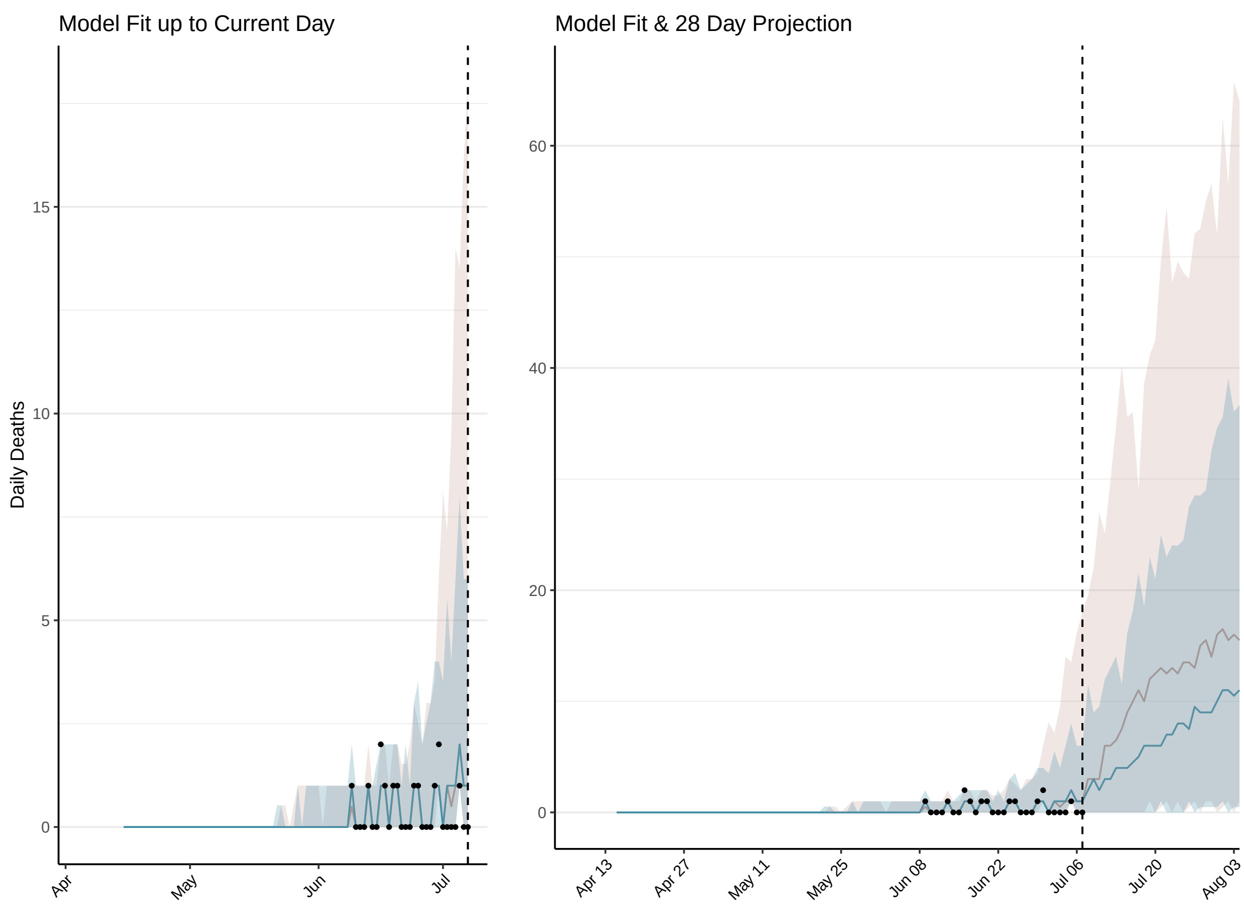

Figure 4: **Estimated daily deaths.** Projected deaths assuming the current level of interventions are maintained are shown in red (median and 95% quantile). Reported deaths are plotted in black. The plot on the left is focussed on the model fit prior to today, while the plot on the right forecasts the next 28 days. The forecasted deaths in blue assumes healthcare capacity has been surged to ensure sufficient supply of ICU and hospital beds. The red curve assumes no surging in healthcare capacity and subsequently projects increased deaths.

Short-term Epidemic Scenarios

We make the following short-term projections of healthcare demand and new infections under the following three scenarios:

- **Scenario 1.** The epidemic continues to grow at the current rate.
- **Scenario 2.** Countries will further scale up interventions (either increasing current strategies or implementing new interventions) leading to a further 50% reduction in transmission.
- **Scenario 3.** Countries will relax current interventions by 50%

N.B. These scenarios currently assume that the impact of mobility on transmission will remain the same in the future as it has in the past. We are working to extend methods to estimate the impact of increases in mobility on transmission as lockdown and interventions are reversed. Consequently, projection are likely to represent an upper estimate of the healthcare demand and case load for each scenario

We estimate that over the next 4 weeks demand for hospital beds will change from 151 (95% CI: 129-173) patients requiring treatment with high-pressure oxygen at the current date to 637 (95% CI: 546-728) hospital beds being required on 2020-08-04 if no further interventions are introduced (Scenario 1). Similarly, we estimate that over the next 4 weeks demand for critical care (ICU) beds will change from 38 (95% CI: 34-42) patients requiring treatment with mechanical ventilation at the current date to 69 (95% CI: 64-74) by 2020-08-04. These projections assume that approximately 5% of all infections will require treatment with high-pressure oxygen and that approximately 30% of hospitalised cases will require treatment with mechanical ventilation (based on analysis of ongoing epidemics in Europe). **N.B. These scenarios are unlikely to show significant differences for the first week since there is a delay of approximately 10 days between infection and hospital admission. Consequently, the effectiveness of a change in policy is likely to be better captured by hospital admission data approximately 2 weeks after the policy change is implemented.**

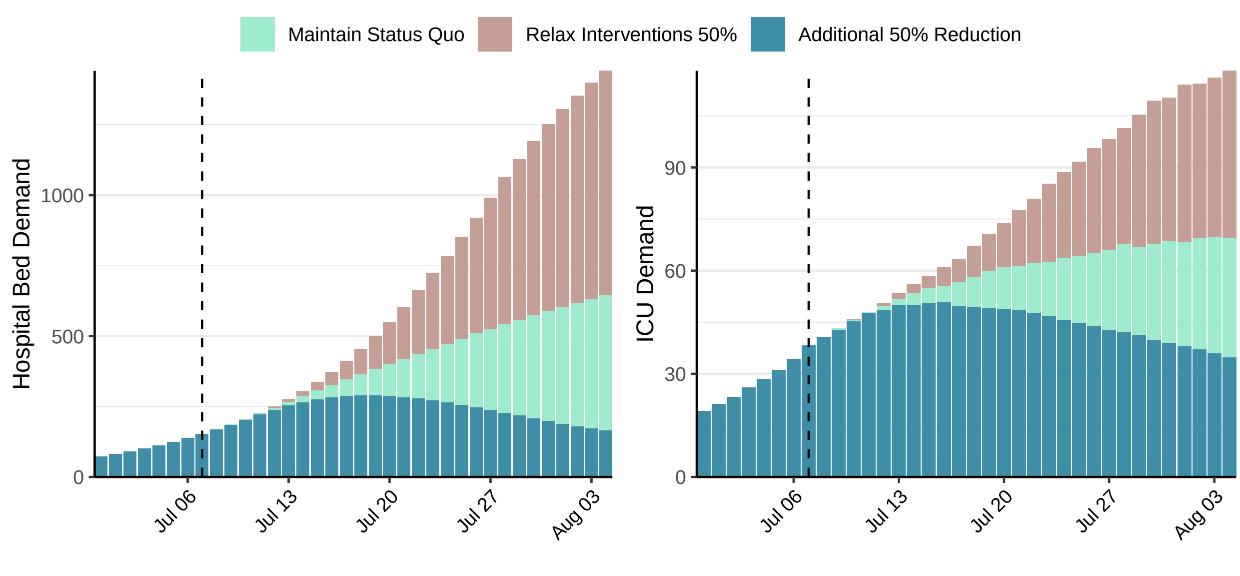

Figure 5: **Healthcare demands in the next 28 days.** Individuals needing an ICU bed are assumed to need mechanical ventilation. Projected demand for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

The impact of each scenario has a more immediate effect on the daily number of infections. The figure below shows the impact of each scenario on the estimated daily incidence of new infections. If interventions are scaled up (Scenario 2), the daily number of infections will change from 2,481 (95% CI: 2,148-2,815) at the current date to 486 (95% CI: 405-567) by 2020-08-04. If current interventions were relaxed by 50%, we estimate the daily number of infections will change from 2,481 (95% CI: 2,148-2,815) at the current date to 9,304 (95% CI: 8,371-10,238) by 2020-08-04.

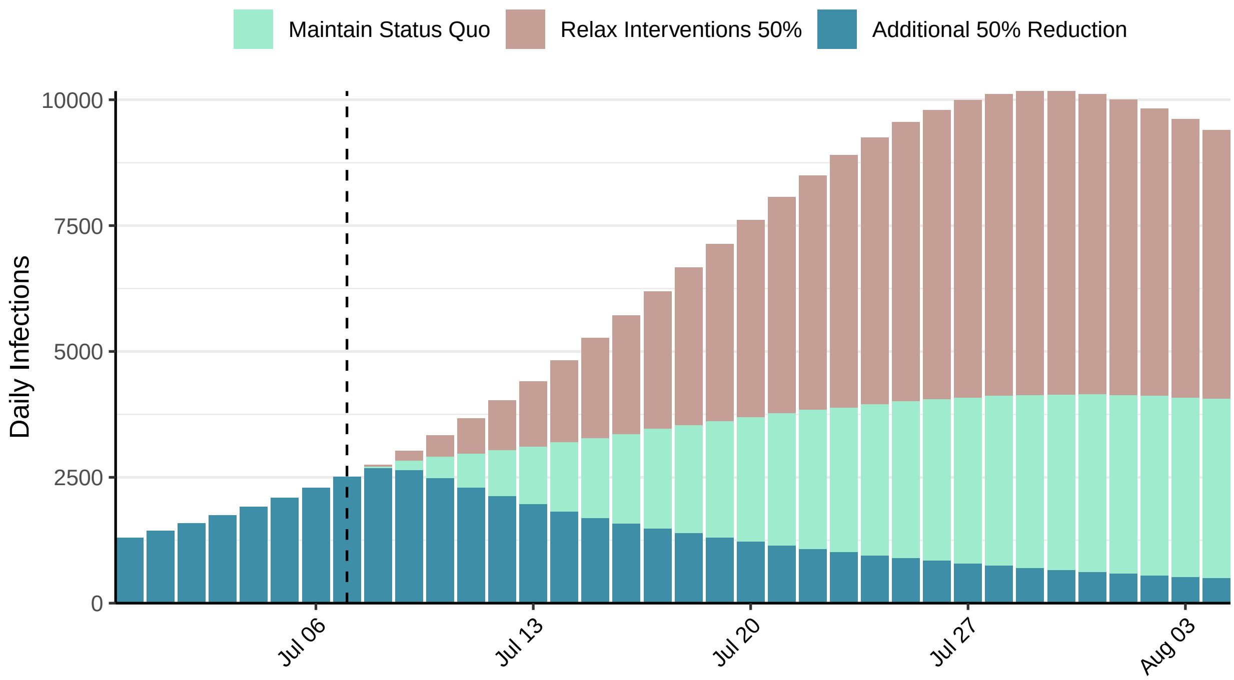

Figure 6: **Daily number of infections estimated by fitting to deaths.** Projected infections for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

To explore different scenarios, we recommend using our COVID-19 Scenario Analysis Tool - https://covidsim.org/, which can be used to simulate different intervention scenarios and explore the long term impact on healthcare demand.

Situation Report for COVID-19: Eswatini, 2020-07-07

Download the report for Eswatini, 2020-07-07 here. This report uses data from the European Centre for Disease Control. These data are updated daily and whilst there may be a short delay, they are generally consistent with Ministry reports. These data are then used to back-calculate an 'inferred number of COVID-19 infections' using mathematical modelling techniques (see Report 12 for further details) to estimate the number of people that have been infected and to make short-term projections for future healthcare needs.

Epidemiological Situation

Total Reported Cases	New Reported Cases	Total Reported Deaths	New Reported Deaths	Estimated R_t
1,011	23	13	0	1.8 (95% CI: 1.35-2.32)

The figure below shows the cumulative reported deaths as a function of the time since the 10th death was reported. Dashed lines show the expected trajectory for different doubling times of the epidemic. For example, with a doubling time of 3 days, if there are currently a total of 20 deaths reported, we would expect there to be 40 deaths in total reported in 3 days-time, 80 deaths in 6 days-time, 160 deaths in 9 days-time etc. For most epidemics, in the absence of interventions, we expect a doubling time of 3-4 days for this disease.

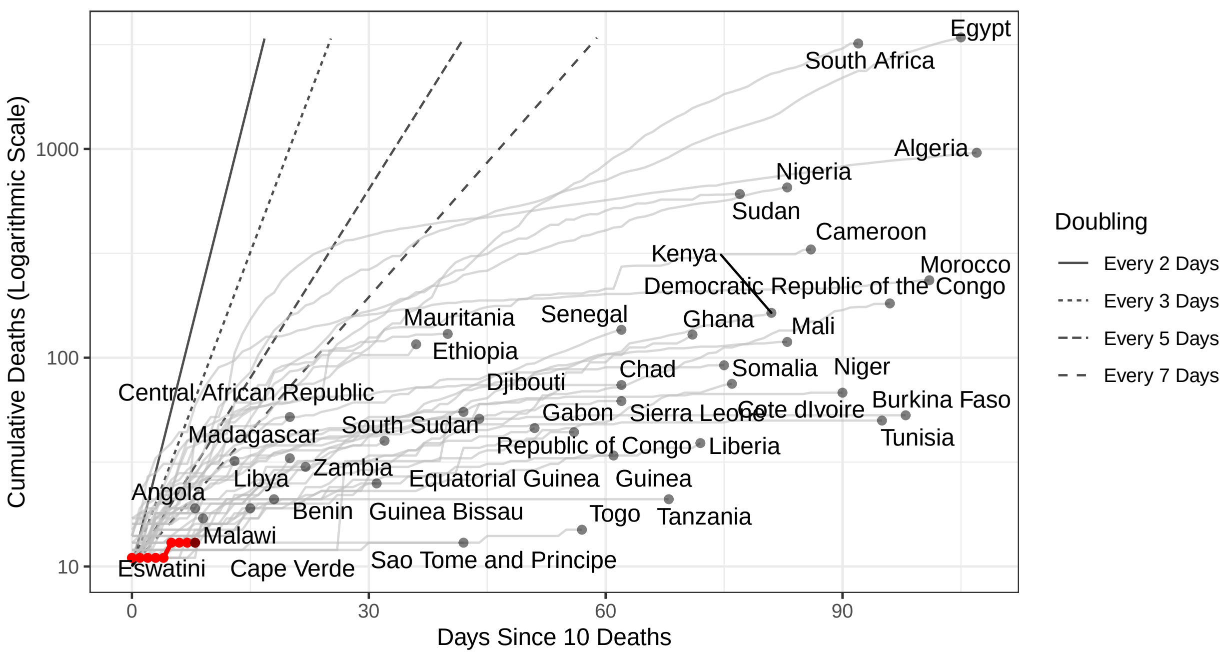

Figure 1: **Cumulative Deaths since 10 deaths.** Country not shown if fewer than 10 deaths.

COVID-19 Transmission Modelling

We assume that the deaths reported to date provide the best indication of the stage of the epidemic, as deaths are more consistently and accurately reported. Our current working estimate is that 1 death indicates that approximately 100 people will have been infected with the other 99 recovering (based on an infection fatality ratio of ~1%). These infections will have happened approximately 21 days previously – capturing a 5-day period from infection to onset of symptoms (the incubation period), 4 days from onset of symptoms to hospitalisation, and 12 days in hospital before death. With a 3-day doubling time, 100 infections that occurred 15 days ago will have generated 200 infections 12 days ago, 400 infections 9 days ago, 800 infections 6 days ago and 1,600 infections 3 days ago resulting in approximately 3,200 infections at the time the first death is observed.

To explore this, we fit our age-structured SEIR model (see Methods) to the time series of deaths in a country, in order to estimate the start date of the epidemic and the baseline R0. We assume that 100% of COVID-19 related deaths have been reported. We have also included the impact of interventions that have been put in place and their effect on human mobility and transmission based on the Google COVID-19 Community Mobility Reports. Using our mathematical model that formalises this approach, we estimate that there has been a total of 9,180 (95% CI: 7,424-10,936) infections over the past 4 weeks.

The figure below shows the estimated number of people infected over the past 4 weeks. The bar charts show, for comparison, the number of reported cases. The right-hand plot shows these data on a different scale as the estimated infections are likely to be much larger than the reported cases. **Importantly**, the estimated infections includes both asymptomatic and mild cases that would not necessarily be identified through surveillance. Consequently, the estimated infections are likely to be significantly higher than the reported cases (see our FAQ for further explanation of these differences and why the reported cases and estimated infections are unlikely to match).

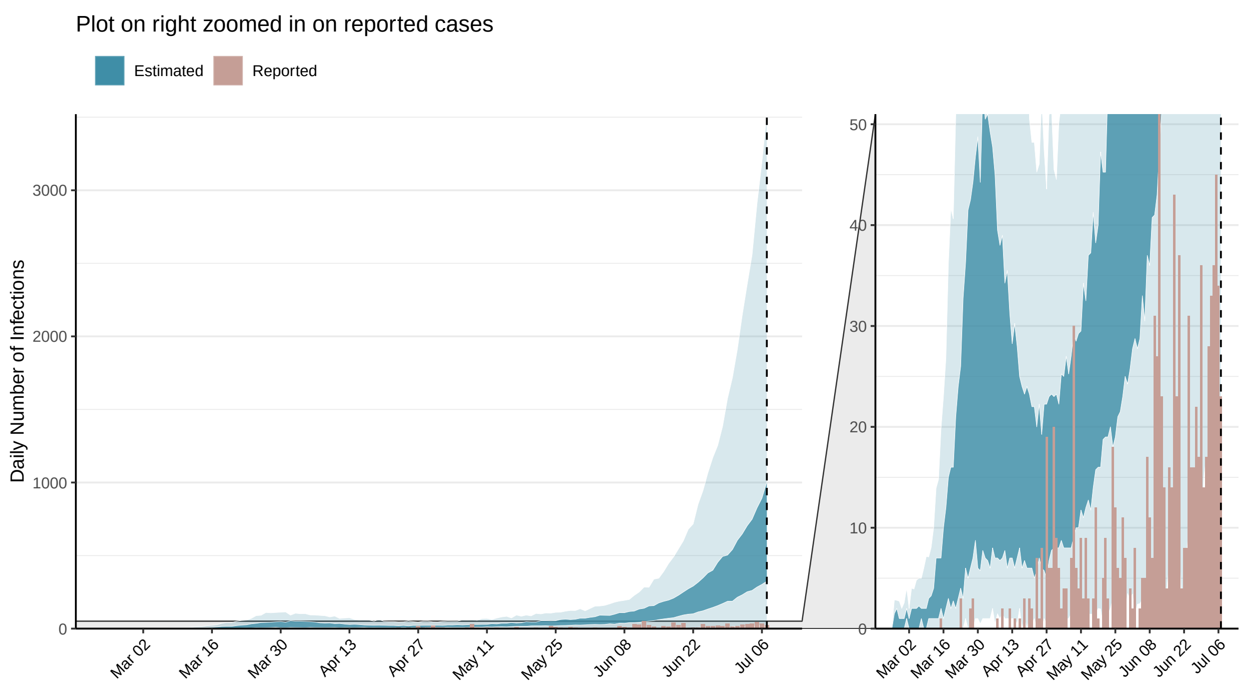

Figure 2: **Daily number of infections estimated by fitting to the current total of deaths.** Reported cases are shown in red. Model estimated infections are shown in blue (dark blue 50% interquartile range, light blue 95% quantile). The dashed line shows the current day.

By fitting to the time series of deaths, we are able to estimate a time-varying reproduction number, R_t. R_t is the the average number of secondary infections caused by a single infected person at a given time. If R_t is above 1, the rate of transmission is increasing and the number of new infections is increasing. R_t is assumed to change in relation to mobility fall in proportion. When fitting our model we assume that 100% of COVID-19 related deaths have been reported (please see our FAQ section for more information about this assumption). We also assume a fixed date at which the impact of mobility on transmission changes from pre-lockdown levels to post-lockdown levels, which may cause large changes in Rt. We are working to refine how this switch occurs and to formally calculate its shape.

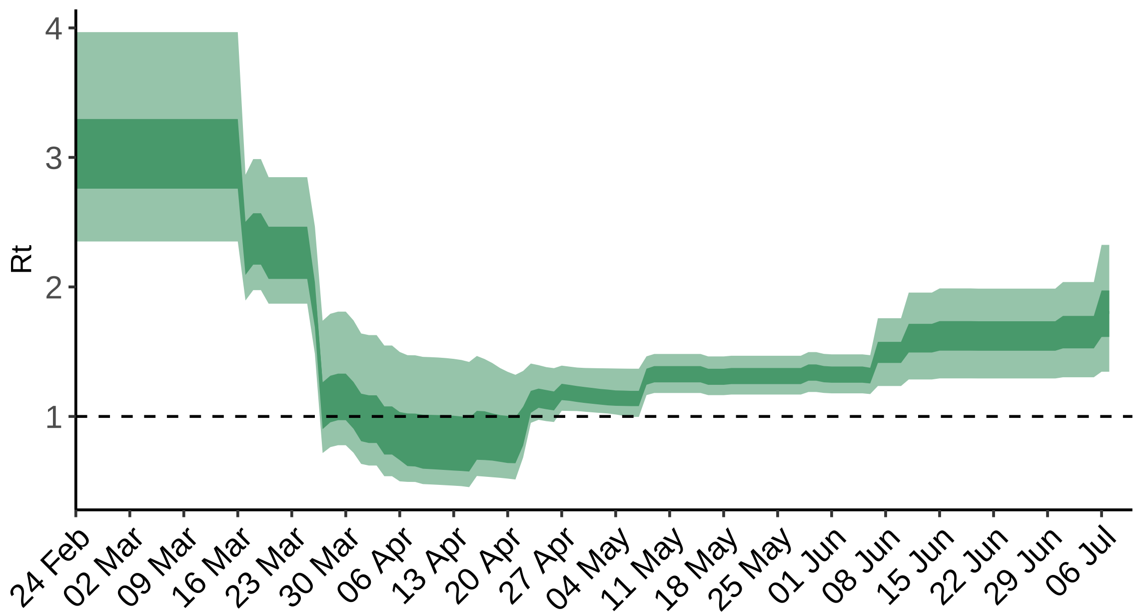

Figure 3: **Time-varying reproduction number, R_t.** R_t is the average number of secondary infections caused by a single infected person at time equal to t. $R_t < 1$ indicates a slowing epidemic in which new infections are not increasing. $R_t > 1$ indicates a growing epidemic in which new infections are increasing over time. Dark green shows the 50% CI and light green shows the 95% CI.

Using the model fit, we can forecast the expected trajectory for cumulative deaths, which is shown in the figure below. This assumes a severity pattern by age that is consistent with that observed in China, Europe and the U.S to date. This projection assumes that transmission is maintained at the current level of transmission as estimated by the final R_t value. **N.B. Eswatini is forecast to be close to or surpassing our best estimates for healthcare capacity in the next 28 days.** Estimates of deaths in the next 28 days may be inaccurate due to our working assumptions for mortality in individuals who do not receive appropriate treatment. See our methods for more information.

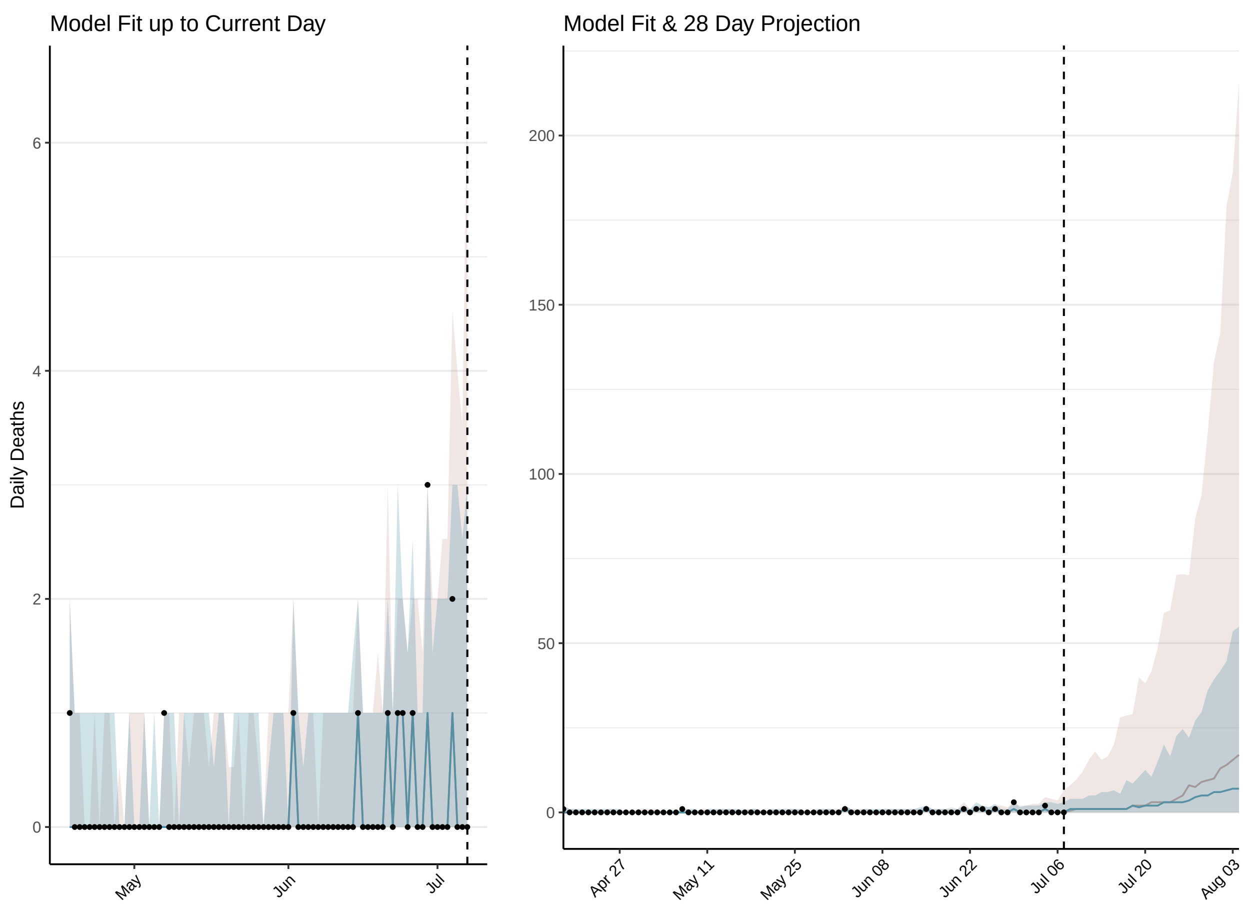

Figure 4: **Estimated daily deaths.** Projected deaths assuming the current level of interventions are maintained are shown in red (median and 95% quantile). Reported deaths are plotted in black. The plot on the left is focussed on the model fit prior to today, while the plot on the right forecasts the next 28 days. The forecasted deaths in blue assumes healthcare capacity has been surged to ensure sufficient supply of ICU and hospital beds. The red curve assumes no surging in healthcare capacity and subsequently projects increased deaths.

Short-term Epidemic Scenarios

We make the following short-term projections of healthcare demand and new infections under the following three scenarios:

- **Scenario 1.** The epidemic continues to grow at the current rate.
- **Scenario 2.** Countries will further scale up interventions (either increasing current strategies or implementing new interventions) leading to a further 50% reduction in transmission.
- **Scenario 3.** Countries will relax current interventions by 50%

N.B. These scenarios currently assume that the impact of mobility on transmission will remain the same in the future as it has in the past. We are working to extend methods to estimate the impact of increases in mobility on transmission as lockdown and interventions are reversed. Consequently, projection are likely to represent an upper estimate of the healthcare demand and case load for each scenario

We estimate that over the next 4 weeks demand for hospital beds will change from 56 (95% CI: 45-66) patients requiring treatment with high-pressure oxygen at the current date to 688 (95% CI: 537-839) hospital beds being required on 2020-08-04 if no further interventions are introduced (Scenario 1). Similarly, we estimate that over the next 4 weeks demand for critical care (ICU) beds will change from 14 (95% CI: 12-17) patients requiring treatment with mechanical ventilation at the current date to 67 (95% CI: 58-76) by 2020-08-04. These projections assume that approximately 5% of all infections will require treatment with high-pressure oxygen and that approximately 30% of hospitalised cases will require treatment with mechanical ventilation (based on analysis of ongoing epidemics in Europe). **N.B. These scenarios are unlikely to show significant differences for the first week since there is a delay of approximately 10 days between infection and hospital admission. Consequently, the effectiveness of a change in policy is likely to be better captured by hospital admission data approximately 2 weeks after the policy change is implemented.**

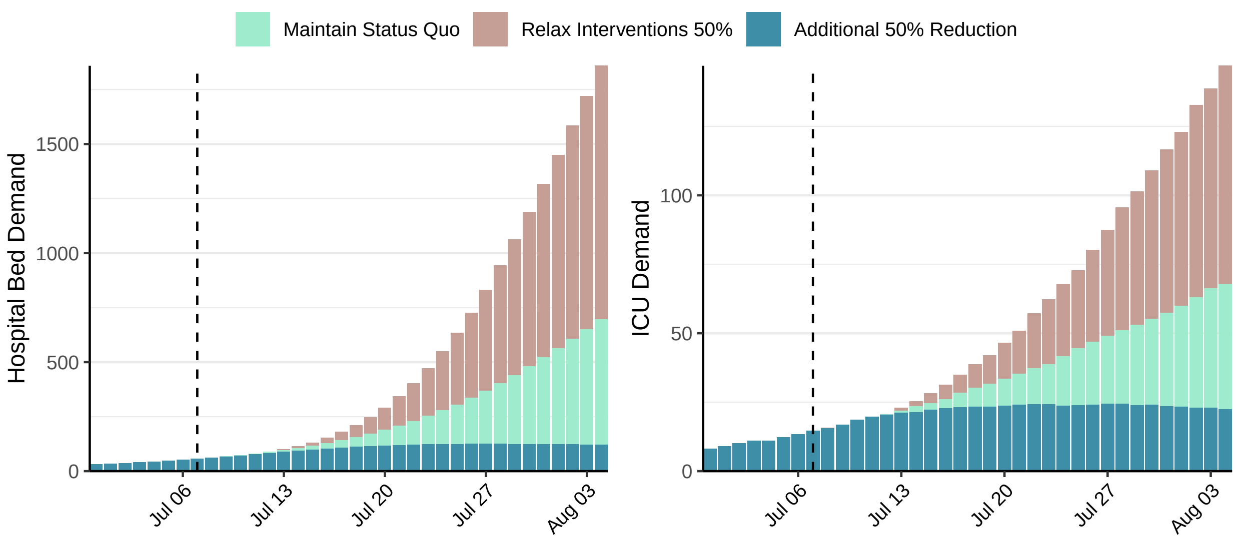

Figure 5: **Healthcare demands in the next 28 days.** Individuals needing an ICU bed are assumed to need mechanical ventilation. Projected demand for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

The impact of each scenario has a more immediate effect on the daily number of infections. The figure below shows the impact of each scenario on the estimated daily incidence of new infections. If interventions are scaled up (Scenario 2), the daily number of infections will change from 831 (95% CI: 649-1,014) at the current date to 749 (95% CI: 533-966) by 2020-08-04. If current interventions were relaxed by 50%, we estimate the daily number of infections will change from 831 (95% CI: 649-1,014) at the current date to 28,452 (95% CI: 25,362-31,541) by 2020-08-04.

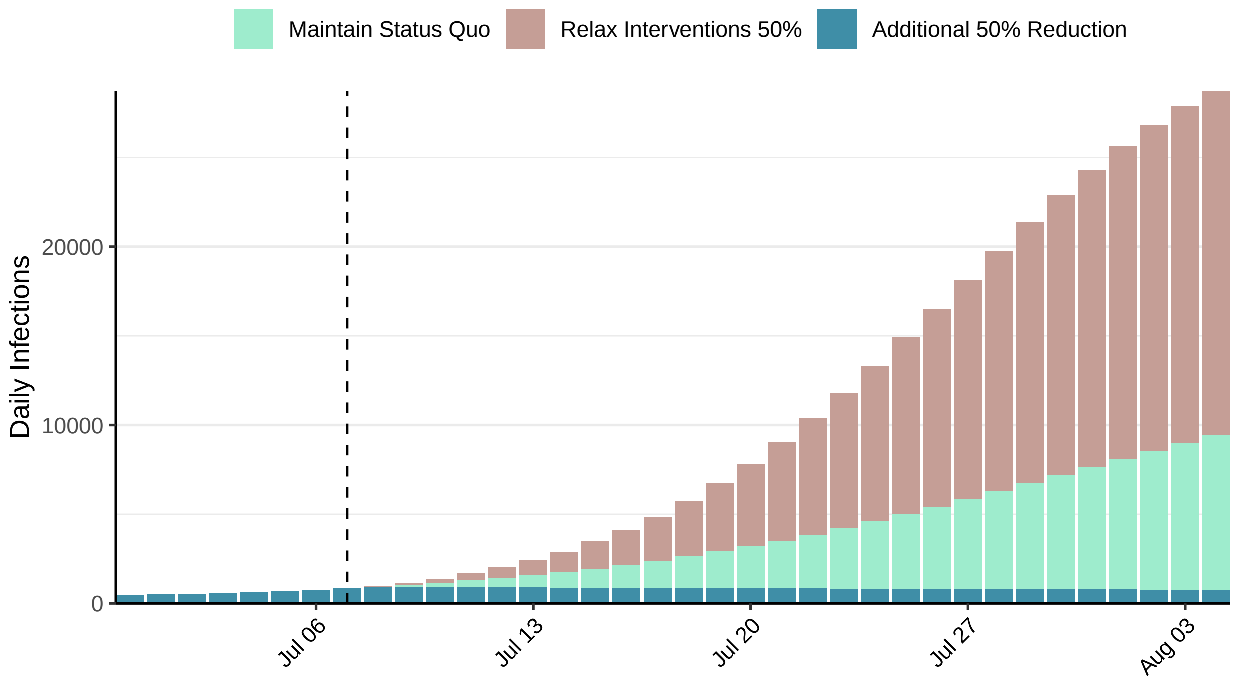

Figure 6: **Daily number of infections estimated by fitting to deaths.** Projected infections for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

To explore different scenarios, we recommend using our COVID-19 Scenario Analysis Tool - https://covidsim.org/, which can be used to simulate different intervention scenarios and explore the long term impact on healthcare demand.

Situation Report for COVID-19: Syria, 2020-07-07

Download the report for Syria, 2020-07-07 here. This report uses data from the European Centre for Disease Control. These data are updated daily and whilst there may be a short delay, they are generally consistent with Ministry reports. These data are then used to back-calculate an 'inferred number of COVID-19 infections' using mathematical modelling techniques (see Report 12 for further details) to estimate the number of people that have been infected and to make short-term projections for future healthcare needs.

Epidemiological Situation

Total Reported Cases	New Reported Cases	Total Reported Deaths	New Reported Deaths	Estimated R_t
372	14	14	1	1.2 (95% CI: 1.09-1.3)

The figure below shows the cumulative reported deaths as a function of the time since the 10th death was reported. Dashed lines show the expected trajectory for different doubling times of the epidemic. For example, with a doubling time of 3 days, if there are currently a total of 20 deaths reported, we would expect there to be 40 deaths in total reported in 3 days-time, 80 deaths in 6 days-time, 160 deaths in 9 days-time etc. For most epidemics, in the absence of interventions, we expect a doubling time of 3-4 days for this disease.

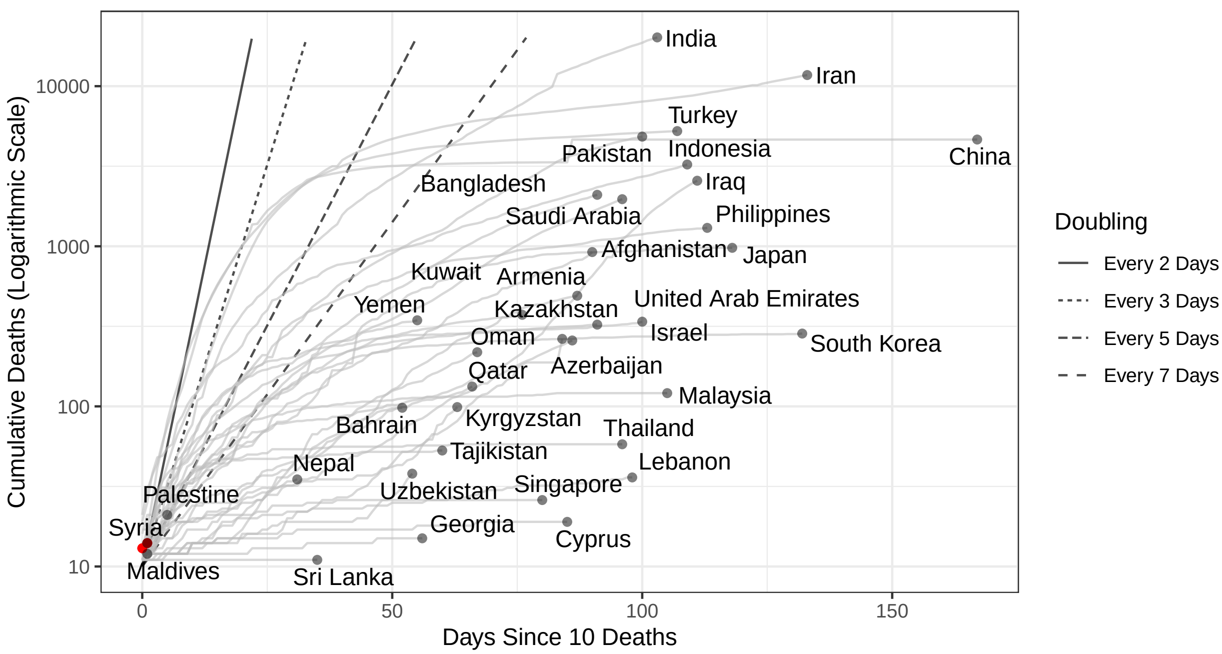

Figure 1: **Cumulative Deaths since 10 deaths.** Country not shown if fewer than 10 deaths.

COVID-19 Transmission Modelling

We assume that the deaths reported to date provide the best indication of the stage of the epidemic, as deaths are more consistently and accurately reported. Our current working estimate is that 1 death indicates that approximately 100 people will have been infected with the other 99 recovering (based on an infection fatality ratio of ~1%). These infections will have happened approximately 21 days previously – capturing a 5-day period from infection to onset of symptoms (the incubation period), 4 days from onset of symptoms to hospitalisation, and 12 days in hospital before death. With a 3-day doubling time, 100 infections that occurred 15 days ago will have generated 200 infections 12 days ago, 400 infections 9 days ago, 800 infections 6 days ago and 1,600 infections 3 days ago resulting in approximately 3,200 infections at the time the first death is observed.

To explore this, we fit our age-structured SEIR model (see Methods) to the time series of deaths in a country, in order to estimate the start date of the epidemic and the baseline R0. We assume that 100% of COVID-19 related deaths have been reported. We have also included the impact of interventions that have been put in place and their effect on human mobility and transmission based on the Google COVID-19 Community Mobility Reports. Using our mathematical model that formalises this approach, we estimate that there has been a total of 3,819 (95% CI: 3,027-4,610) infections over the past 4 weeks.

The figure below shows the estimated number of people infected over the past 4 weeks. The bar charts show, for comparison, the number of reported cases. The right-hand plot shows these data on a different scale as the estimated infections are likely to be much larger than the reported cases. **Importantly**, the estimated infections includes both asymptomatic and mild cases that would not necessarily be identified through surveillance. Consequently, the estimated infections are likely to be significantly higher than the reported cases (see our FAQ for further explanation of these differences and why the reported cases and estimated infections are unlikely to match).

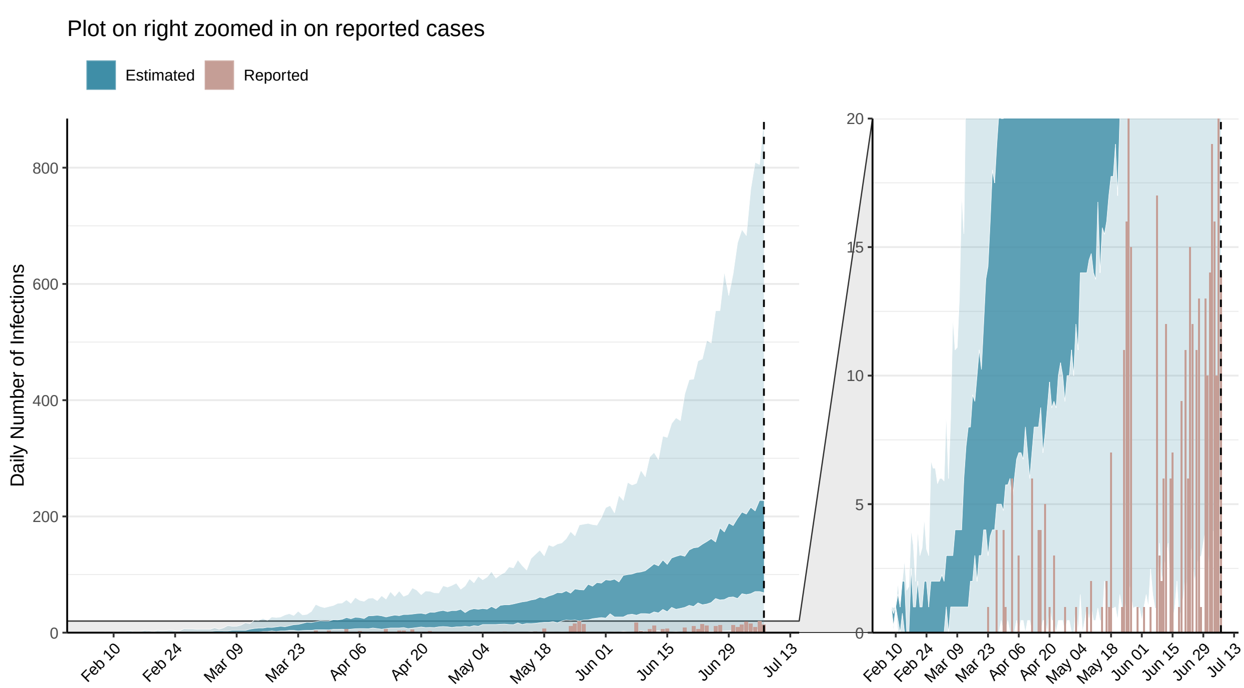

Figure 2: **Daily number of infections estimated by fitting to the current total of deaths.** Reported cases are shown in red. Model estimated infections are shown in blue (dark blue 50% interquartile range, light blue 95% quantile). The dashed line shows the current day.

By fitting to the time series of deaths, we are able to estimate a time-varying reproduction number, R_t. R_t is the the average number of secondary infections caused by a single infected person at a given time. If R_t is above 1, the rate of transmission is increasing and the number of new infections is increasing. R_t is assumed to change in relation to mobility fall in proportion. When fitting our model we assume that 100% of COVID-19 related deaths have been reported (please see our FAQ section for more information about this assumption). We also assume a fixed date at which the impact of mobility on transmission changes from pre-lockdown levels to post-lockdown levels, which may cause large changes in Rt. We are working to refine how this switch occurs and to formally calculate its shape.

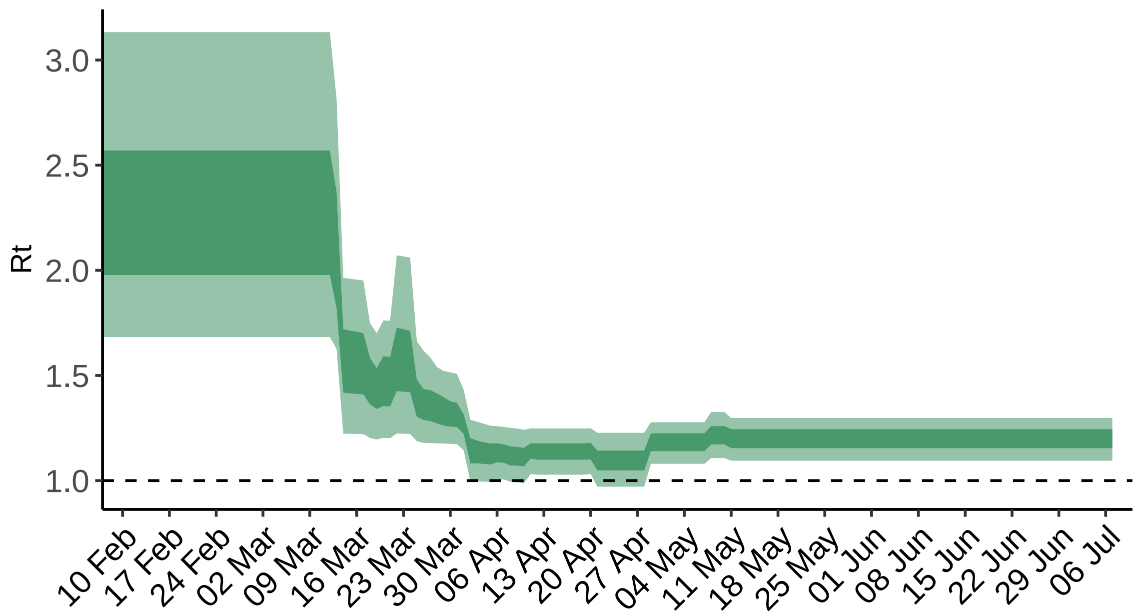

Figure 3: **Time-varying reproduction number, R_t.** R_t is the average number of secondary infections caused by a single infected person at time equal to t. $R_t < 1$ indicates a slowing epidemic in which new infections are not increasing. $R_t > 1$ indicates a growing epidemic in which new infections are increasing over time. Dark green shows the 50% CI and light green shows the 95% CI.

Using the model fit, we can forecast the expected trajectory for cumulative deaths, which is shown in the figure below. This assumes a severity pattern by age that is consistent with that observed in China, Europe and the U.S to date. This projection assumes that transmission is maintained at the current level of transmission as estimated by the final R_t value.

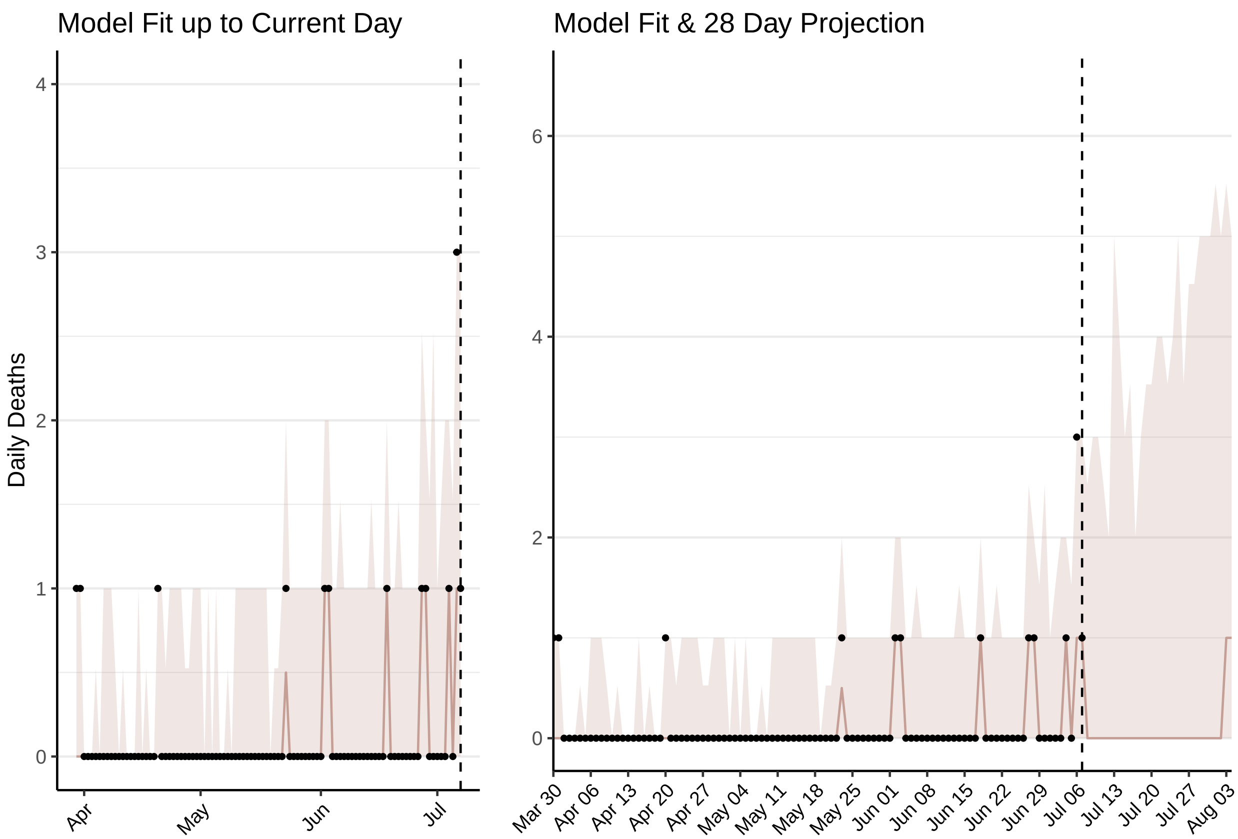

Figure 4: **Estimated daily deaths.** Projected deaths assuming the current level of interventions are maintained are shown in red (median and 95% quantile). Reported deaths are plotted in black. The plot on the left is focussed on the model fit prior to today, while the plot on the right forecasts the next 28 days.

Short-term Epidemic Scenarios

We make the following short-term projections of healthcare demand and new infections under the following three scenarios:

- **Scenario 1.** The epidemic continues to grow at the current rate.
- **Scenario 2.** Countries will further scale up interventions (either increasing current strategies or implementing new interventions) leading to a further 50% reduction in transmission.
- **Scenario 3.** Countries will relax current interventions by 50%

N.B. These scenarios currently assume that the impact of mobility on transmission will remain the same in the future as it has in the past. We are working to extend methods to estimate the impact of increases in mobility on transmission as lockdown and interventions are reversed. Consequently, projection are likely to represent an upper estimate of the healthcare demand and case load for each scenario

We estimate that over the next 4 weeks demand for hospital beds will change from 25 (95% CI: 20-31) patients requiring treatment with high-pressure oxygen at the current date to 59 (95% CI: 45-73) hospital beds being required on 2020-08-04 if no further interventions are introduced (Scenario 1). Similarly, we estimate that over the next 4 weeks demand for critical care (ICU) beds will change from 7 (95% CI: 5-8) patients requiring treatment with mechanical ventilation at the current date to 17 (95% CI: 13-20) by 2020-08-04. These projections assume that approximately 5% of all infections will require treatment with high-pressure oxygen and that approximately 30% of hospitalised cases will require treatment with mechanical ventilation (based on analysis of ongoing epidemics in Europe). **N.B. These scenarios are unlikely to show significant differences for the first week since there is a delay of approximately 10 days between infection and hospital admission. Consequently, the effectiveness of a change in policy is likely to be better captured by hospital admission data approximately 2 weeks after the policy change is implemented.**

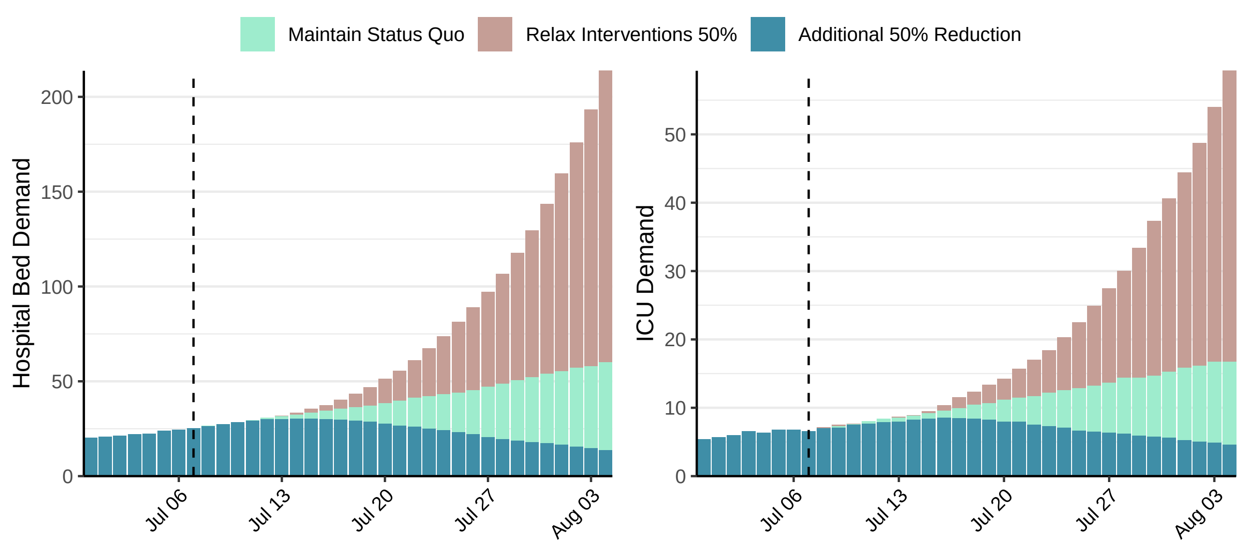

Figure 5: **Healthcare demands in the next 28 days.** Individuals needing an ICU bed are assumed to need mechanical ventilation. Projected demand for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

The impact of each scenario has a more immediate effect on the daily number of infections. The figure below shows the impact of each scenario on the estimated daily incidence of new infections. If interventions are scaled up (Scenario 2), the daily number of infections will change from 200 (95% CI: 156-244) at the current date to 35 (95% CI: 27-44) by 2020-08-04. If current interventions were relaxed by 50%, we estimate the daily number of infections will change from 200 (95% CI: 156-244) at the current date to 3,124 (95% CI: 2,315-3,932) by 2020-08-04.

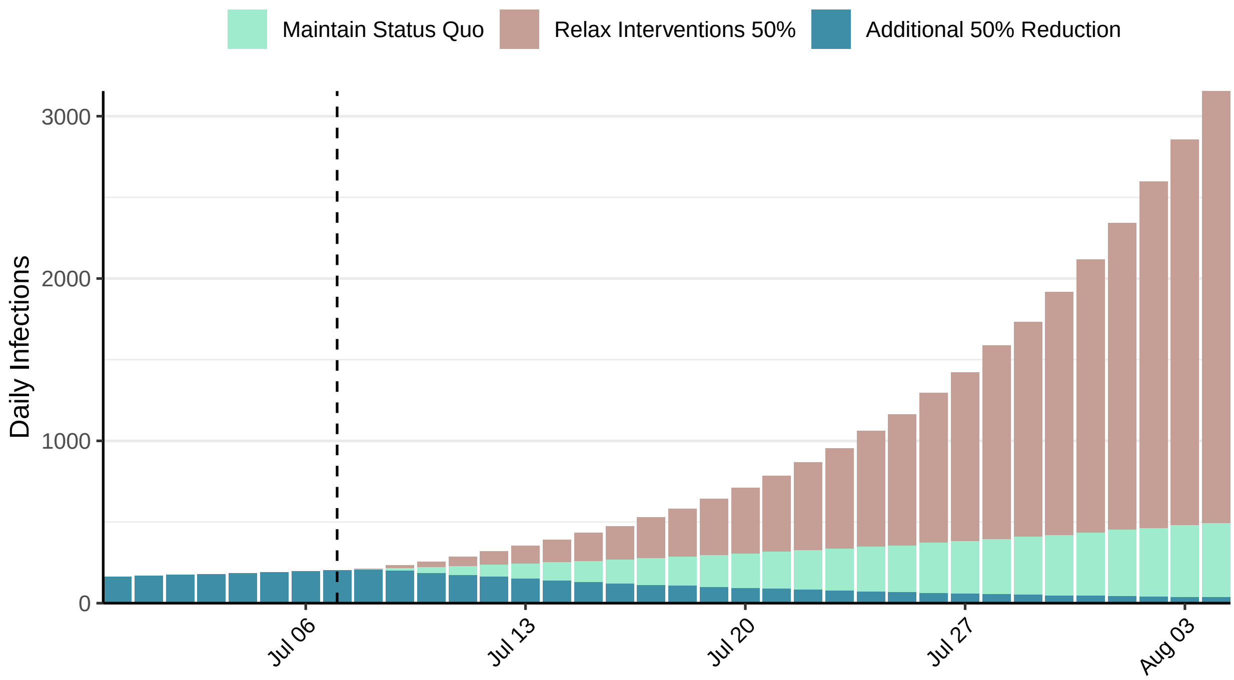

Figure 6: **Daily number of infections estimated by fitting to deaths.** Projected infections for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

To explore different scenarios, we recommend using our COVID-19 Scenario Analysis Tool - https://covidsim.org/, which can be used to simulate different intervention scenarios and explore the long term impact on healthcare demand.

Situation Report for COVID-19: Chad, 2020-07-07

Download the report for Chad, 2020-07-07 here. This report uses data from the European Centre for Disease Control. These data are updated daily and whilst there may be a short delay, they are generally consistent with Ministry reports. These data are then used to back-calculate an 'inferred number of COVID-19 infections' using mathematical modelling techniques (see Report 12 for further details) to estimate the number of people that have been infected and to make short-term projections for future healthcare needs.

Epidemiological Situation

Total Reported Cases	New Reported Cases	Total Reported Deaths	New Reported Deaths	Estimated R_t
872	0	74	0	0.51 (95% CI: 0.41-0.61)

The figure below shows the cumulative reported deaths as a function of the time since the 10th death was reported. Dashed lines show the expected trajectory for different doubling times of the epidemic. For example, with a doubling time of 3 days, if there are currently a total of 20 deaths reported, we would expect there to be 40 deaths in total reported in 3 days-time, 80 deaths in 6 days-time, 160 deaths in 9 days-time etc. For most epidemics, in the absence of interventions, we expect a doubling time of 3-4 days for this disease.

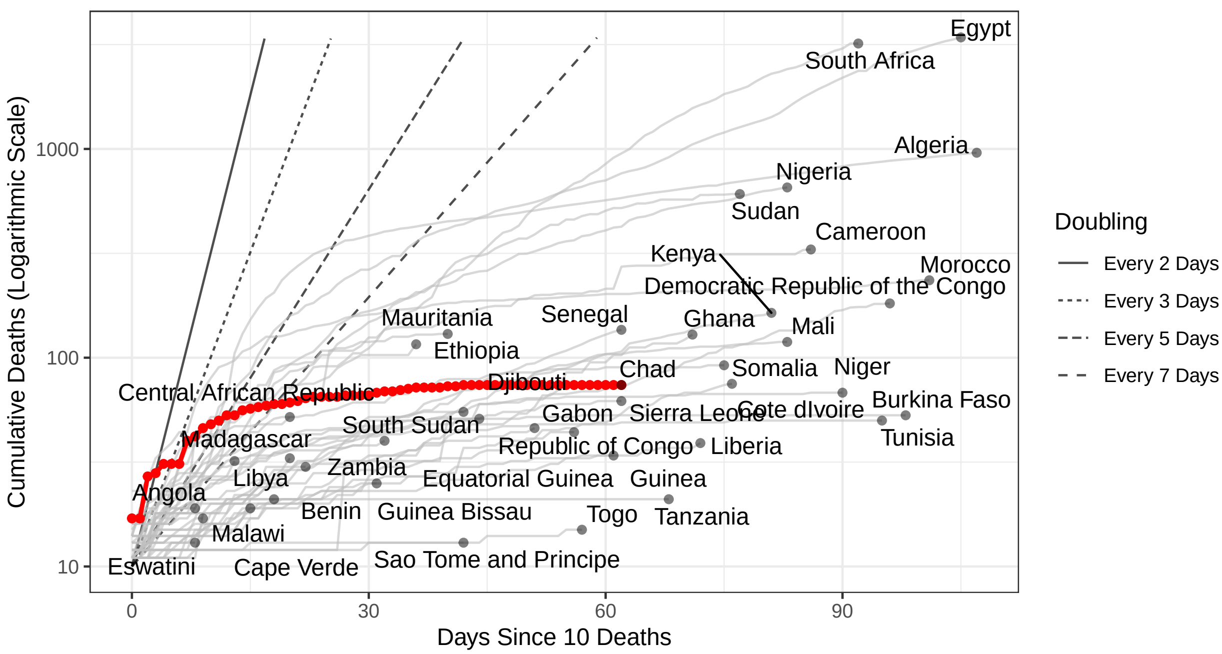

Figure 1: **Cumulative Deaths since 10 deaths.** Country not shown if fewer than 10 deaths.

COVID-19 Transmission Modelling

We assume that the deaths reported to date provide the best indication of the stage of the epidemic, as deaths are more consistently and accurately reported. Our current working estimate is that 1 death indicates that approximately 100 people will have been infected with the other 99 recovering (based on an infection fatality ratio of ~1%). These infections will have happened approximately 21 days previously – capturing a 5-day period from infection to onset of symptoms (the incubation period), 4 days from onset of symptoms to hospitalisation, and 12 days in hospital before death. With a 3-day doubling time, 100 infections that occurred 15 days ago will have generated 200 infections 12 days ago, 400 infections 9 days ago, 800 infections 6 days ago and 1,600 infections 3 days ago resulting in approximately 3,200 infections at the time the first death is observed.

To explore this, we fit our age-structured SEIR model (see Methods) to the time series of deaths in a country, in order to estimate the start date of the epidemic and the baseline R0. We assume that 100% of COVID-19 related deaths have been reported. We have also included the impact of interventions that have been put in place and their effect on human mobility and transmission based on the Google COVID-19 Community Mobility Reports. Using our mathematical model that formalises this approach, we estimate that there has been a total of 401 (95% CI: 343-459) infections over the past 4 weeks.

The figure below shows the estimated number of people infected over the past 4 weeks. The bar charts show, for comparison, the number of reported cases. The right-hand plot shows these data on a different scale as the estimated infections are likely to be much larger than the reported cases. **Importantly**, the estimated infections includes both asymptomatic and mild cases that would not necessarily be identified through surveillance. Consequently, the estimated infections are likely to be significantly higher than the reported cases (see our FAQ for further explanation of these differences and why the reported cases and estimated infections are unlikely to match).

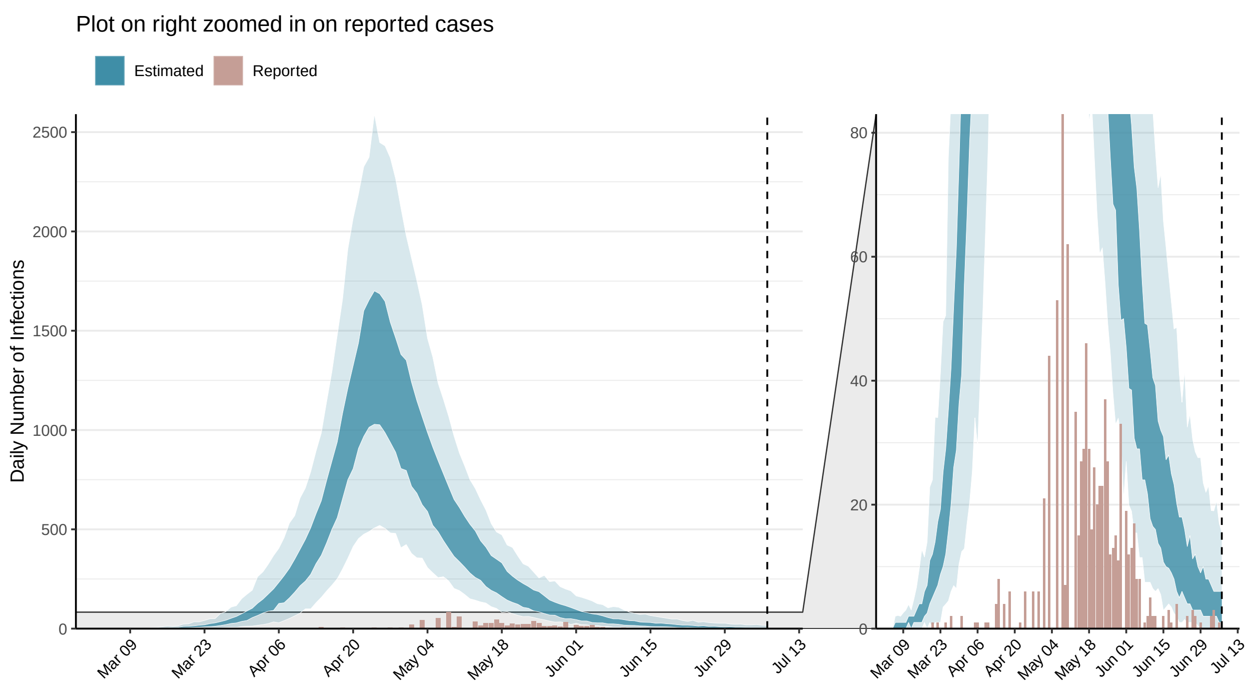

Figure 2: **Daily number of infections estimated by fitting to the current total of deaths.** Reported cases are shown in red. Model estimated infections are shown in blue (dark blue 50% interquartile range, light blue 95% quantile). The dashed line shows the current day.

By fitting to the time series of deaths, we are able to estimate a time-varying reproduction number, R_t. R_t is the the average number of secondary infections caused by a single infected person at a given time. If R_t is above 1, the rate of transmission is increasing and the number of new infections is increasing. R_t is assumed to change in relation to mobility fall in proportion. When fitting our model we assume that 100% of COVID-19 related deaths have been reported (please see our FAQ section for more information about this assumption). We also assume a fixed date at which the impact of mobility on transmission changes from pre-lockdown levels to post-lockdown levels, which may cause large changes in Rt. We are working to refine how this switch occurs and to formally calculate its shape.

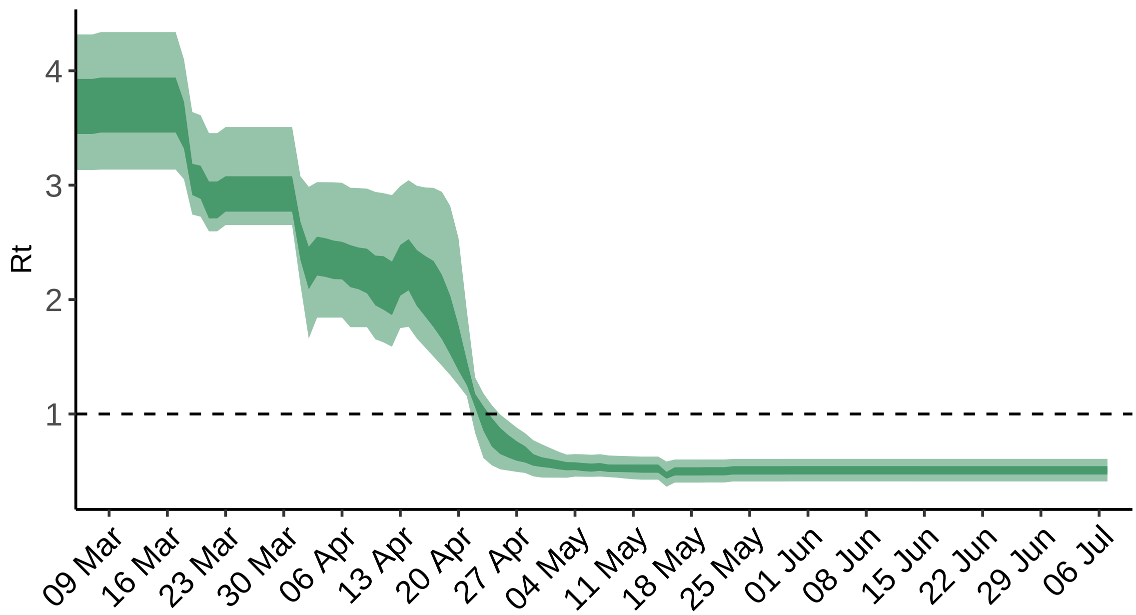

Figure 3: **Time-varying reproduction number, R_t.** R_t is the average number of secondary infections caused by a single infected person at time equal to t. $R_t < 1$ indicates a slowing epidemic in which new infections are not increasing. $R_t > 1$ indicates a growing epidemic in which new infections are increasing over time. Dark green shows the 50% CI and light green shows the 95% CI.

Using the model fit, we can forecast the expected trajectory for cumulative deaths, which is shown in the figure below. This assumes a severity pattern by age that is consistent with that observed in China, Europe and the U.S to date. This projection assumes that transmission is maintained at the current level of transmission as estimated by the final R_t value.

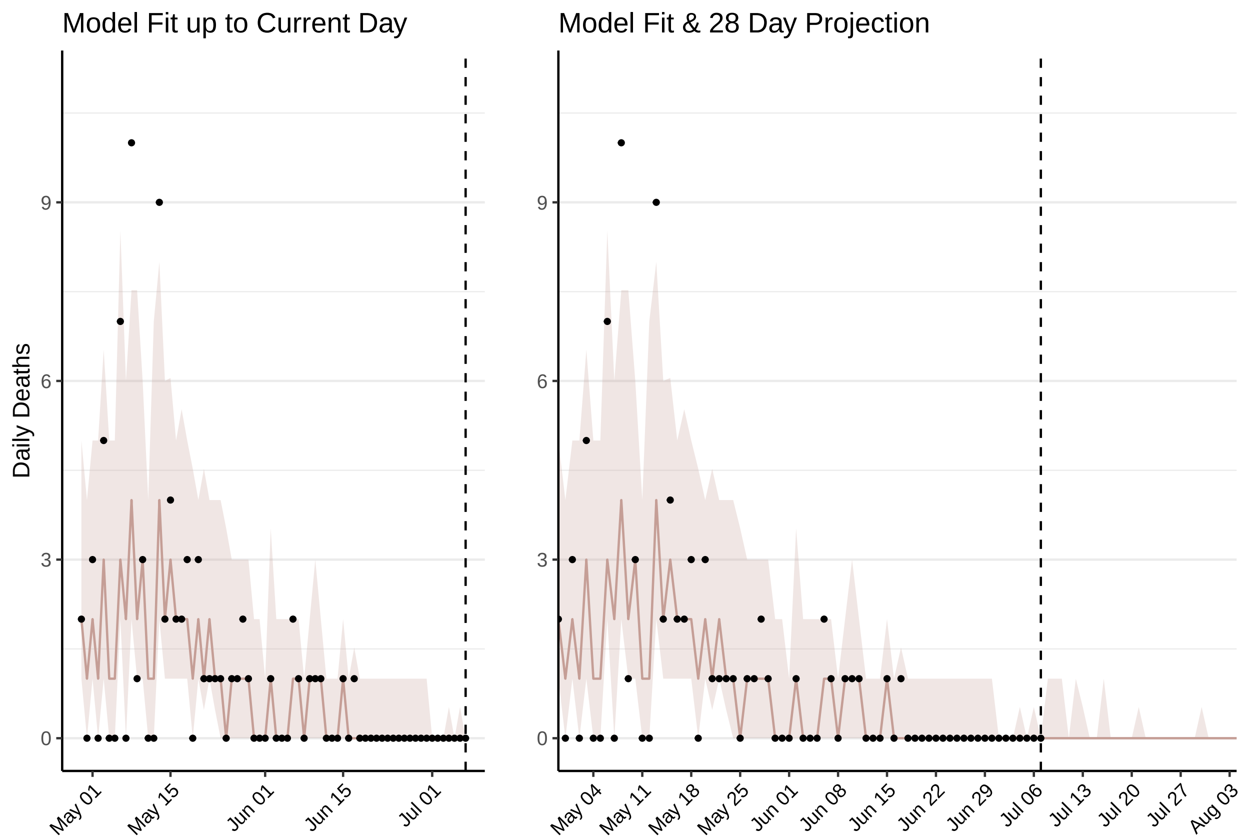

Figure 4: **Estimated daily deaths.** Projected deaths assuming the current level of interventions are maintained are shown in red (median and 95% quantile). Reported deaths are plotted in black. The plot on the left is focussed on the model fit prior to today, while the plot on the right forecasts the next 28 days.

Short-term Epidemic Scenarios

We make the following short-term projections of healthcare demand and new infections under the following three scenarios:

- **Scenario 1.** The epidemic continues to grow at the current rate.
- **Scenario 2.** Countries will further scale up interventions (either increasing current strategies or implementing new interventions) leading to a further 50% reduction in transmission.
- **Scenario 3.** Countries will relax current interventions by 50%

N.B. These scenarios currently assume that the impact of mobility on transmission will remain the same in the future as it has in the past. We are working to extend methods to estimate the impact of increases in mobility on transmission as lockdown and interventions are reversed. Consequently, projection are likely to represent an upper estimate of the healthcare demand and case load for each scenario

We estimate that over the next 4 weeks demand for hospital beds will change from 2 (95% CI: 1-2) patients requiring treatment with high-pressure oxygen at the current date to 0 (95% CI: 0-0) hospital beds being required on 2020-08-04 if no further interventions are introduced (Scenario 1). Similarly, we estimate that over the next 4 weeks demand for critical care (ICU) beds will change from 1 (95% CI: 0-1) patients requiring treatment with mechanical ventilation at the current date to 0 (95% CI: 0-0) by 2020-08-04. These projections assume that approximately 5% of all infections will require treatment with high-pressure oxygen and that approximately 30% of hospitalised cases will require treatment with mechanical ventilation (based on analysis of ongoing epidemics in Europe). **N.B. These scenarios are unlikely to show significant differences for the first week since there is a delay of approximately 10 days between infection and hospital admission. Consequently, the effectiveness of a change in policy is likely to be better captured by hospital admission data approximately 2 weeks after the policy change is implemented.**

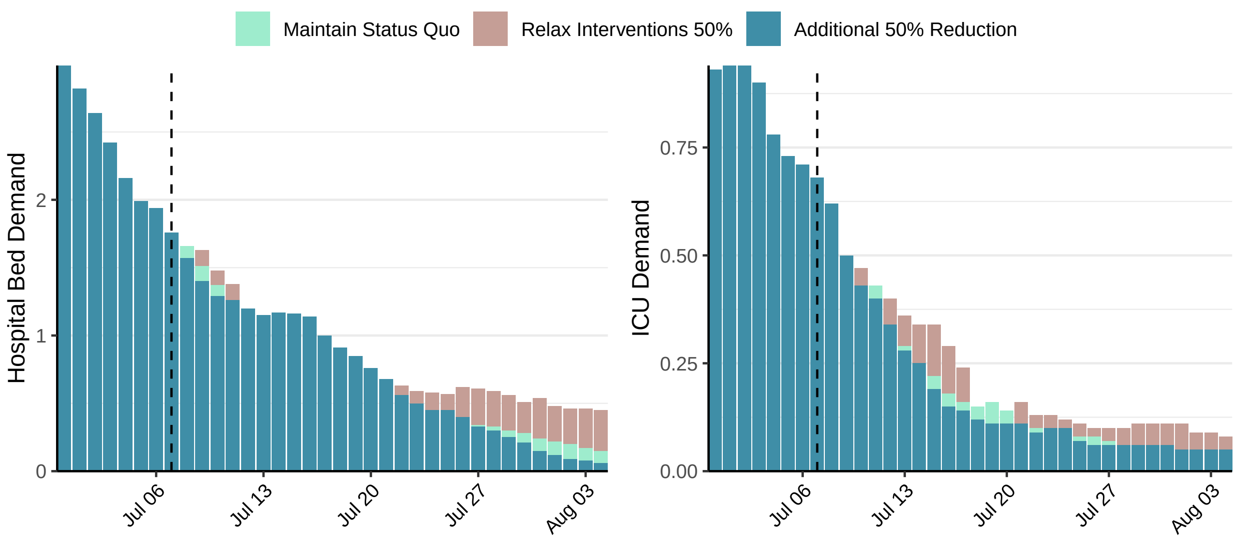

Figure 5: **Healthcare demands in the next 28 days.** Individuals needing an ICU bed are assumed to need mechanical ventilation. Projected demand for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

The impact of each scenario has a more immediate effect on the daily number of infections. The figure below shows the impact of each scenario on the estimated daily incidence of new infections. If interventions are scaled up (Scenario 2), the daily number of infections will change from 4 (95% CI: 3-5) at the current date to 0 (95% CI: 0-0) by 2020-08-04. If current interventions were relaxed by 50%, we estimate the daily number of infections will change from 4 (95% CI: 3-5) at the current date to 2 (95% CI: 1-3) by 2020-08-04.

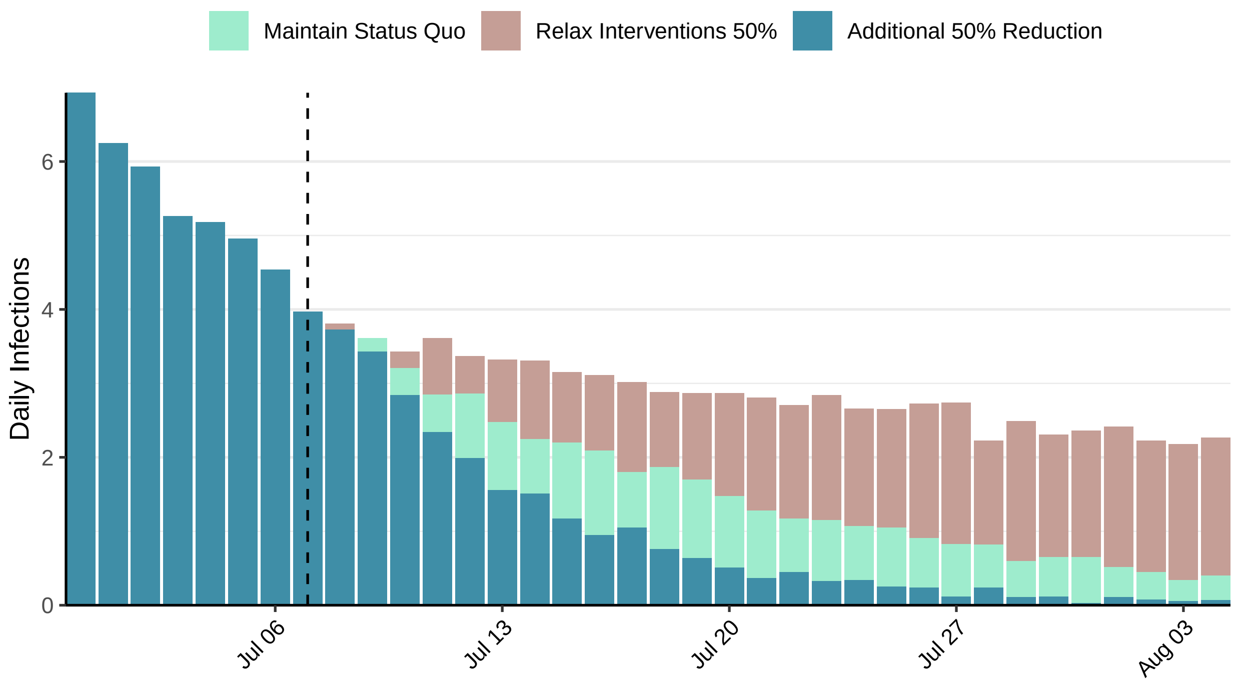

Figure 6: **Daily number of infections estimated by fitting to deaths.** Projected infections for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

To explore different scenarios, we recommend using our COVID-19 Scenario Analysis Tool - https://covidsim.org/, which can be used to simulate different intervention scenarios and explore the long term impact on healthcare demand.

Situation Report for COVID-19: Togo, 2020-07-07

Download the report for Togo, 2020-07-07 here. This report uses data from the European Centre for Disease Control. These data are updated daily and whilst there may be a short delay, they are generally consistent with Ministry reports. These data are then used to back-calculate an 'inferred number of COVID-19 infections' using mathematical modelling techniques (see Report 12 for further details) to estimate the number of people that have been infected and to make short-term projections for future healthcare needs.

Epidemiological Situation

Total Reported Cases	New Reported Cases	Total Reported Deaths	New Reported Deaths	Estimated R_t
680	0	15	0	1.04 (95% CI: 0.8-1.32)

The figure below shows the cumulative reported deaths as a function of the time since the 10th death was reported. Dashed lines show the expected trajectory for different doubling times of the epidemic. For example, with a doubling time of 3 days, if there are currently a total of 20 deaths reported, we would expect there to be 40 deaths in total reported in 3 days-time, 80 deaths in 6 days-time, 160 deaths in 9 days-time etc. For most epidemics, in the absence of interventions, we expect a doubling time of 3-4 days for this disease.

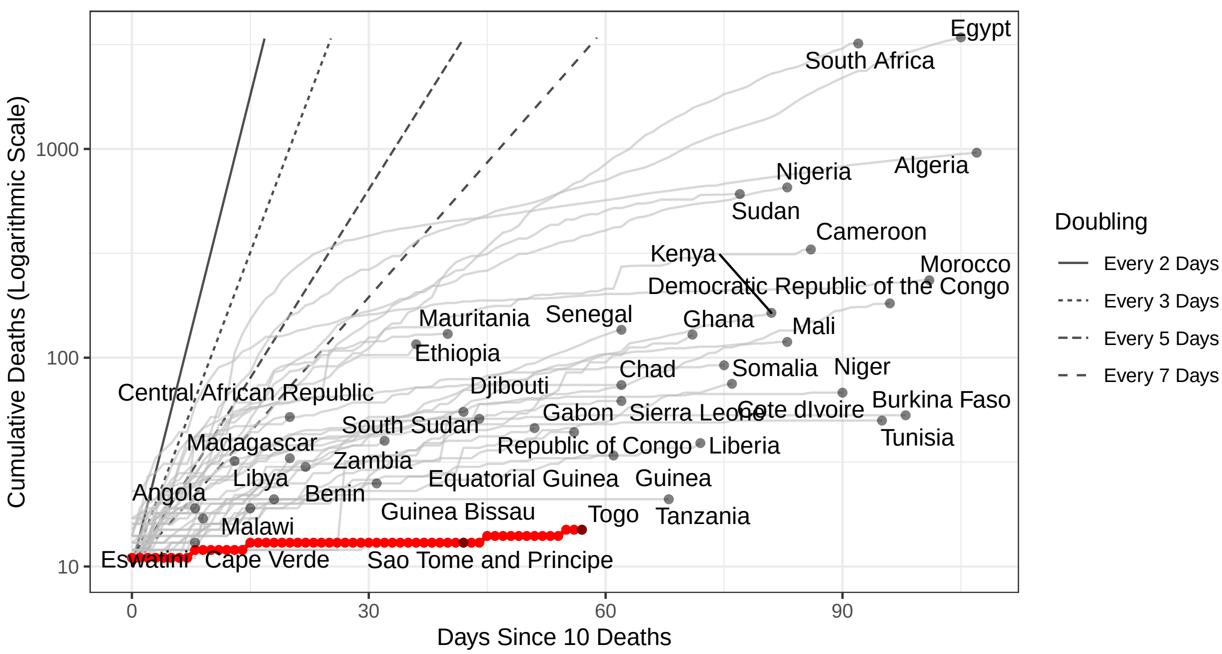

Figure 1: **Cumulative Deaths since 10 deaths.** Country not shown if fewer than 10 deaths.

COVID-19 Transmission Modelling

We assume that the deaths reported to date provide the best indication of the stage of the epidemic, as deaths are more consistently and accurately reported. Our current working estimate is that 1 death indicates that approximately 100 people will have been infected with the other 99 recovering (based on an infection fatality ratio of ~1%). These infections will have happened approximately 21 days previously – capturing a 5-day period from infection to onset of symptoms (the incubation period), 4 days from onset of symptoms to hospitalisation, and 12 days in hospital before death. With a 3-day doubling time, 100 infections that occurred 15 days ago will have generated 200 infections 12 days ago, 400 infections 9 days ago, 800 infections 6 days ago and 1,600 infections 3 days ago resulting in approximately 3,200 infections at the time the first death is observed.

To explore this, we fit our age-structured SEIR model (see Methods) to the time series of deaths in a country, in order to estimate the start date of the epidemic and the baseline R0. We assume that 100% of COVID-19 related deaths have been reported. We have also included the impact of interventions that have been put in place and their effect on human mobility and transmission based on the Google COVID-19 Community Mobility Reports. Using our mathematical model that formalises this approach, we estimate that there has been a total of 1,307 (95% CI: 1,032-1,582) infections over the past 4 weeks.

The figure below shows the estimated number of people infected over the past 4 weeks. The bar charts show, for comparison, the number of reported cases. The right-hand plot shows these data on a different scale as the estimated infections are likely to be much larger than the reported cases. **Importantly**, the estimated infections includes both asymptomatic and mild cases that would not necessarily be identified through surveillance. Consequently, the estimated infections are likely to be significantly higher than the reported cases (see our FAQ for further explanation of these differences and why the reported cases and estimated infections are unlikely to match).

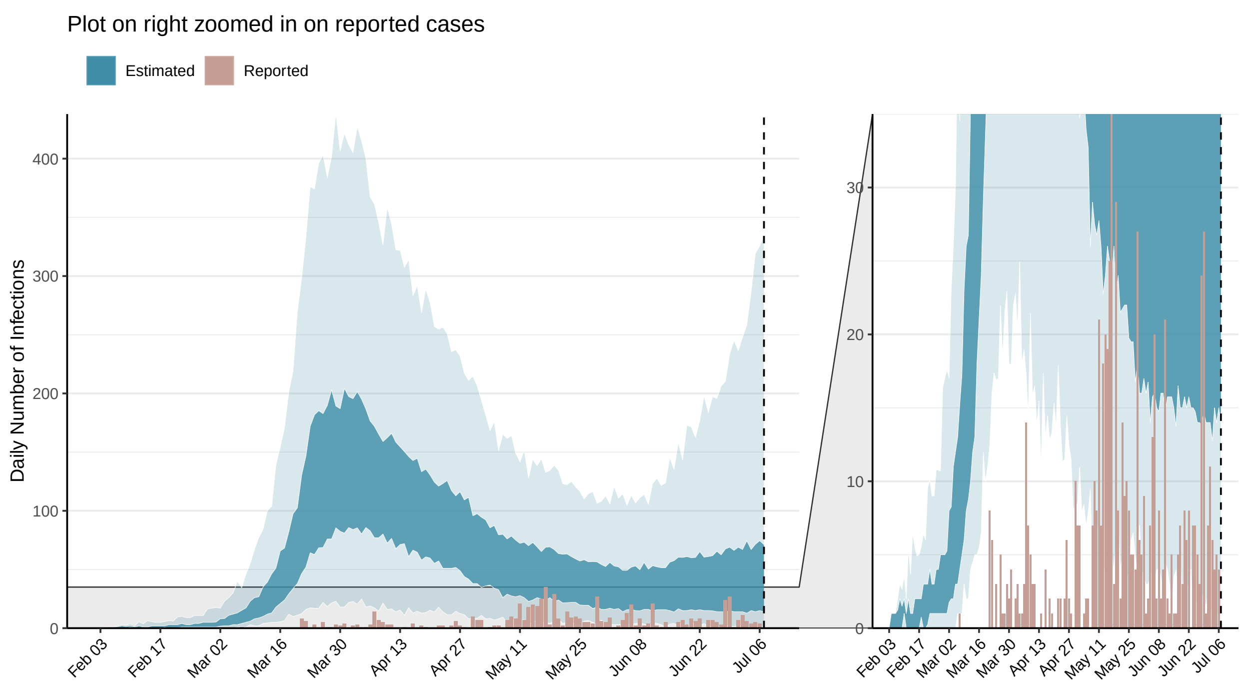

Figure 2: **Daily number of infections estimated by fitting to the current total of deaths.** Reported cases are shown in red. Model estimated infections are shown in blue (dark blue 50% interquartile range, light blue 95% quantile). The dashed line shows the current day.

By fitting to the time series of deaths, we are able to estimate a time-varying reproduction number, R_t. R_t is the the average number of secondary infections caused by a single infected person at a given time. If R_t is above 1, the rate of transmission is increasing and the number of new infections is increasing. R_t is assumed to change in relation to mobility fall in proportion. When fitting our model we assume that 100% of COVID-19 related deaths have been reported (please see our FAQ section for more information about this assumption). We also assume a fixed date at which the impact of mobility on transmission changes from pre-lockdown levels to post-lockdown levels, which may cause large changes in Rt. We are working to refine how this switch occurs and to formally calculate its shape.

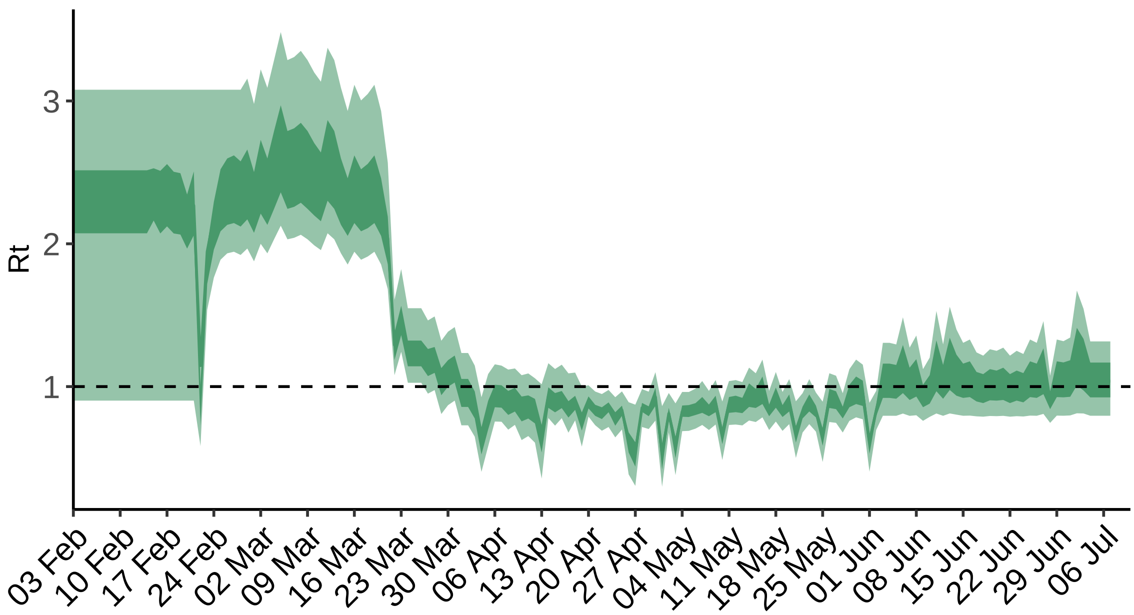

Figure 3: **Time-varying reproduction number, R_t.** R_t is the average number of secondary infections caused by a single infected person at time equal to t. $R_t < 1$ indicates a slowing epidemic in which new infections are not increasing. $R_t > 1$ indicates a growing epidemic in which new infections are increasing over time. Dark green shows the 50% CI and light green shows the 95% CI.

Using the model fit, we can forecast the expected trajectory for cumulative deaths, which is shown in the figure below. This assumes a severity pattern by age that is consistent with that observed in China, Europe and the U.S to date. This projection assumes that transmission is maintained at the current level of transmission as estimated by the final R_t value.

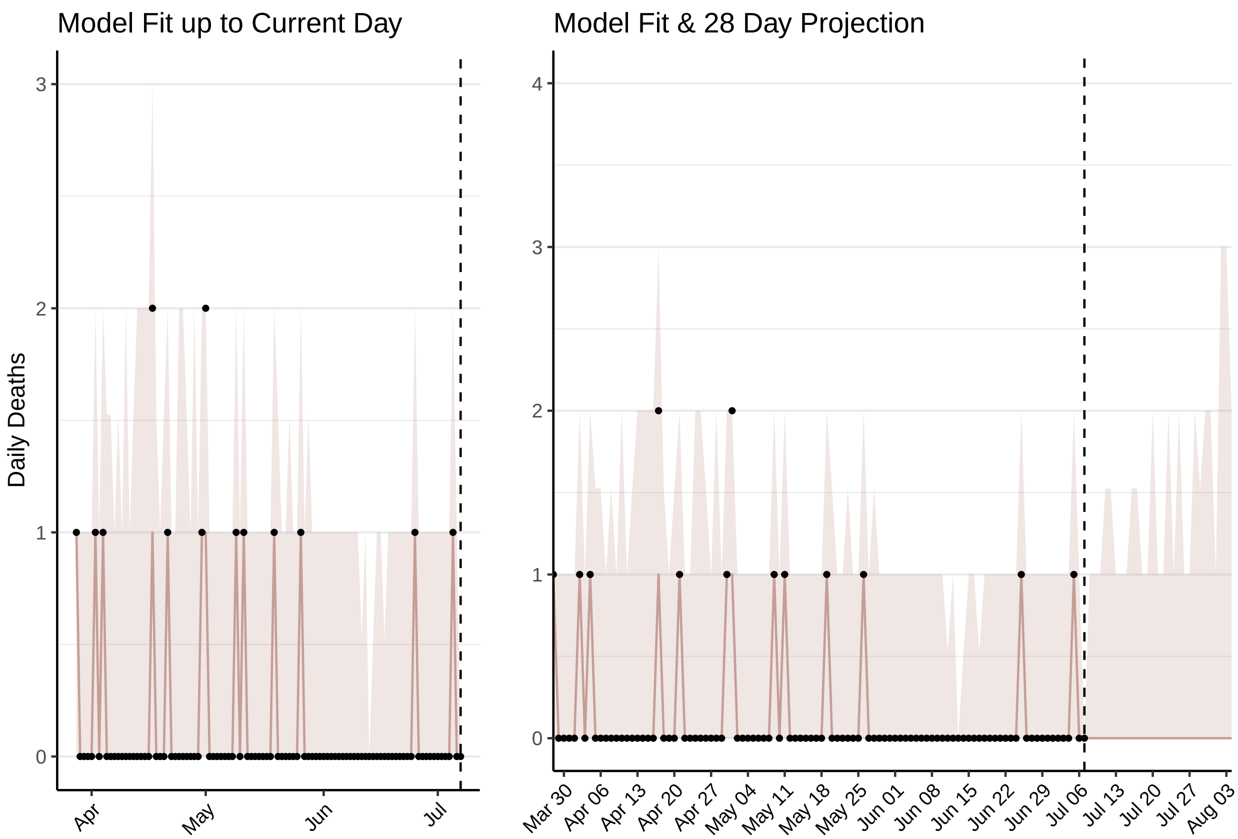

Figure 4: **Estimated daily deaths.** Projected deaths assuming the current level of interventions are maintained are shown in red (median and 95% quantile). Reported deaths are plotted in black. The plot on the left is focussed on the model fit prior to today, while the plot on the right forecasts the next 28 days.

Short-term Epidemic Scenarios

We make the following short-term projections of healthcare demand and new infections under the following three scenarios:

- **Scenario 1.** The epidemic continues to grow at the current rate.
- **Scenario 2.** Countries will further scale up interventions (either increasing current strategies or implementing new interventions) leading to a further 50% reduction in transmission.
- **Scenario 3.** Countries will relax current interventions by 50%

N.B. These scenarios currently assume that the impact of mobility on transmission will remain the same in the future as it has in the past. We are working to extend methods to estimate the impact of increases in mobility on transmission as lockdown and interventions are reversed. Consequently, projection are likely to represent an upper estimate of the healthcare demand and case load for each scenario

We estimate that over the next 4 weeks demand for hospital beds will change from 7 (95% CI: 6-9) patients requiring treatment with high-pressure oxygen at the current date to 14 (95% CI: 9-19) hospital beds being required on 2020-08-04 if no further interventions are introduced (Scenario 1). Similarly, we estimate that over the next 4 weeks demand for critical care (ICU) beds will change from 2 (95% CI: 1-3) patients requiring treatment with mechanical ventilation at the current date to 4 (95% CI: 2-5) by 2020-08-04. These projections assume that approximately 5% of all infections will require treatment with high-pressure oxygen and that approximately 30% of hospitalised cases will require treatment with mechanical ventilation (based on analysis of ongoing epidemics in Europe). **N.B. These scenarios are unlikely to show significant differences for the first week since there is a delay of approximately 10 days between infection and hospital admission. Consequently, the effectiveness of a change in policy is likely to be better captured by hospital admission data approximately 2 weeks after the policy change is implemented.**

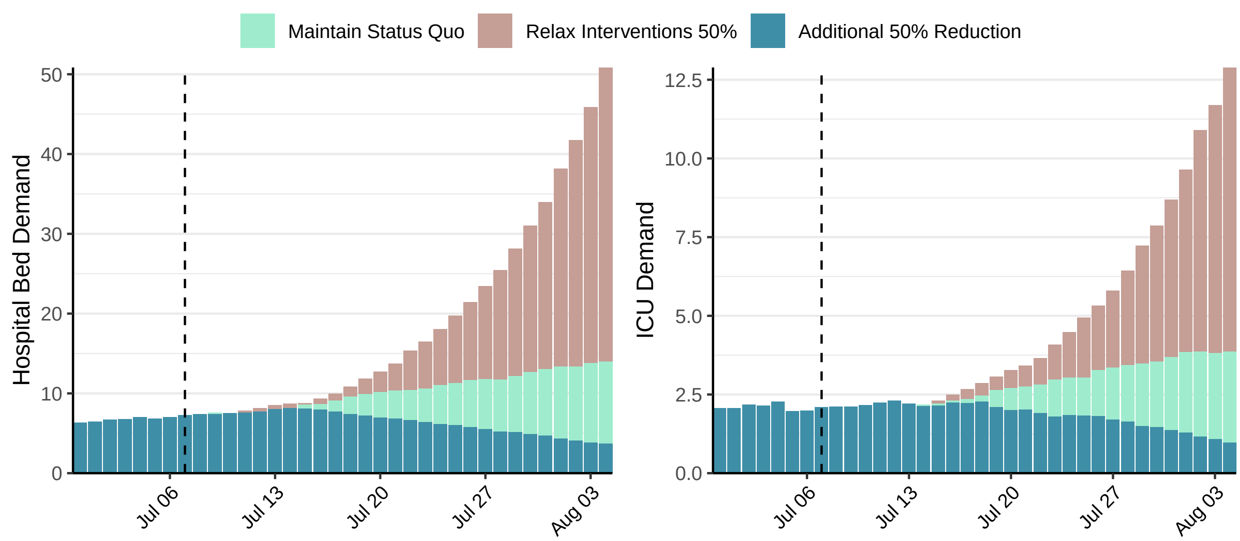

Figure 5: **Healthcare demands in the next 28 days.** Individuals needing an ICU bed are assumed to need mechanical ventilation. Projected demand for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

The impact of each scenario has a more immediate effect on the daily number of infections. The figure below shows the impact of each scenario on the estimated daily incidence of new infections. If interventions are scaled up (Scenario 2), the daily number of infections will change from 61 (95% CI: 45-78) at the current date to 9 (95% CI: 6-12) by 2020-08-04. If current interventions were relaxed by 50%, we estimate the daily number of infections will change from 61 (95% CI: 45-78) at the current date to 845 (95% CI: 497-1,193) by 2020-08-04.

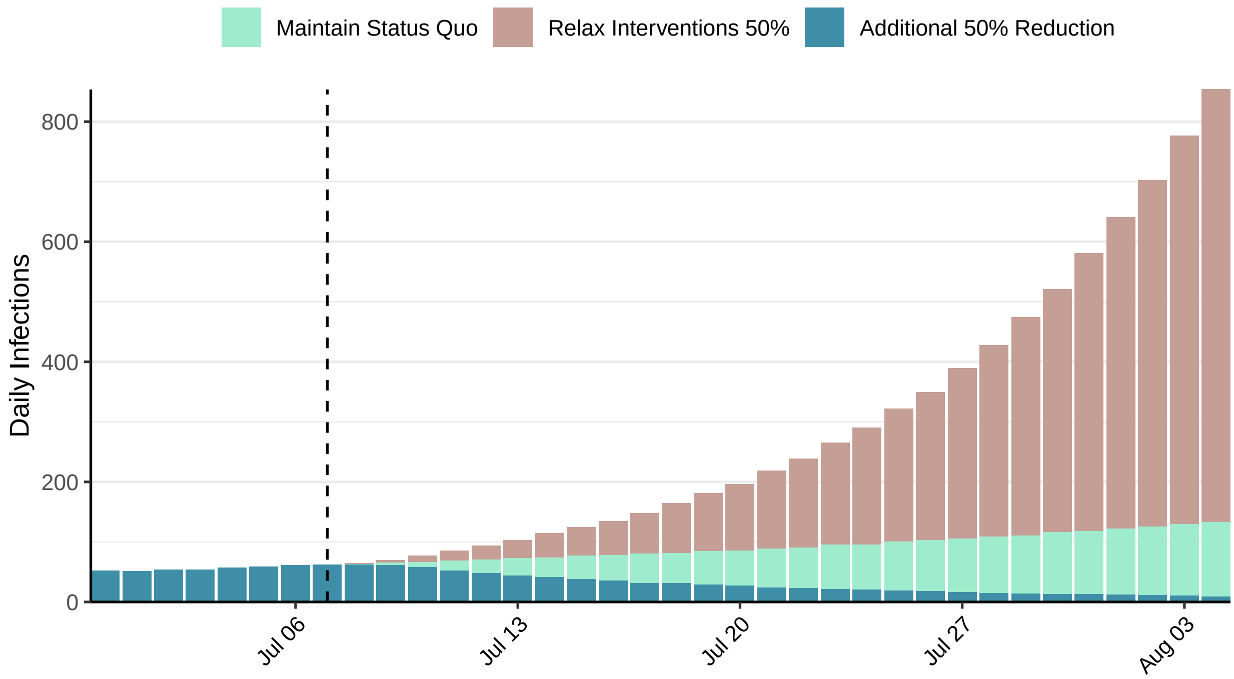

Figure 6: **Daily number of infections estimated by fitting to deaths.** Projected infections for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

To explore different scenarios, we recommend using our COVID-19 Scenario Analysis Tool - https://covidsim.org/, which can be used to simulate different intervention scenarios and explore the long term impact on healthcare demand.

Situation Report for COVID-19: Thailand, 2020-07-07

Download the report for Thailand, 2020-07-07 here. This report uses data from the European Centre for Disease Control. These data are updated daily and whilst there may be a short delay, they are generally consistent with Ministry reports. These data are then used to back-calculate an 'inferred number of COVID-19 infections' using mathematical modelling techniques (see Report 12 for further details) to estimate the number of people that have been infected and to make short-term projections for future healthcare needs.

Epidemiological Situation

Total Reported Cases	New Reported Cases	Total Reported Deaths	New Reported Deaths	Estimated R_t
3,195	0	58	0	0.77 (95% CI: 0.29-1.46)

The figure below shows the cumulative reported deaths as a function of the time since the 10th death was reported. Dashed lines show the expected trajectory for different doubling times of the epidemic. For example, with a doubling time of 3 days, if there are currently a total of 20 deaths reported, we would expect there to be 40 deaths in total reported in 3 days-time, 80 deaths in 6 days-time, 160 deaths in 9 days-time etc. For most epidemics, in the absence of interventions, we expect a doubling time of 3-4 days for this disease.

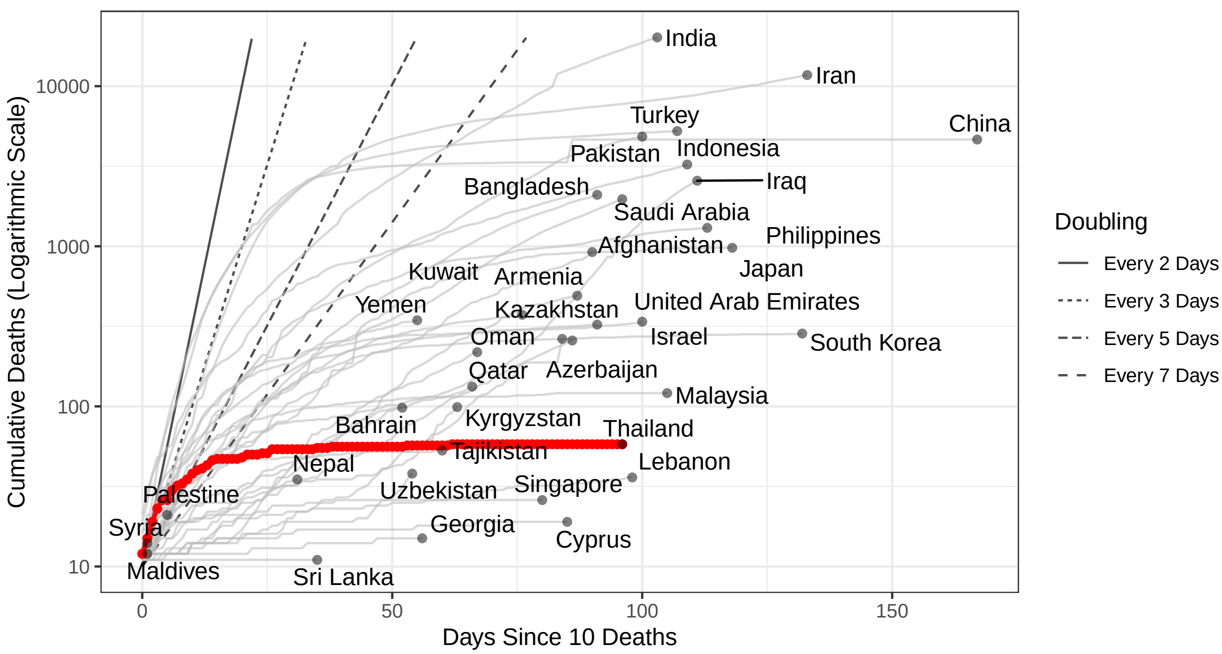

Figure 1: **Cumulative Deaths since 10 deaths.** Country not shown if fewer than 10 deaths.

COVID-19 Transmission Modelling

We assume that the deaths reported to date provide the best indication of the stage of the epidemic, as deaths are more consistently and accurately reported. Our current working estimate is that 1 death indicates that approximately 100 people will have been infected with the other 99 recovering (based on an infection fatality ratio of ~1%). These infections will have happened approximately 21 days previously – capturing a 5-day period from infection to onset of symptoms (the incubation period), 4 days from onset of symptoms to hospitalisation, and 12 days in hospital before death. With a 3-day doubling time, 100 infections that occurred 15 days ago will have generated 200 infections 12 days ago, 400 infections 9 days ago, 800 infections 6 days ago and 1,600 infections 3 days ago resulting in approximately 3,200 infections at the time the first death is observed.

To explore this, we fit our age-structured SEIR model (see Methods) to the time series of deaths in a country, in order to estimate the start date of the epidemic and the baseline R0. We assume that 100% of COVID-19 related deaths have been reported. We have also included the impact of interventions that have been put in place and their effect on human mobility and transmission based on the Google COVID-19 Community Mobility Reports. Using our mathematical model that formalises this approach, we estimate that there has been a total of 26 (95% CI: 15-37) infections over the past 4 weeks.

The figure below shows the estimated number of people infected over the past 4 weeks. The bar charts show, for comparison, the number of reported cases. The right-hand plot shows these data on a different scale as the estimated infections are likely to be much larger than the reported cases. **Importantly**, the estimated infections includes both asymptomatic and mild cases that would not necessarily be identified through surveillance. Consequently, the estimated infections are likely to be significantly higher than the reported cases (see our FAQ for further explanation of these differences and why the reported cases and estimated infections are unlikely to match).

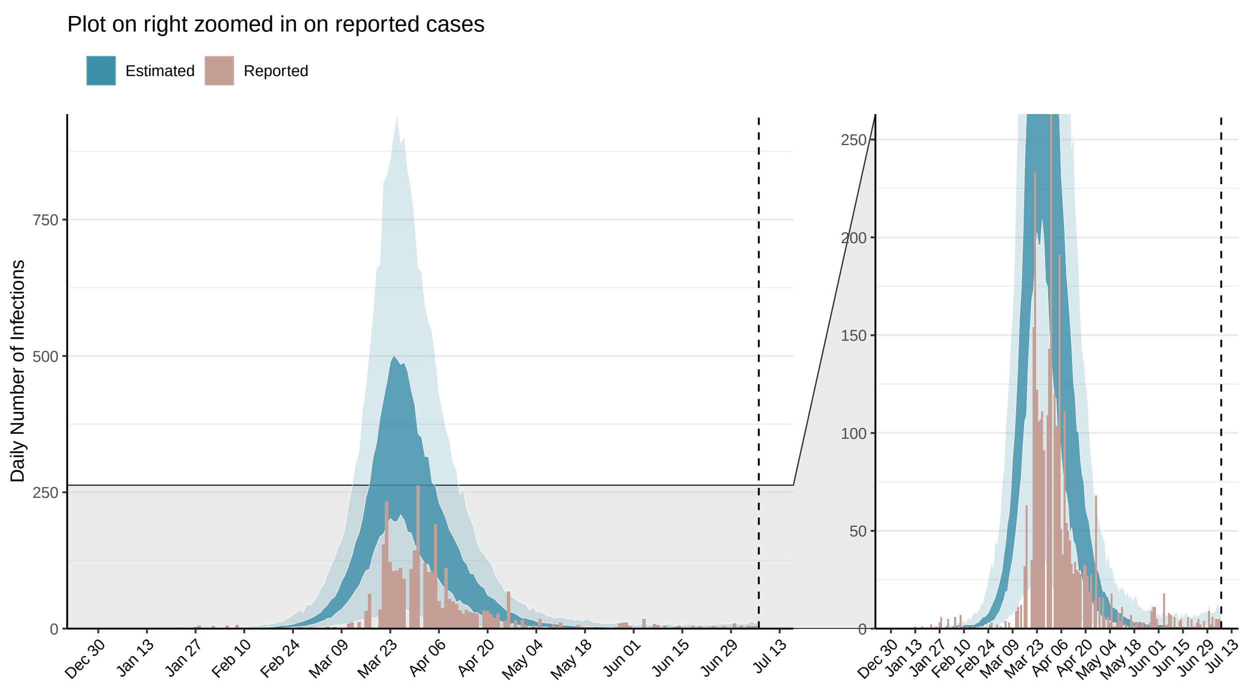

Figure 2: **Daily number of infections estimated by fitting to the current total of deaths.** Reported cases are shown in red. Model estimated infections are shown in blue (dark blue 50% interquartile range, light blue 95% quantile). The dashed line shows the current day.

By fitting to the time series of deaths, we are able to estimate a time-varying reproduction number, R_t. R_t is the the average number of secondary infections caused by a single infected person at a given time. If R_t is above 1, the rate of transmission is increasing and the number of new infections is increasing. R_t is assumed to change in relation to mobility fall in proportion. When fitting our model we assume that 100% of COVID-19 related deaths have been reported (please see our FAQ section for more information about this assumption). We also assume a fixed date at which the impact of mobility on transmission changes from pre-lockdown levels to post-lockdown levels, which may cause large changes in Rt. We are working to refine how this switch occurs and to formally calculate its shape.

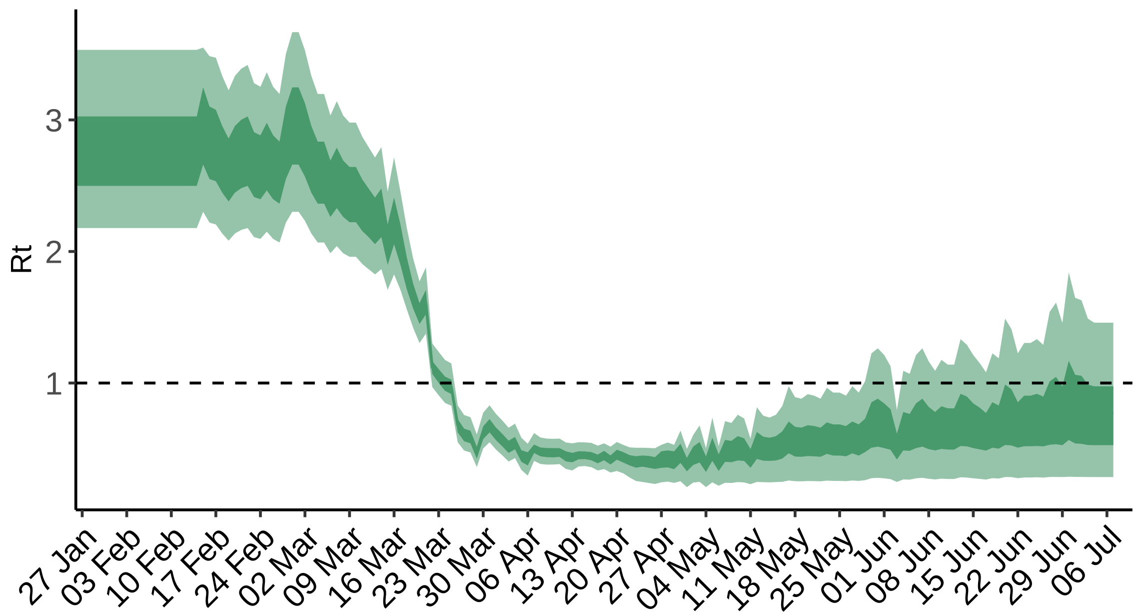

Figure 3: **Time-varying reproduction number, R_t.** R_t is the average number of secondary infections caused by a single infected person at time equal to t. $R_t < 1$ indicates a slowing epidemic in which new infections are not increasing. $R_t > 1$ indicates a growing epidemic in which new infections are increasing over time. Dark green shows the 50% CI and light green shows the 95% CI.

Using the model fit, we can forecast the expected trajectory for cumulative deaths, which is shown in the figure below. This assumes a severity pattern by age that is consistent with that observed in China, Europe and the U.S to date. This projection assumes that transmission is maintained at the current level of transmission as estimated by the final R_t value.

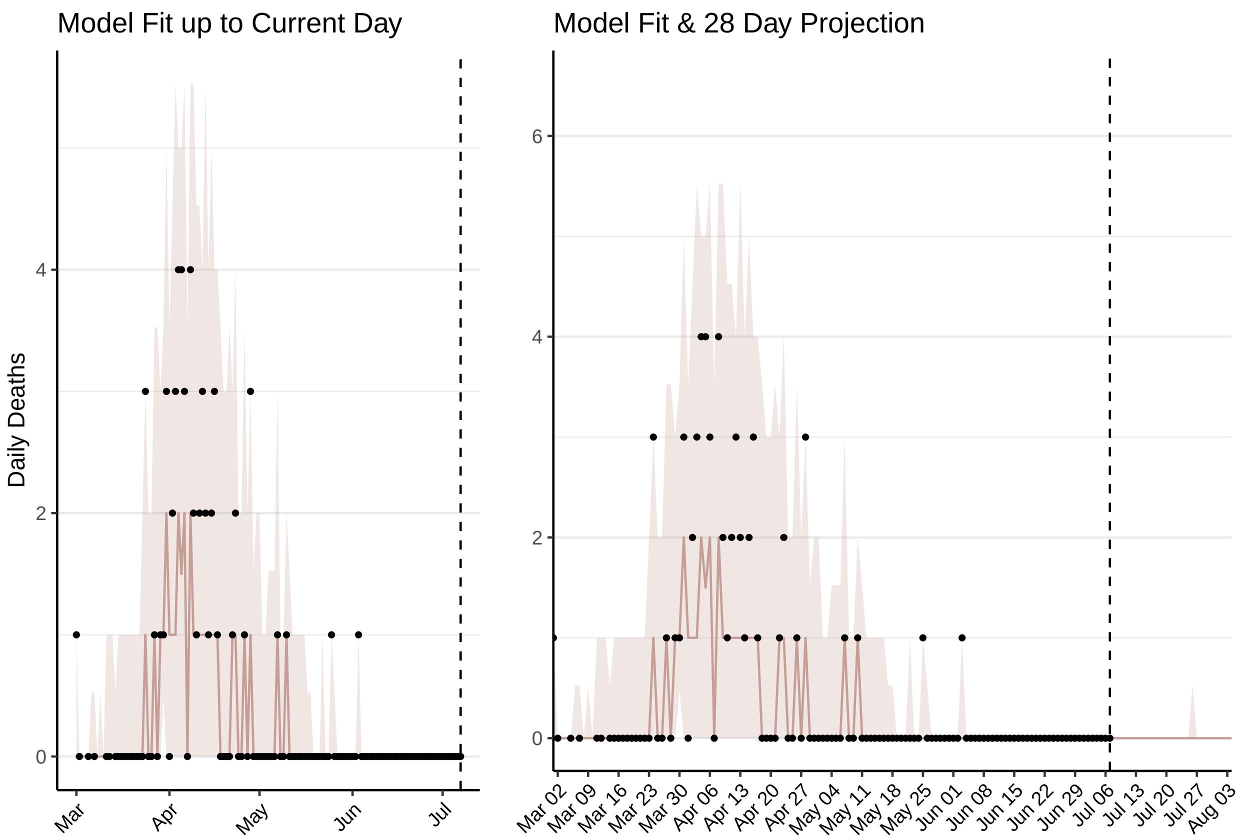

Figure 4: **Estimated daily deaths.** Projected deaths assuming the current level of interventions are maintained are shown in red (median and 95% quantile). Reported deaths are plotted in black. The plot on the left is focussed on the model fit prior to today, while the plot on the right forecasts the next 28 days.

Short-term Epidemic Scenarios

We make the following short-term projections of healthcare demand and new infections under the following three scenarios:

- **Scenario 1.** The epidemic continues to grow at the current rate.
- **Scenario 2.** Countries will further scale up interventions (either increasing current strategies or implementing new interventions) leading to a further 50% reduction in transmission.
- **Scenario 3.** Countries will relax current interventions by 50%

N.B. These scenarios currently assume that the impact of mobility on transmission will remain the same in the future as it has in the past. We are working to extend methods to estimate the impact of increases in mobility on transmission as lockdown and interventions are reversed. Consequently, projection are likely to represent an upper estimate of the healthcare demand and case load for each scenario

We estimate that over the next 4 weeks demand for hospital beds will change from 0 (95% CI: 0-0) patients requiring treatment with high-pressure oxygen at the current date to 1 (95% CI: 0-1) hospital beds being required on 2020-08-04 if no further interventions are introduced (Scenario 1). Similarly, we estimate that over the next 4 weeks demand for critical care (ICU) beds will change from 0 (95% CI: 0-0) patients requiring treatment with mechanical ventilation at the current date to 0 (95% CI: 0-0) by 2020-08-04. These projections assume that approximately 5% of all infections will require treatment with high-pressure oxygen and that approximately 30% of hospitalised cases will require treatment with mechanical ventilation (based on analysis of ongoing epidemics in Europe). **N.B. These scenarios are unlikely to show significant differences for the first week since there is a delay of approximately 10 days between infection and hospital admission. Consequently, the effectiveness of a change in policy is likely to be better captured by hospital admission data approximately 2 weeks after the policy change is implemented.**

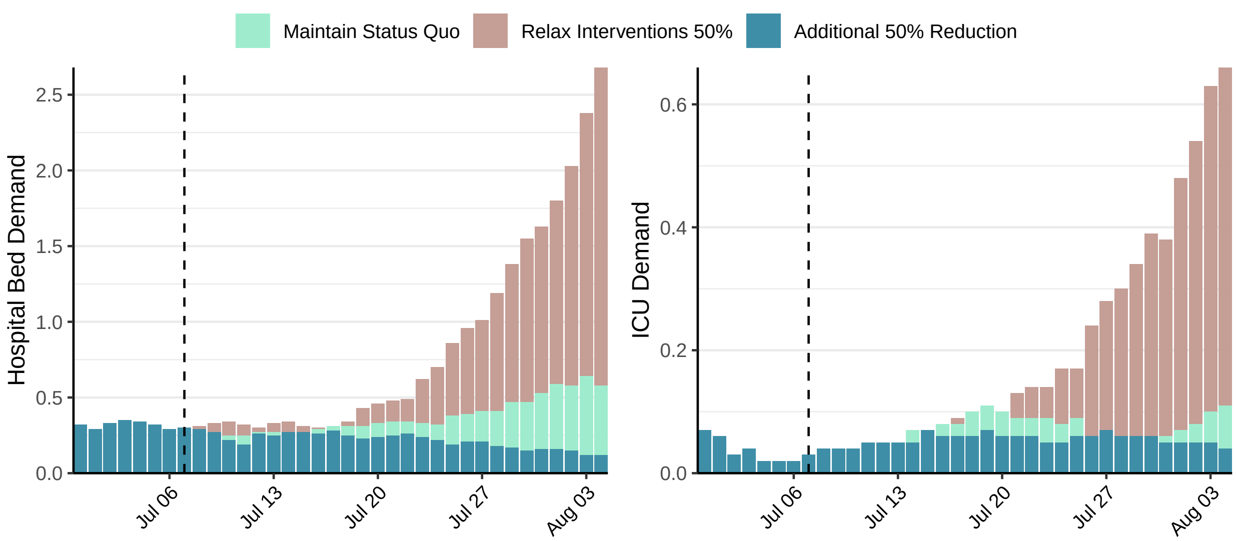

Figure 5: **Healthcare demands in the next 28 days.** Individuals needing an ICU bed are assumed to need mechanical ventilation. Projected demand for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

The impact of each scenario has a more immediate effect on the daily number of infections. The figure below shows the impact of each scenario on the estimated daily incidence of new infections. If interventions are scaled up (Scenario 2), the daily number of infections will change from 1 (95% CI: 1-2) at the current date to 0 (95% CI: 0-0) by 2020-08-04. If current interventions were relaxed by 50%, we estimate the daily number of infections will change from 1 (95% CI: 1-2) at the current date to 29 (95% CI: 10-48) by 2020-08-04.

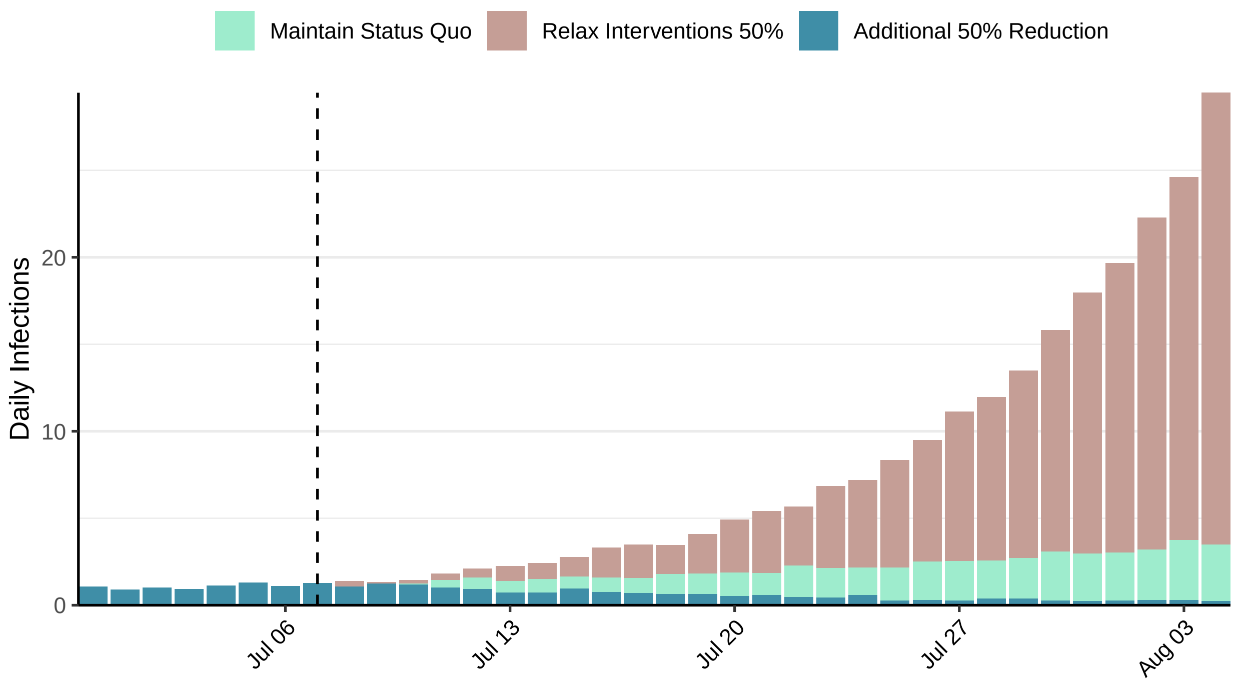

Figure 6: **Daily number of infections estimated by fitting to deaths.** Projected infections for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

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Situation Report for COVID-19: Tajikistan, 2020-07-07

Download the report for Tajikistan, 2020-07-07 here. This report uses data from the European Centre for Disease Control. These data are updated daily and whilst there may be a short delay, they are generally consistent with Ministry reports. These data are then used to back-calculate an 'inferred number of COVID-19 infections' using mathematical modelling techniques (see Report 12 for further details) to estimate the number of people that have been infected and to make short-term projections for future healthcare needs.

Epidemiological Situation

Total Reported Cases	New Reported Cases	Total Reported Deaths	New Reported Deaths	Estimated R_t
6,262	49	53	0	1.25 (95% CI: 0.73-1.65)

The figure below shows the cumulative reported deaths as a function of the time since the 10th death was reported. Dashed lines show the expected trajectory for different doubling times of the epidemic. For example, with a doubling time of 3 days, if there are currently a total of 20 deaths reported, we would expect there to be 40 deaths in total reported in 3 days-time, 80 deaths in 6 days-time, 160 deaths in 9 days-time etc. For most epidemics, in the absence of interventions, we expect a doubling time of 3-4 days for this disease.

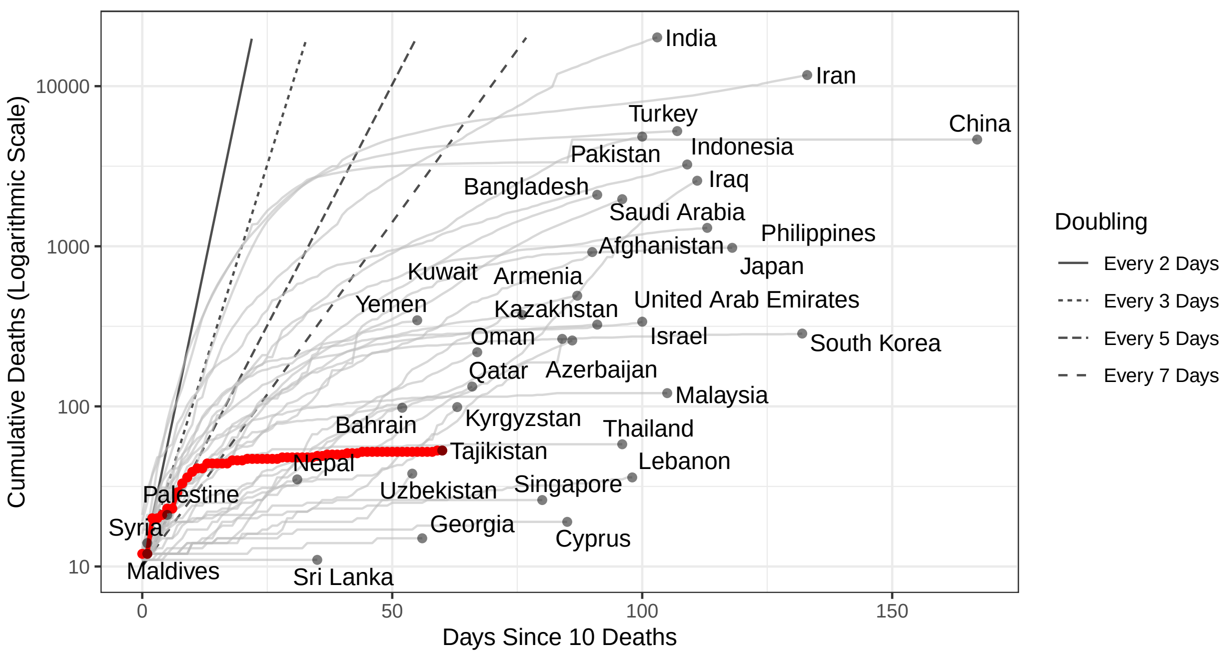


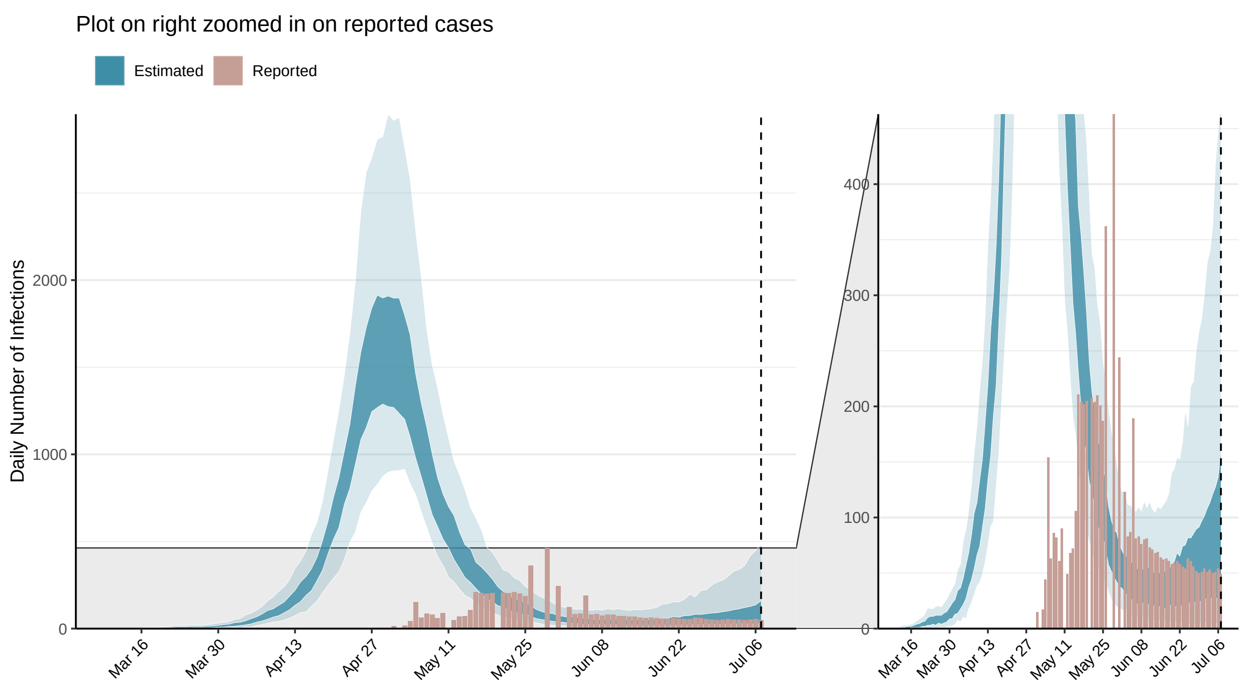
Figure 1: **Cumulative Deaths since 10 deaths.** Country not shown if fewer than 10 deaths.

COVID-19 Transmission Modelling

We assume that the deaths reported to date provide the best indication of the stage of the epidemic, as deaths are more consistently and accurately reported. Our current working estimate is that 1 death indicates that approximately 100 people will have been infected with the other 99 recovering (based on an infection fatality ratio of ~1%). These infections will have happened approximately 21 days previously – capturing a 5-day period from infection to onset of symptoms (the incubation period), 4 days from onset of symptoms to hospitalisation, and 12 days in hospital before death. With a 3-day doubling time, 100 infections that occurred 15 days ago will have generated 200 infections 12 days ago, 400 infections 9 days ago, 800 infections 6 days ago and 1,600 infections 3 days ago resulting in approximately 3,200 infections at the time the first death is observed.

To explore this, we fit our age-structured SEIR model (see Methods) to the time series of deaths in a country, in order to estimate the start date of the epidemic and the baseline R0. We assume that 100% of COVID-19 related deaths have been reported. We have also included the impact of interventions that have been put in place and their effect on human mobility and transmission based on the Google COVID-19 Community Mobility Reports. Using our mathematical model that formalises this approach, we estimate that there has been a total of 1,713 (95% CI: 1,401-2,024) infections over the past 4 weeks.

The figure below shows the estimated number of people infected over the past 4 weeks. The bar charts show, for comparison, the number of reported cases. The right-hand plot shows these data on a different scale as the estimated infections are likely to be much larger than the reported cases. **Importantly**, the estimated infections includes both asymptomatic and mild cases that would not necessarily be identified through surveillance. Consequently, the estimated infections are likely to be significantly higher than the reported cases (see our FAQ for further explanation of these differences and why the reported cases and estimated infections are unlikely to match).



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By fitting to the time series of deaths, we are able to estimate a time-varying reproduction number, R_t. R_t is the the average number of secondary infections caused by a single infected person at a given time. If R_t is above 1, the rate of transmission is increasing and the number of new infections is increasing. R_t is assumed to change in relation to mobility fall in proportion. When fitting our model we assume that 100% of COVID-19 related deaths have been reported (please see our FAQ section for more information about this assumption). We also assume a fixed date at which the impact of mobility on transmission changes from pre-lockdown levels to post-lockdown levels, which may cause large changes in Rt. We are working to refine how this switch occurs and to formally calculate its shape.

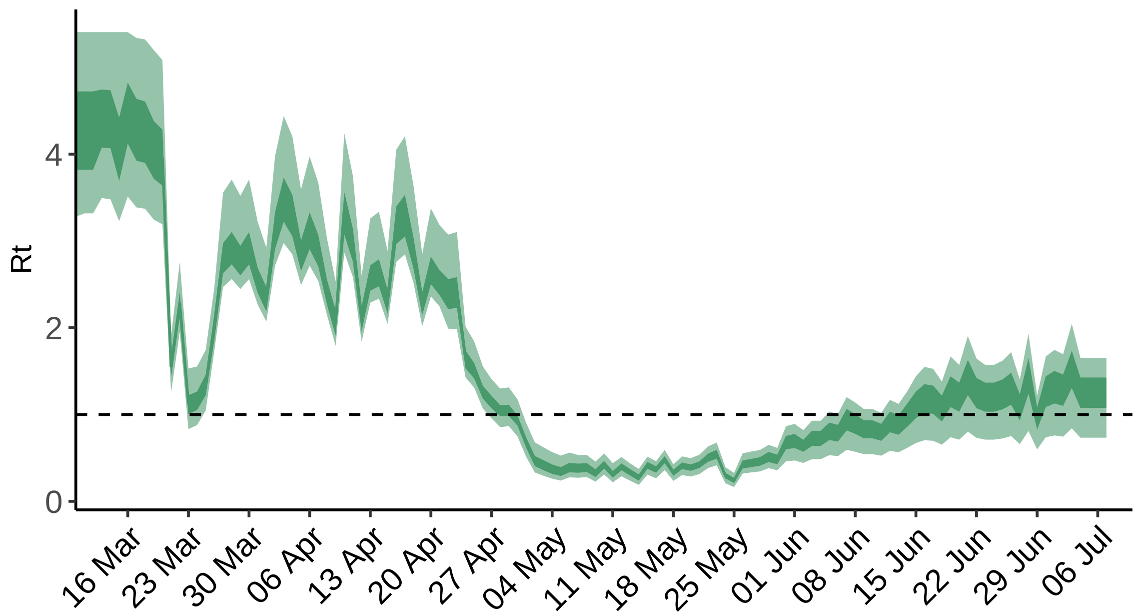

Figure 3: **Time-varying reproduction number, R_t.** R_t is the average number of secondary infections caused by a single infected person at time equal to t. $R_t < 1$ indicates a slowing epidemic in which new infections are not increasing. $R_t > 1$ indicates a growing epidemic in which new infections are increasing over time. Dark green shows the 50% CI and light green shows the 95% CI.

Using the model fit, we can forecast the expected trajectory for cumulative deaths, which is shown in the figure below. This assumes a severity pattern by age that is consistent with that observed in China, Europe and the U.S to date. This projection assumes that transmission is maintained at the current level of transmission as estimated by the final R_t value.

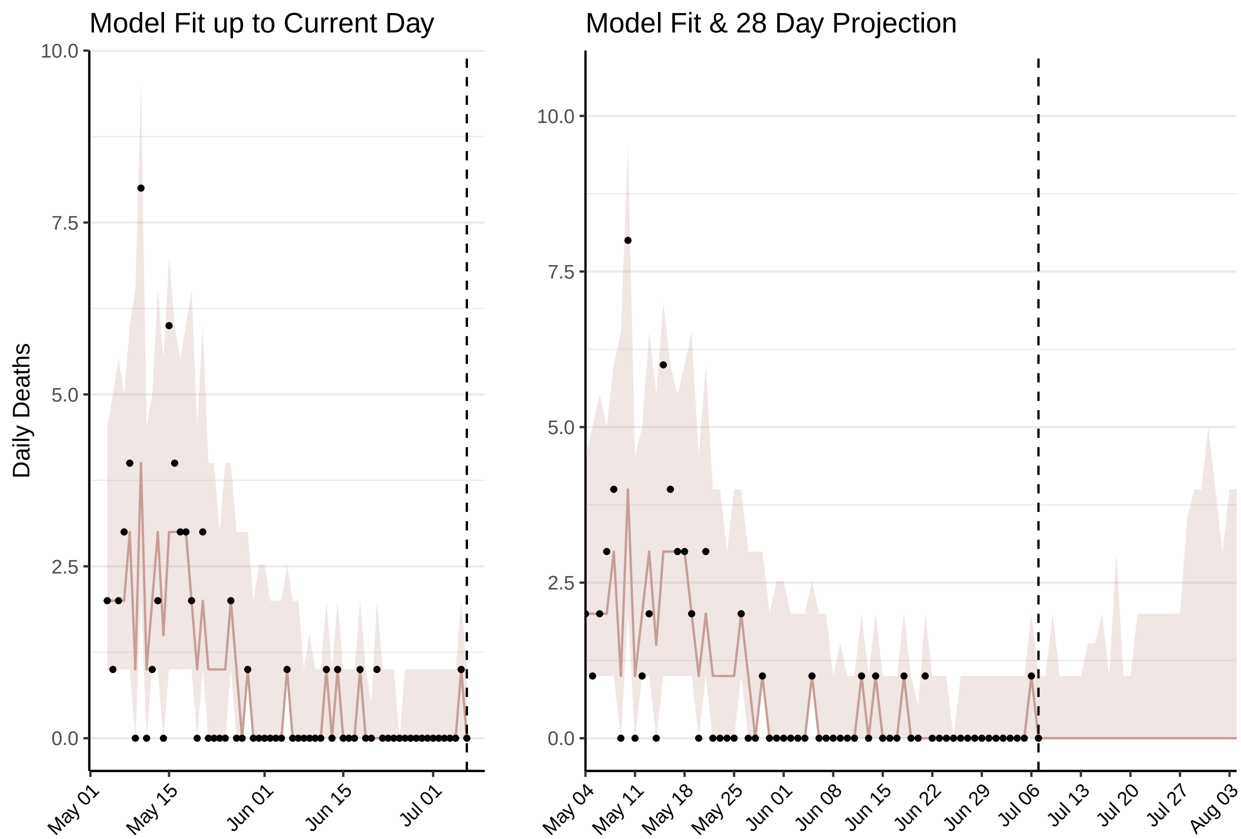

Figure 4: **Estimated daily deaths.** Projected deaths assuming the current level of interventions are maintained are shown in red (median and 95% quantile). Reported deaths are plotted in black. The plot on the left is focussed on the model fit prior to today, while the plot on the right forecasts the next 28 days.

Short-term Epidemic Scenarios

We make the following short-term projections of healthcare demand and new infections under the following three scenarios:

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- **Scenario 2.** Countries will further scale up interventions (either increasing current strategies or implementing new interventions) leading to a further 50% reduction in transmission.
- **Scenario 3.** Countries will relax current interventions by 50%

N.B. These scenarios currently assume that the impact of mobility on transmission will remain the same in the future as it has in the past. We are working to extend methods to estimate the impact of increases in mobility on transmission as lockdown and interventions are reversed. Consequently, projection are likely to represent an upper estimate of the healthcare demand and case load for each scenario

We estimate that over the next 4 weeks demand for hospital beds will change from 10 (95% CI: 8-12) patients requiring treatment with high-pressure oxygen at the current date to 54 (95% CI: 34-74) hospital beds being required on 2020-08-04 if no further interventions are introduced (Scenario 1). Similarly, we estimate that over the next 4 weeks demand for critical care (ICU) beds will change from 2 (95% CI: 2-3) patients requiring treatment with mechanical ventilation at the current date to 12 (95% CI: 8-16) by 2020-08-04. These projections assume that approximately 5% of all infections will require treatment with high-pressure oxygen and that approximately 30% of hospitalised cases will require treatment with mechanical ventilation (based on analysis of ongoing epidemics in Europe). **N.B. These scenarios are unlikely to show significant differences for the first week since there is a delay of approximately 10 days between infection and hospital admission. Consequently, the effectiveness of a change in policy is likely to be better captured by hospital admission data approximately 2 weeks after the policy change is implemented.**

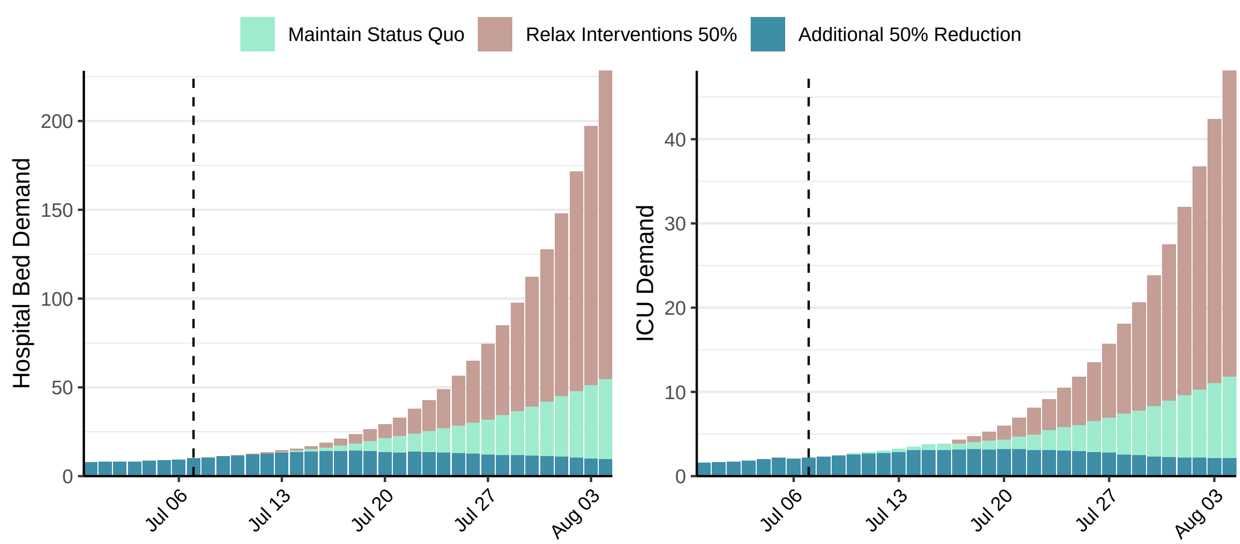

Figure 5: **Healthcare demands in the next 28 days.** Individuals needing an ICU bed are assumed to need mechanical ventilation. Projected demand for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

The impact of each scenario has a more immediate effect on the daily number of infections. The figure below shows the impact of each scenario on the estimated daily incidence of new infections. If interventions are scaled up (Scenario 2), the daily number of infections will change from 116 (95% CI: 89-144) at the current date to 41 (95% CI: 24-57) by 2020-08-04. If current interventions were relaxed by 50%, we estimate the daily number of infections will change from 116 (95% CI: 89-144) at the current date to 5,240 (95% CI: 2,924-7,556) by 2020-08-04.

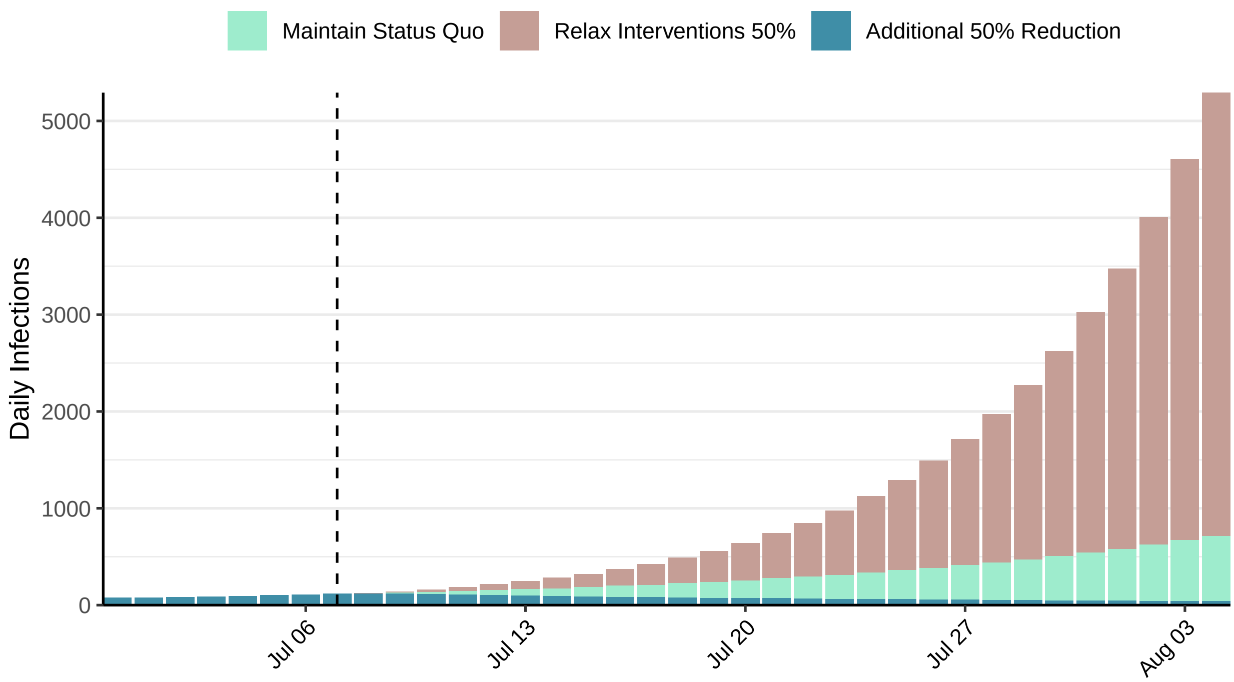

Figure 6: **Daily number of infections estimated by fitting to deaths.** Projected infections for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

To explore different scenarios, we recommend using our COVID-19 Scenario Analysis Tool - https://covidsim.org/, which can be used to simulate different intervention scenarios and explore the long term impact on healthcare demand.

Situation Report for COVID-19: Tunisia, 2020-07-07

Download the report for Tunisia, 2020-07-07 here. This report uses data from the European Centre for Disease Control. These data are updated daily and whilst there may be a short delay, they are generally consistent with Ministry reports. These data are then used to back-calculate an 'inferred number of COVID-19 infections' using mathematical modelling techniques (see Report 12 for further details) to estimate the number of people that have been infected and to make short-term projections for future healthcare needs.

Epidemiological Situation

Total Reported Cases	New Reported Cases	Total Reported Deaths	New Reported Deaths	Estimated R_t
1,199	11	50	0	0.71 (95% CI: 0.35-1.13)

The figure below shows the cumulative reported deaths as a function of the time since the 10th death was reported. Dashed lines show the expected trajectory for different doubling times of the epidemic. For example, with a doubling time of 3 days, if there are currently a total of 20 deaths reported, we would expect there to be 40 deaths in total reported in 3 days-time, 80 deaths in 6 days-time, 160 deaths in 9 days-time etc. For most epidemics, in the absence of interventions, we expect a doubling time of 3-4 days for this disease.

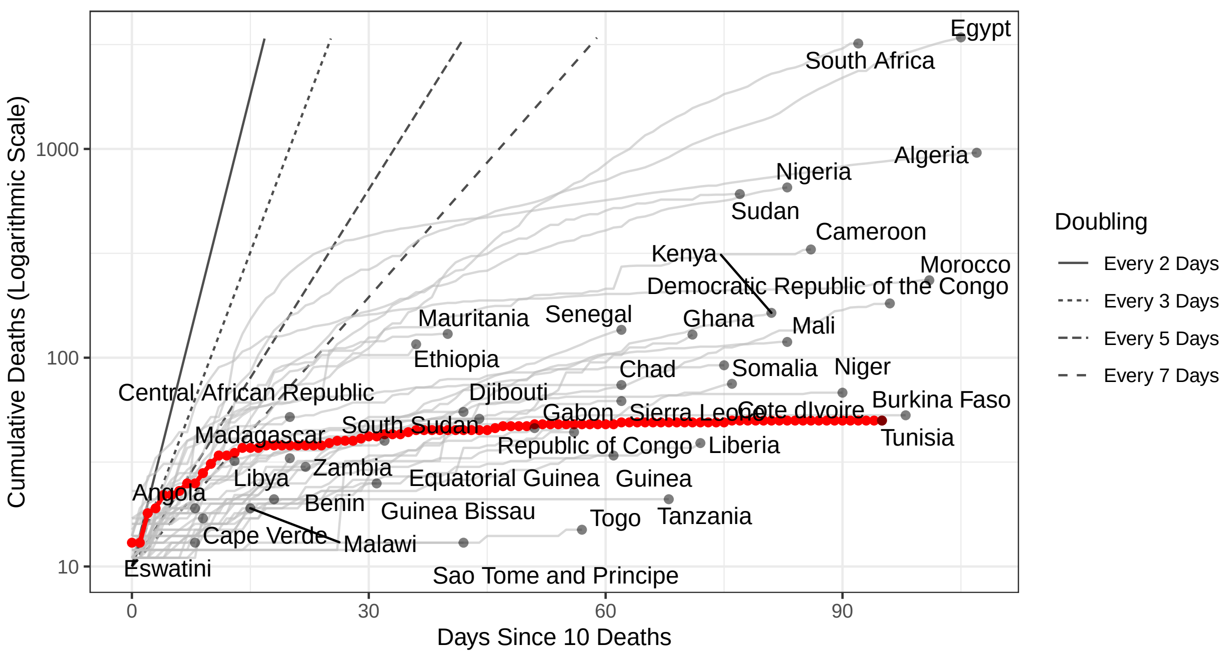

Figure 1: **Cumulative Deaths since 10 deaths.** Country not shown if fewer than 10 deaths.

COVID-19 Transmission Modelling

We assume that the deaths reported to date provide the best indication of the stage of the epidemic, as deaths are more consistently and accurately reported. Our current working estimate is that 1 death indicates that approximately 100 people will have been infected with the other 99 recovering (based on an infection fatality ratio of ~1%). These infections will have happened approximately 21 days previously – capturing a 5-day period from infection to onset of symptoms (the incubation period), 4 days from onset of symptoms to hospitalisation, and 12 days in hospital before death. With a 3-day doubling time, 100 infections that occurred 15 days ago will have generated 200 infections 12 days ago, 400 infections 9 days ago, 800 infections 6 days ago and 1,600 infections 3 days ago resulting in approximately 3,200 infections at the time the first death is observed.

To explore this, we fit our age-structured SEIR model (see Methods) to the time series of deaths in a country, in order to estimate the start date of the epidemic and the baseline R0. We assume that 100% of COVID-19 related deaths have been reported. We have also included the impact of interventions that have been put in place and their effect on human mobility and transmission based on the Google COVID-19 Community Mobility Reports. Using our mathematical model that formalises this approach, we estimate that there has been a total of 131 (95% CI: 94-167) infections over the past 4 weeks.

The figure below shows the estimated number of people infected over the past 4 weeks. The bar charts show, for comparison, the number of reported cases. The right-hand plot shows these data on a different scale as the estimated infections are likely to be much larger than the reported cases. **Importantly**, the estimated infections includes both asymptomatic and mild cases that would not necessarily be identified through surveillance. Consequently, the estimated infections are likely to be significantly higher than the reported cases (see our FAQ for further explanation of these differences and why the reported cases and estimated infections are unlikely to match).

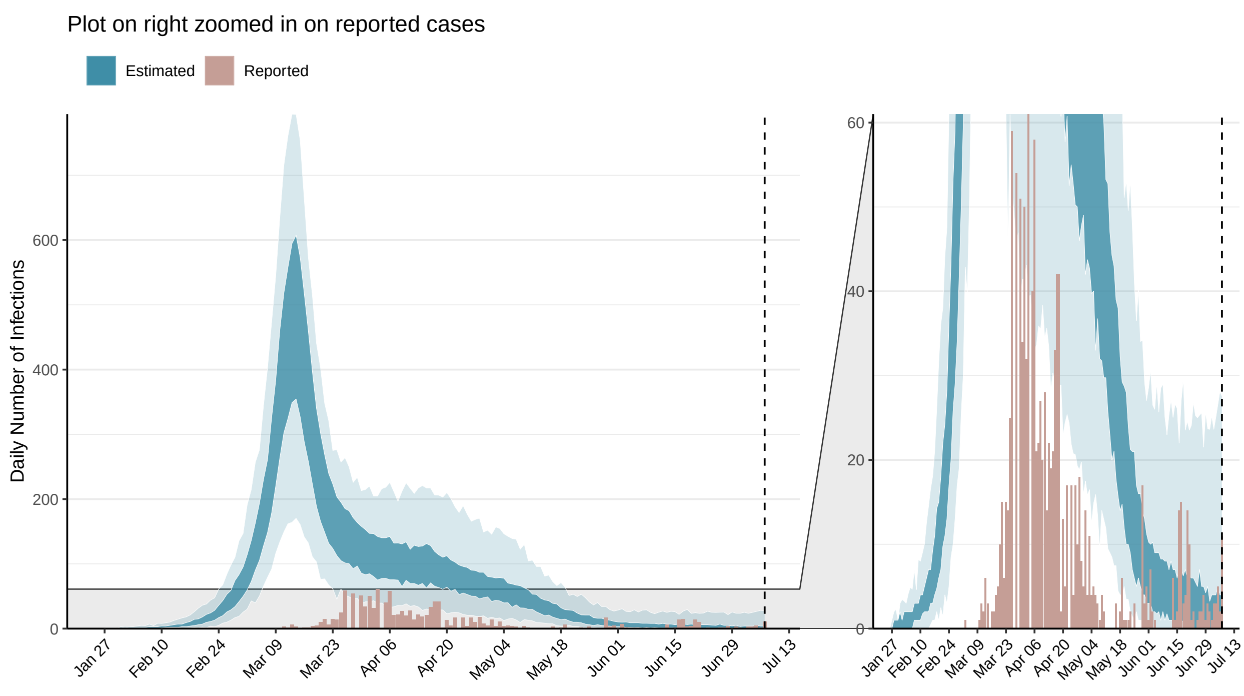

Figure 2: **Daily number of infections estimated by fitting to the current total of deaths.** Reported cases are shown in red. Model estimated infections are shown in blue (dark blue 50% interquartile range, light blue 95% quantile). The dashed line shows the current day.

By fitting to the time series of deaths, we are able to estimate a time-varying reproduction number, R_t. R_t is the the average number of secondary infections caused by a single infected person at a given time. If R_t is above 1, the rate of transmission is increasing and the number of new infections is increasing. R_t is assumed to change in relation to mobility fall in proportion. When fitting our model we assume that 100% of COVID-19 related deaths have been reported (please see our FAQ section for more information about this assumption). We also assume a fixed date at which the impact of mobility on transmission changes from pre-lockdown levels to post-lockdown levels, which may cause large changes in Rt. We are working to refine how this switch occurs and to formally calculate its shape.

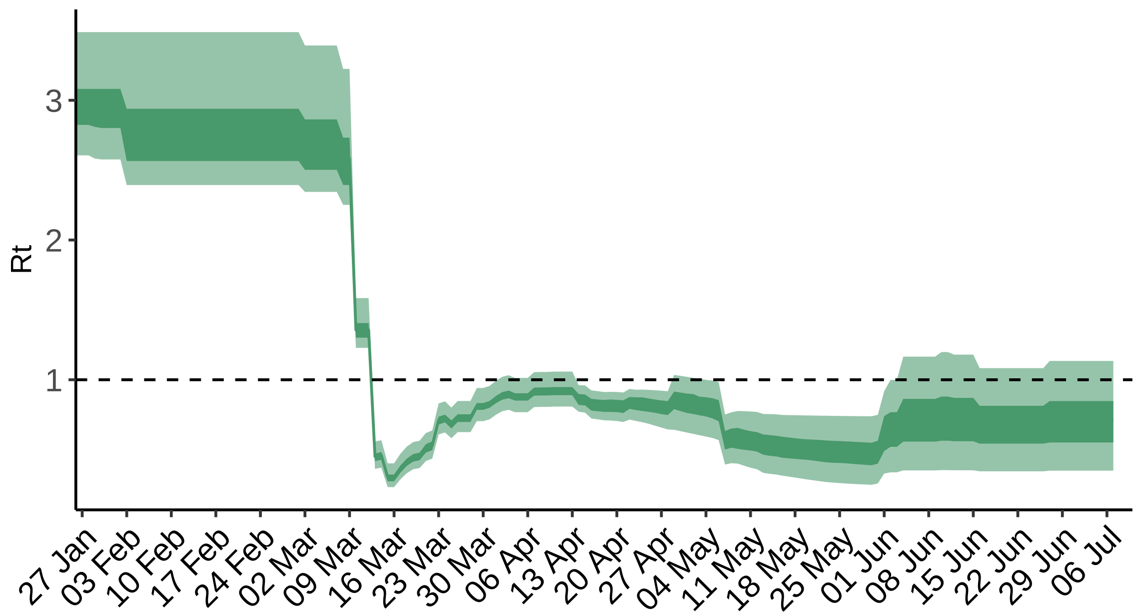

Figure 3: **Time-varying reproduction number, R_t.** R_t is the average number of secondary infections caused by a single infected person at time equal to t. $R_t < 1$ indicates a slowing epidemic in which new infections are not increasing. $R_t > 1$ indicates a growing epidemic in which new infections are increasing over time. Dark green shows the 50% CI and light green shows the 95% CI.

Using the model fit, we can forecast the expected trajectory for cumulative deaths, which is shown in the figure below. This assumes a severity pattern by age that is consistent with that observed in China, Europe and the U.S to date. This projection assumes that transmission is maintained at the current level of transmission as estimated by the final R_t value.

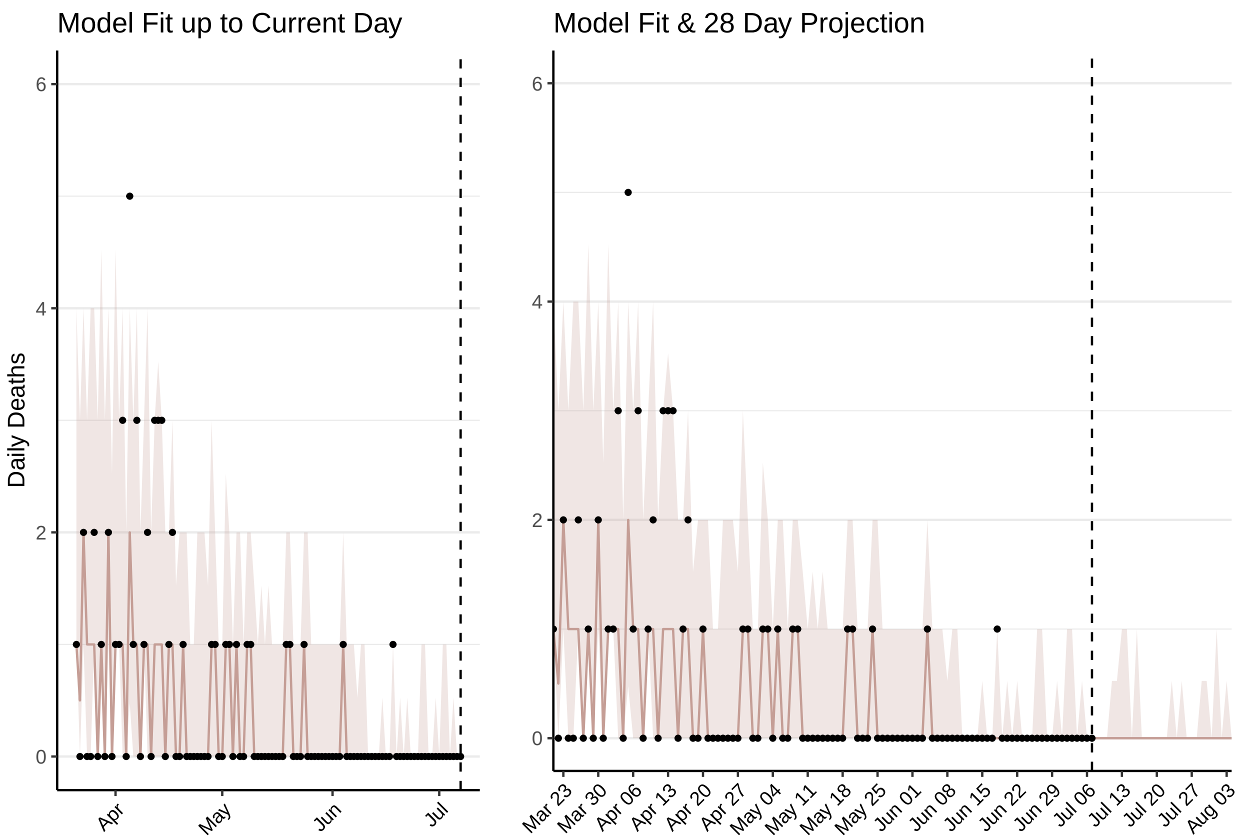

Figure 4: **Estimated daily deaths.** Projected deaths assuming the current level of interventions are maintained are shown in red (median and 95% quantile). Reported deaths are plotted in black. The plot on the left is focussed on the model fit prior to today, while the plot on the right forecasts the next 28 days.

Short-term Epidemic Scenarios

We make the following short-term projections of healthcare demand and new infections under the following three scenarios:

- **Scenario 1.** The epidemic continues to grow at the current rate.
- **Scenario 2.** Countries will further scale up interventions (either increasing current strategies or implementing new interventions) leading to a further 50% reduction in transmission.
- **Scenario 3.** Countries will relax current interventions by 50%

N.B. These scenarios currently assume that the impact of mobility on transmission will remain the same in the future as it has in the past. We are working to extend methods to estimate the impact of increases in mobility on transmission as lockdown and interventions are reversed. Consequently, projection are likely to represent an upper estimate of the healthcare demand and case load for each scenario

We estimate that over the next 4 weeks demand for hospital beds will change from 1 (95% CI: 1-1) patients requiring treatment with high-pressure oxygen at the current date to 1 (95% CI: 0-1) hospital beds being required on 2020-08-04 if no further interventions are introduced (Scenario 1). Similarly, we estimate that over the next 4 weeks demand for critical care (ICU) beds will change from 0 (95% CI: 0-1) patients requiring treatment with mechanical ventilation at the current date to 0 (95% CI: 0-1) by 2020-08-04. These projections assume that approximately 5% of all infections will require treatment with high-pressure oxygen and that approximately 30% of hospitalised cases will require treatment with mechanical ventilation (based on analysis of ongoing epidemics in Europe). **N.B. These scenarios are unlikely to show significant differences for the first week since there is a delay of approximately 10 days between infection and hospital admission. Consequently, the effectiveness of a change in policy is likely to be better captured by hospital admission data approximately 2 weeks after the policy change is implemented.**

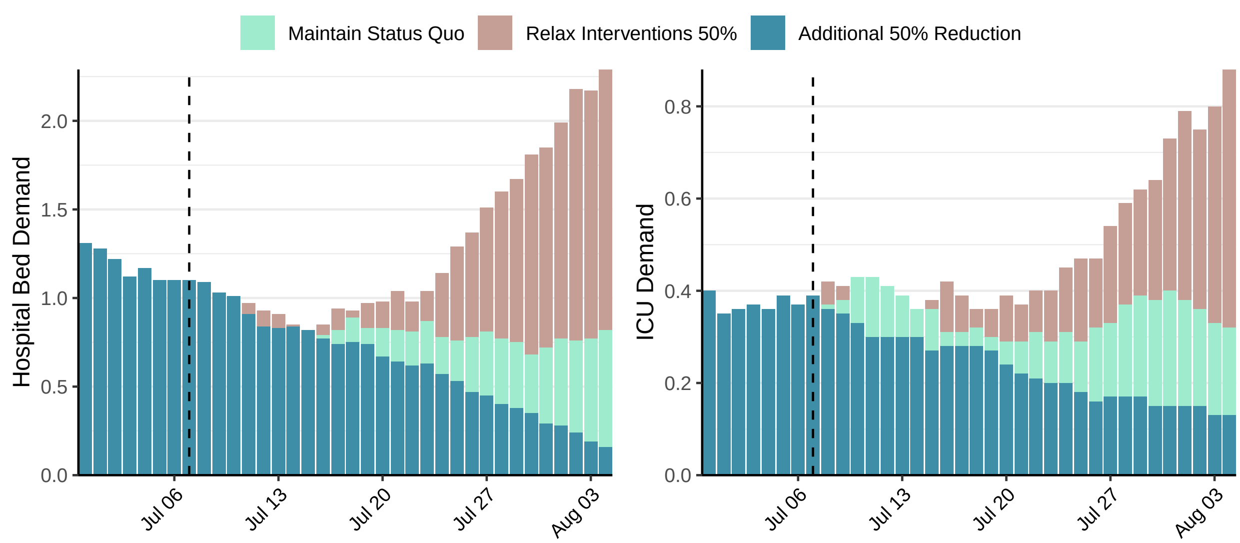

Figure 5: **Healthcare demands in the next 28 days.** Individuals needing an ICU bed are assumed to need mechanical ventilation. Projected demand for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

The impact of each scenario has a more immediate effect on the daily number of infections. The figure below shows the impact of each scenario on the estimated daily incidence of new infections. If interventions are scaled up (Scenario 2), the daily number of infections will change from 4 (95% CI: 2-5) at the current date to 0 (95% CI: 0-1) by 2020-08-04. If current interventions were relaxed by 50%, we estimate the daily number of infections will change from 4 (95% CI: 2-5) at the current date to 23 (95% CI: 11-34) by 2020-08-04.

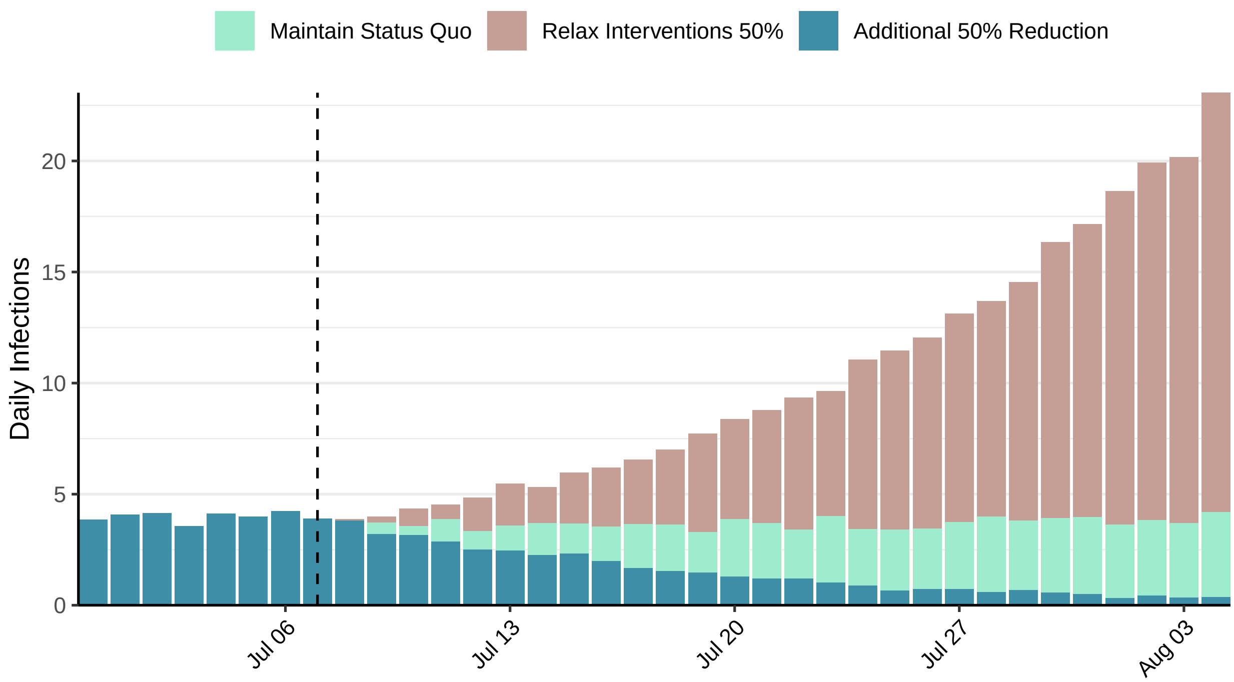

Figure 6: **Daily number of infections estimated by fitting to deaths.** Projected infections for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

To explore different scenarios, we recommend using our COVID-19 Scenario Analysis Tool - https://covidsim.org/, which can be used to simulate different intervention scenarios and explore the long term impact on healthcare demand.

Situation Report for COVID-19: Turkey, 2020-07-07

Download the report for Turkey, 2020-07-07 here. This report uses data from the European Centre for Disease Control. These data are updated daily and whilst there may be a short delay, they are generally consistent with Ministry reports. These data are then used to back-calculate an 'inferred number of COVID-19 infections' using mathematical modelling techniques (see Report 12 for further details) to estimate the number of people that have been infected and to make short-term projections for future healthcare needs.

Epidemiological Situation

Total Reported Cases	New Reported Cases	Total Reported Deaths	New Reported Deaths	Estimated R_t
206,844	1,086	5,241	16	1.2 (95% CI: 1.06-1.35)

The figure below shows the cumulative reported deaths as a function of the time since the 10th death was reported. Dashed lines show the expected trajectory for different doubling times of the epidemic. For example, with a doubling time of 3 days, if there are currently a total of 20 deaths reported, we would expect there to be 40 deaths in total reported in 3 days-time, 80 deaths in 6 days-time, 160 deaths in 9 days-time etc. For most epidemics, in the absence of interventions, we expect a doubling time of 3-4 days for this disease.

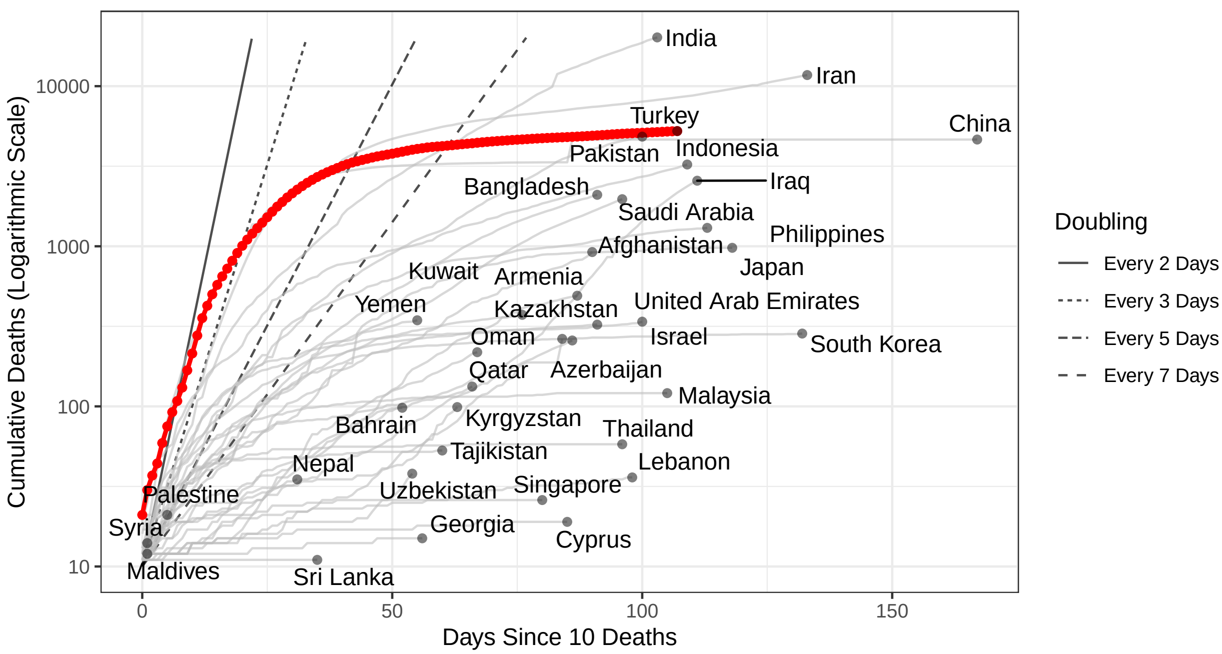

Figure 1: **Cumulative Deaths since 10 deaths.** Country not shown if fewer than 10 deaths.

COVID-19 Transmission Modelling

We assume that the deaths reported to date provide the best indication of the stage of the epidemic, as deaths are more consistently and accurately reported. Our current working estimate is that 1 death indicates that approximately 100 people will have been infected with the other 99 recovering (based on an infection fatality ratio of ~1%). These infections will have happened approximately 21 days previously – capturing a 5-day period from infection to onset of symptoms (the incubation period), 4 days from onset of symptoms to hospitalisation, and 12 days in hospital before death. With a 3-day doubling time, 100 infections that occurred 15 days ago will have generated 200 infections 12 days ago, 400 infections 9 days ago, 800 infections 6 days ago and 1,600 infections 3 days ago resulting in approximately 3,200 infections at the time the first death is observed.

To explore this, we fit our age-structured SEIR model (see Methods) to the time series of deaths in a country, in order to estimate the start date of the epidemic and the baseline R0. We assume that 100% of COVID-19 related deaths have been reported. We have also included the impact of interventions that have been put in place and their effect on human mobility and transmission based on the Google COVID-19 Community Mobility Reports. Using our mathematical model that formalises this approach, we estimate that there has been a total of 241,900 (95% CI: 229,165-254,635) infections over the past 4 weeks.

The figure below shows the estimated number of people infected over the past 4 weeks. The bar charts show, for comparison, the number of reported cases. The right-hand plot shows these data on a different scale as the estimated infections are likely to be much larger than the reported cases. **Importantly**, the estimated infections includes both asymptomatic and mild cases that would not necessarily be identified through surveillance. Consequently, the estimated infections are likely to be significantly higher than the reported cases (see our FAQ for further explanation of these differences and why the reported cases and estimated infections are unlikely to match).

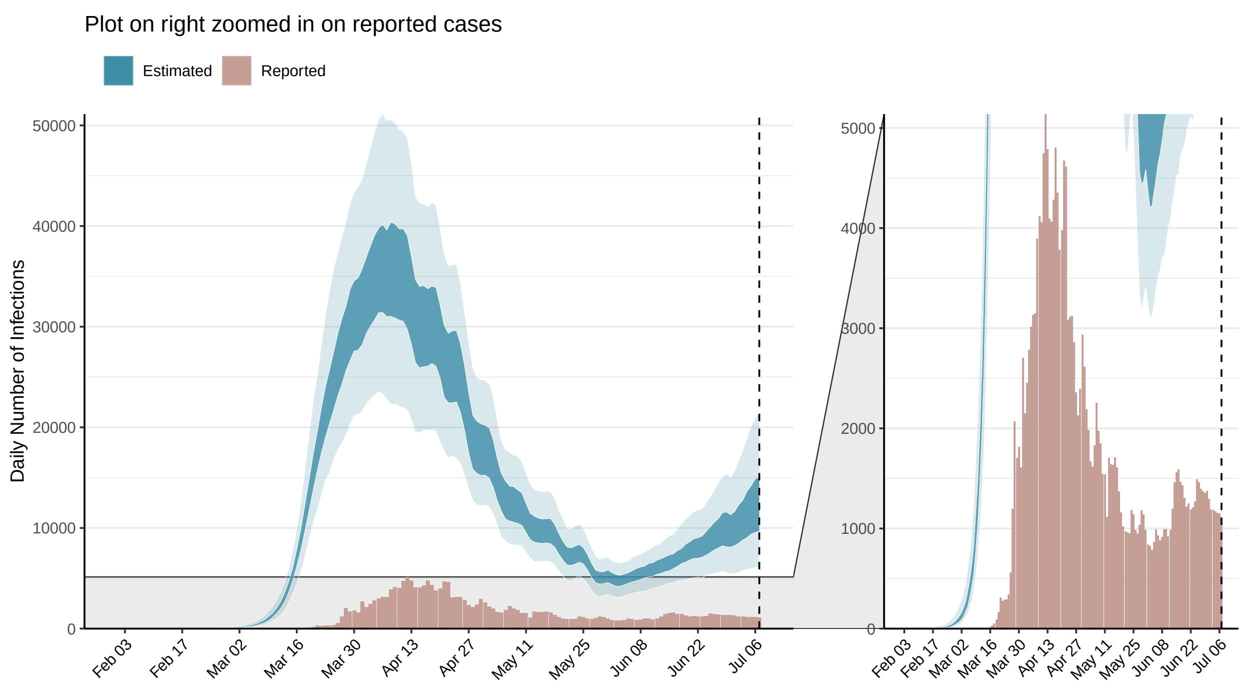

Figure 2: **Daily number of infections estimated by fitting to the current total of deaths.** Reported cases are shown in red. Model estimated infections are shown in blue (dark blue 50% interquartile range, light blue 95% quantile). The dashed line shows the current day.

By fitting to the time series of deaths, we are able to estimate a time-varying reproduction number, R_t. R_t is the the average number of secondary infections caused by a single infected person at a given time. If R_t is above 1, the rate of transmission is increasing and the number of new infections is increasing. R_t is assumed to change in relation to mobility fall in proportion. When fitting our model we assume that 100% of COVID-19 related deaths have been reported (please see our FAQ section for more information about this assumption). We also assume a fixed date at which the impact of mobility on transmission changes from pre-lockdown levels to post-lockdown levels, which may cause large changes in Rt. We are working to refine how this switch occurs and to formally calculate its shape.

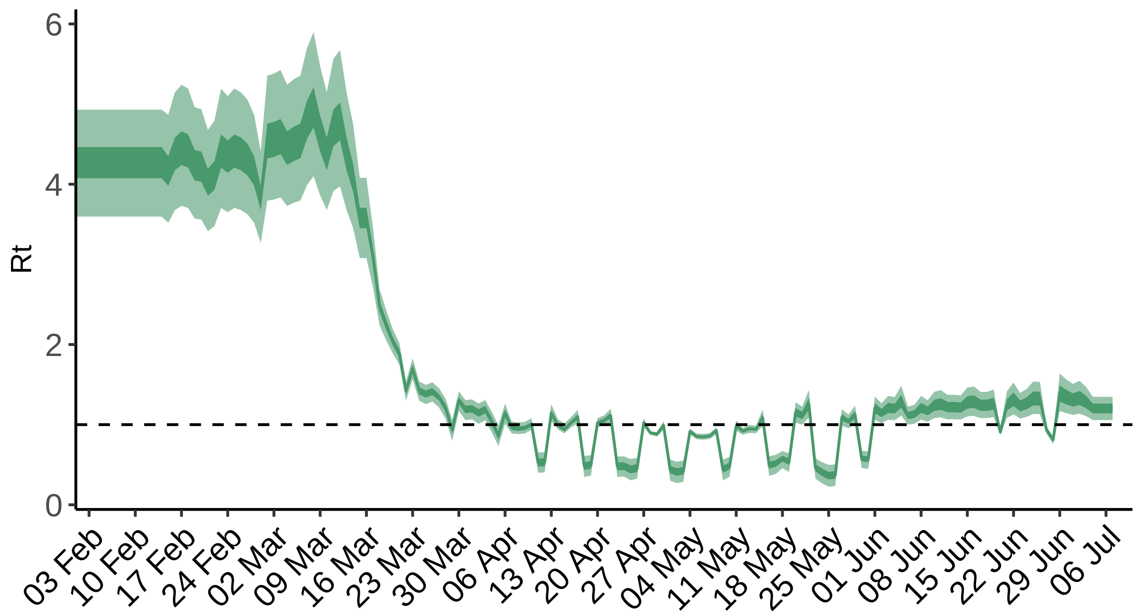

Figure 3: **Time-varying reproduction number, R_t.** R_t is the average number of secondary infections caused by a single infected person at time equal to t. $R_t < 1$ indicates a slowing epidemic in which new infections are not increasing. $R_t > 1$ indicates a growing epidemic in which new infections are increasing over time. Dark green shows the 50% CI and light green shows the 95% CI.

Using the model fit, we can forecast the expected trajectory for cumulative deaths, which is shown in the figure below. This assumes a severity pattern by age that is consistent with that observed in China, Europe and the U.S to date. This projection assumes that transmission is maintained at the current level of transmission as estimated by the final R_t value.

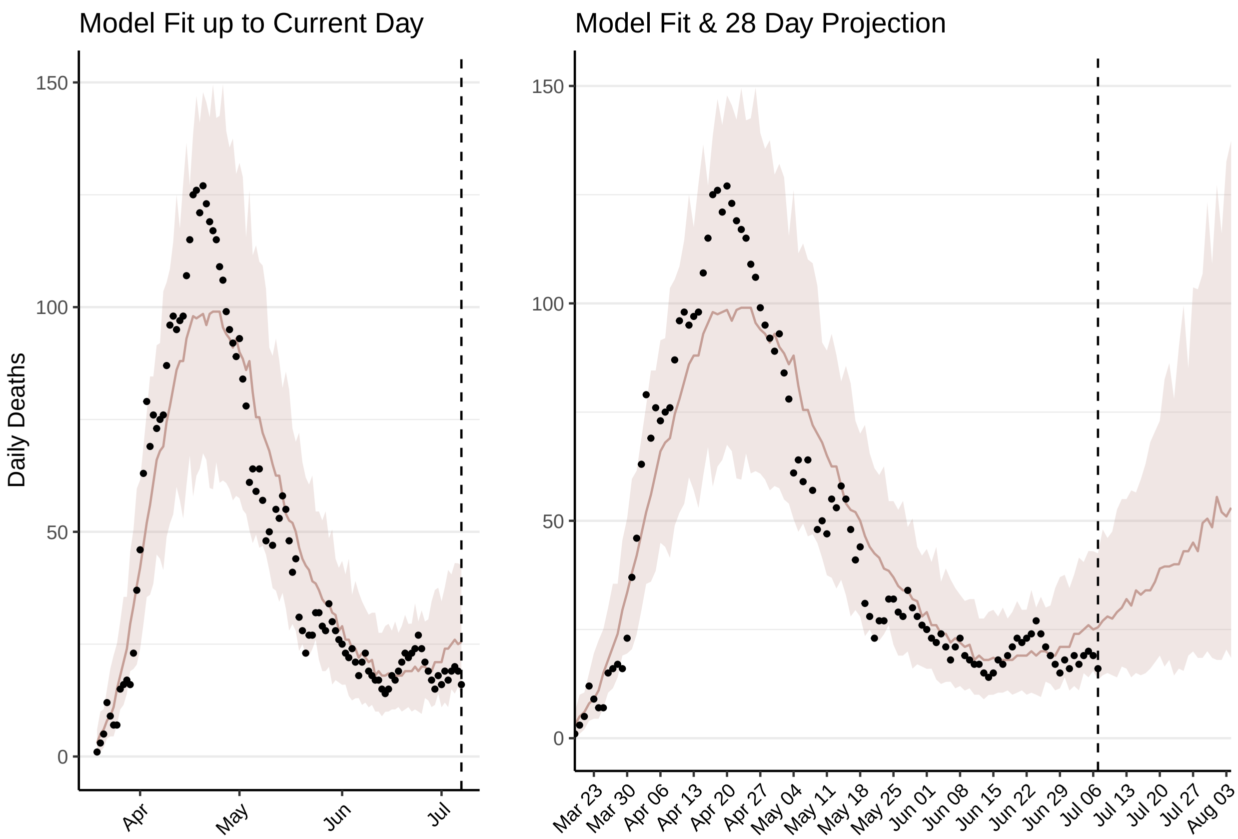

Figure 4: **Estimated daily deaths.** Projected deaths assuming the current level of interventions are maintained are shown in red (median and 95% quantile). Reported deaths are plotted in black. The plot on the left is focussed on the model fit prior to today, while the plot on the right forecasts the next 28 days.

Short-term Epidemic Scenarios

We make the following short-term projections of healthcare demand and new infections under the following three scenarios:

- **Scenario 1.** The epidemic continues to grow at the current rate.
- **Scenario 2.** Countries will further scale up interventions (either increasing current strategies or implementing new interventions) leading to a further 50% reduction in transmission.
- **Scenario 3.** Countries will relax current interventions by 50%

N.B. These scenarios currently assume that the impact of mobility on transmission will remain the same in the future as it has in the past. We are working to extend methods to estimate the impact of increases in mobility on transmission as lockdown and interventions are reversed. Consequently, projection are likely to represent an upper estimate of the healthcare demand and case load for each scenario

We estimate that over the next 4 weeks demand for hospital beds will change from 1,633 (95% CI: 1,542-1,725) patients requiring treatment with high-pressure oxygen at the current date to 3,706 (95% CI: 3,313-4,099) hospital beds being required on 2020-08-04 if no further interventions are introduced (Scenario 1). Similarly, we estimate that over the next 4 weeks demand for critical care (ICU) beds will change from 412 (95% CI: 390-434) patients requiring treatment with mechanical ventilation at the current date to 932 (95% CI: 834-1,030) by 2020-08-04. These projections assume that approximately 5% of all infections will require treatment with high-pressure oxygen and that approximately 30% of hospitalised cases will require treatment with mechanical ventilation (based on analysis of ongoing epidemics in Europe). **N.B. These scenarios are unlikely to show significant differences for the first week since there is a delay of approximately 10 days between infection and hospital admission. Consequently, the effectiveness of a change in policy is likely to be better captured by hospital admission data approximately 2 weeks after the policy change is implemented.**

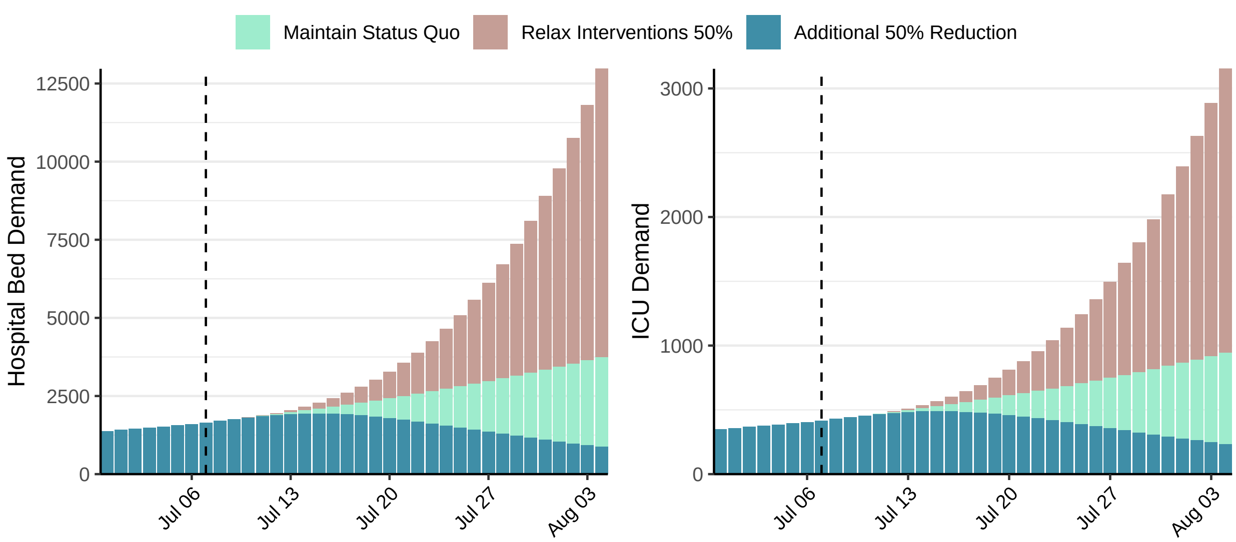

Figure 5: **Healthcare demands in the next 28 days.** Individuals needing an ICU bed are assumed to need mechanical ventilation. Projected demand for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

The impact of each scenario has a more immediate effect on the daily number of infections. The figure below shows the impact of each scenario on the estimated daily incidence of new infections. If interventions are scaled up (Scenario 2), the daily number of infections will change from 12,638 (95% CI: 11,720-13,556) at the current date to 2,029 (95% CI: 1,794-2,265) by 2020-08-04. If current interventions were relaxed by 50%, we estimate the daily number of infections will change from 12,638 (95% CI: 11,720-13,556) at the current date to 170,752 (95% CI: 148,937-192,567) by 2020-08-04.

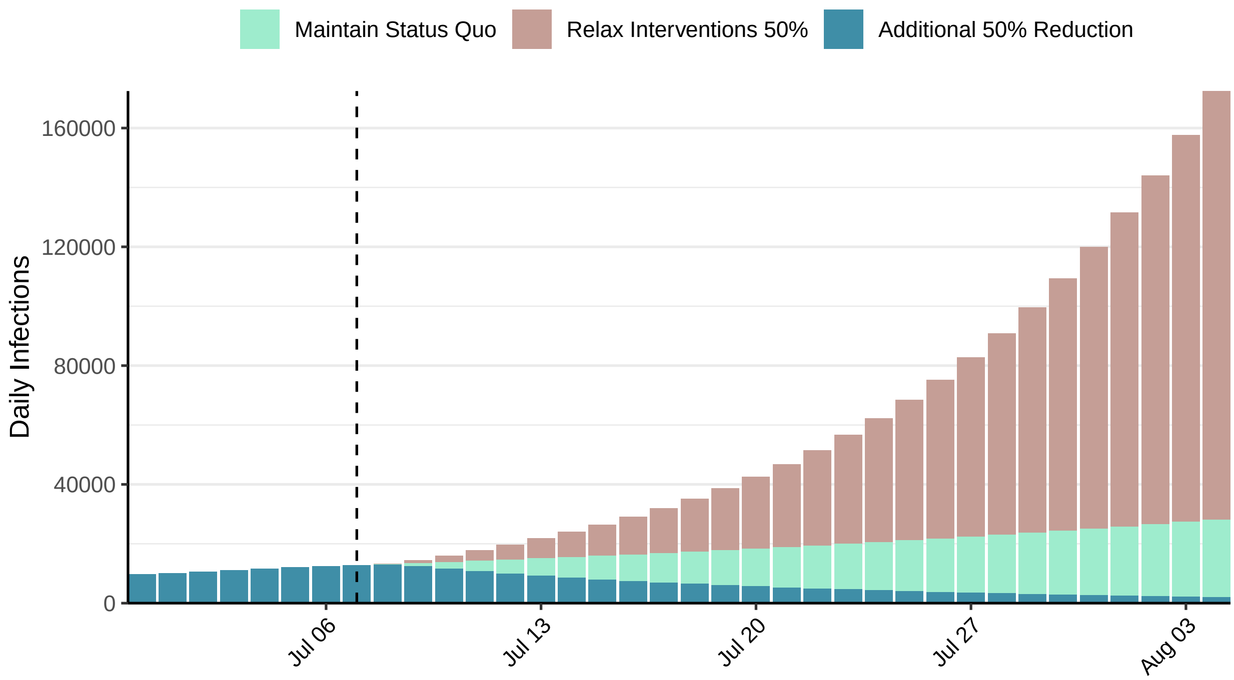

Figure 6: **Daily number of infections estimated by fitting to deaths.** Projected infections for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

To explore different scenarios, we recommend using our COVID-19 Scenario Analysis Tool - https://covidsim.org/, which can be used to simulate different intervention scenarios and explore the long term impact on healthcare demand.

Situation Report for COVID-19: Tanzania, 2020-07-07

Download the report for Tanzania, 2020-07-07 here. This report uses data from the European Centre for Disease Control. These data are updated daily and whilst there may be a short delay, they are generally consistent with Ministry reports. These data are then used to back-calculate an 'inferred number of COVID-19 infections' using mathematical modelling techniques (see Report 12 for further details) to estimate the number of people that have been infected and to make short-term projections for future healthcare needs.

Epidemiological Situation

Total Reported Cases	New Reported Cases	Total Reported Deaths	New Reported Deaths	Estimated R_t
509	0	21	0	0.58 (95% CI: 0.22-1.31)

The figure below shows the cumulative reported deaths as a function of the time since the 10th death was reported. Dashed lines show the expected trajectory for different doubling times of the epidemic. For example, with a doubling time of 3 days, if there are currently a total of 20 deaths reported, we would expect there to be 40 deaths in total reported in 3 days-time, 80 deaths in 6 days-time, 160 deaths in 9 days-time etc. For most epidemics, in the absence of interventions, we expect a doubling time of 3-4 days for this disease.

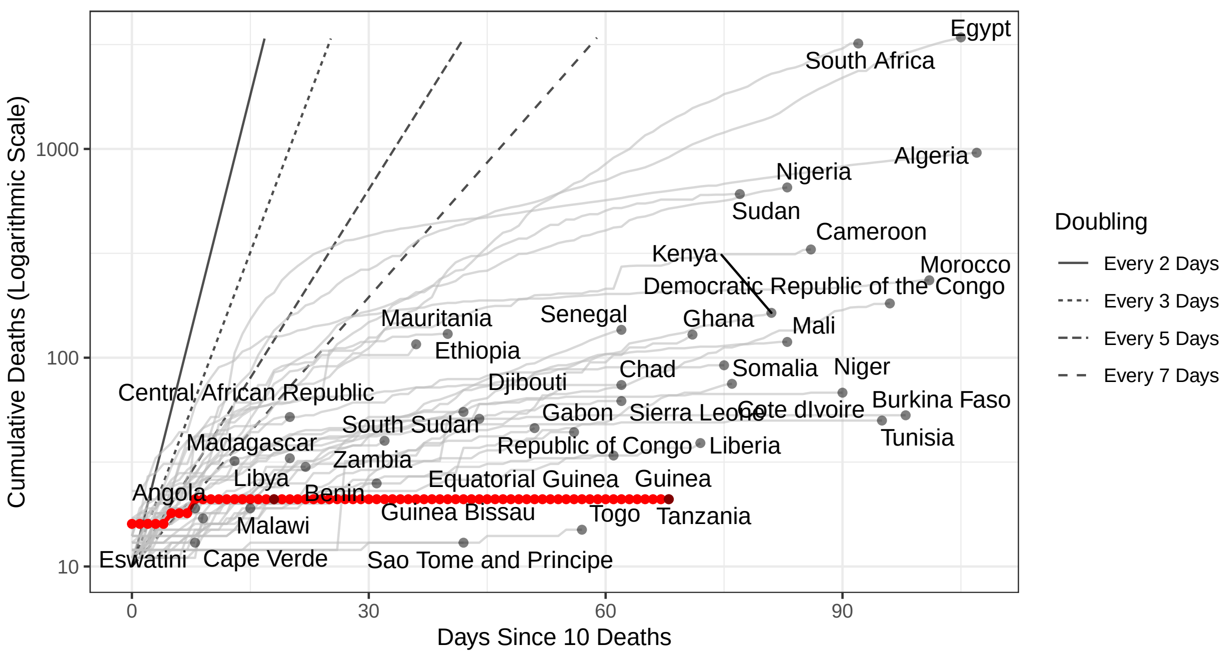

Figure 1: **Cumulative Deaths since 10 deaths.** Country not shown if fewer than 10 deaths.

COVID-19 Transmission Modelling

We assume that the deaths reported to date provide the best indication of the stage of the epidemic, as deaths are more consistently and accurately reported. Our current working estimate is that 1 death indicates that approximately 100 people will have been infected with the other 99 recovering (based on an infection fatality ratio of ~1%). These infections will have happened approximately 21 days previously – capturing a 5-day period from infection to onset of symptoms (the incubation period), 4 days from onset of symptoms to hospitalisation, and 12 days in hospital before death. With a 3-day doubling time, 100 infections that occurred 15 days ago will have generated 200 infections 12 days ago, 400 infections 9 days ago, 800 infections 6 days ago and 1,600 infections 3 days ago resulting in approximately 3,200 infections at the time the first death is observed.

To explore this, we fit our age-structured SEIR model (see Methods) to the time series of deaths in a country, in order to estimate the start date of the epidemic and the baseline R0. We assume that 100% of COVID-19 related deaths have been reported. We have also included the impact of interventions that have been put in place and their effect on human mobility and transmission based on the Google COVID-19 Community Mobility Reports. Using our mathematical model that formalises this approach, we estimate that there has been a total of 41 (95% CI: 4-77) infections over the past 4 weeks.

The figure below shows the estimated number of people infected over the past 4 weeks. The bar charts show, for comparison, the number of reported cases. The right-hand plot shows these data on a different scale as the estimated infections are likely to be much larger than the reported cases. **Importantly**, the estimated infections includes both asymptomatic and mild cases that would not necessarily be identified through surveillance. Consequently, the estimated infections are likely to be significantly higher than the reported cases (see our FAQ for further explanation of these differences and why the reported cases and estimated infections are unlikely to match).

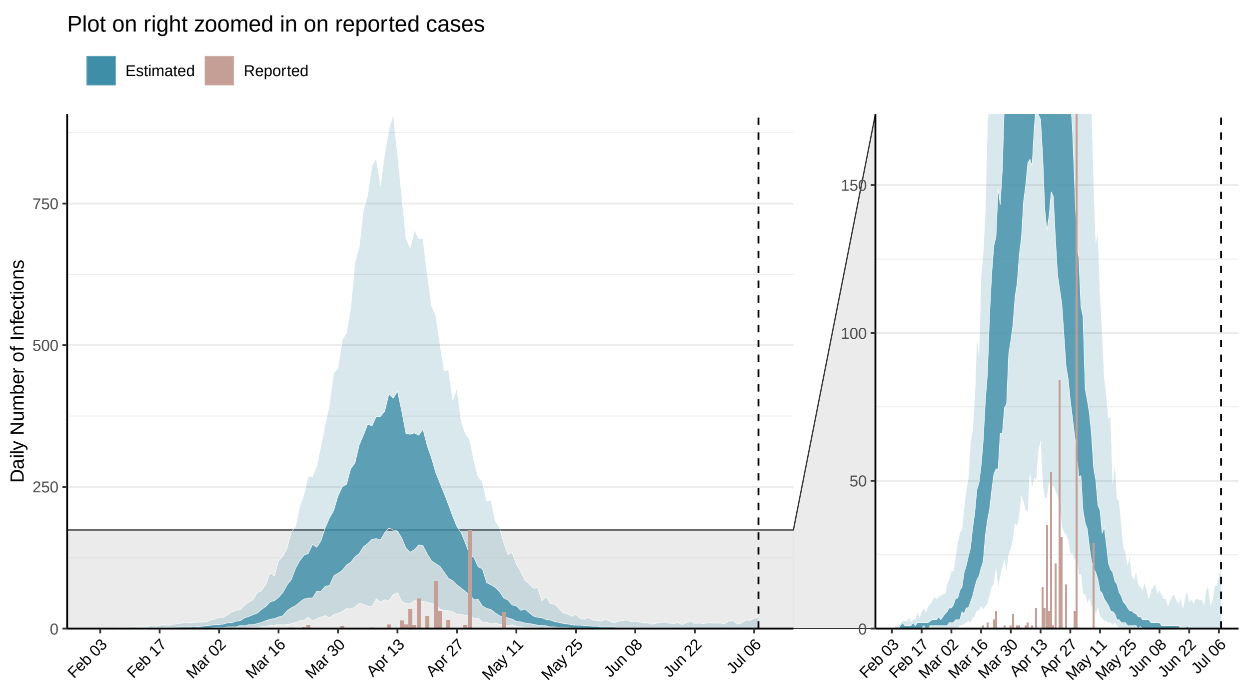

Figure 2: **Daily number of infections estimated by fitting to the current total of deaths.** Reported cases are shown in red. Model estimated infections are shown in blue (dark blue 50% interquartile range, light blue 95% quantile). The dashed line shows the current day.

By fitting to the time series of deaths, we are able to estimate a time-varying reproduction number, R_t. R_t is the the average number of secondary infections caused by a single infected person at a given time. If R_t is above 1, the rate of transmission is increasing and the number of new infections is increasing. R_t is assumed to change in relation to mobility fall in proportion. When fitting our model we assume that 100% of COVID-19 related deaths have been reported (please see our FAQ section for more information about this assumption). We also assume a fixed date at which the impact of mobility on transmission changes from pre-lockdown levels to post-lockdown levels, which may cause large changes in Rt. We are working to refine how this switch occurs and to formally calculate its shape.

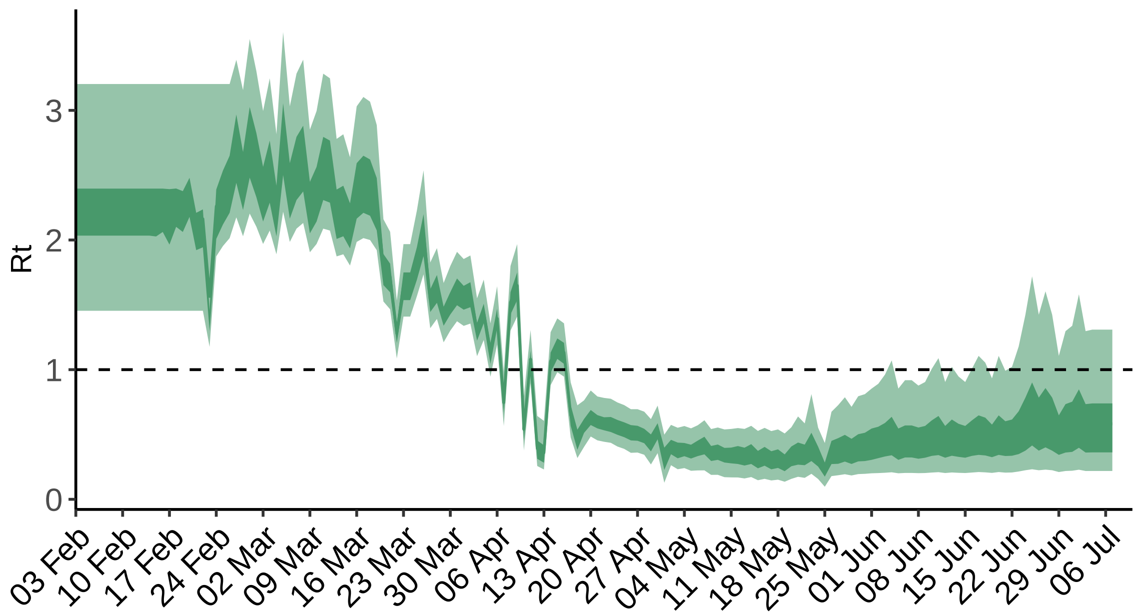

Figure 3: **Time-varying reproduction number, R_t.** R_t is the average number of secondary infections caused by a single infected person at time equal to t. $R_t < 1$ indicates a slowing epidemic in which new infections are not increasing. $R_t > 1$ indicates a growing epidemic in which new infections are increasing over time. Dark green shows the 50% CI and light green shows the 95% CI.

Using the model fit, we can forecast the expected trajectory for cumulative deaths, which is shown in the figure below. This assumes a severity pattern by age that is consistent with that observed in China, Europe and the U.S to date. This projection assumes that transmission is maintained at the current level of transmission as estimated by the final R_t value.

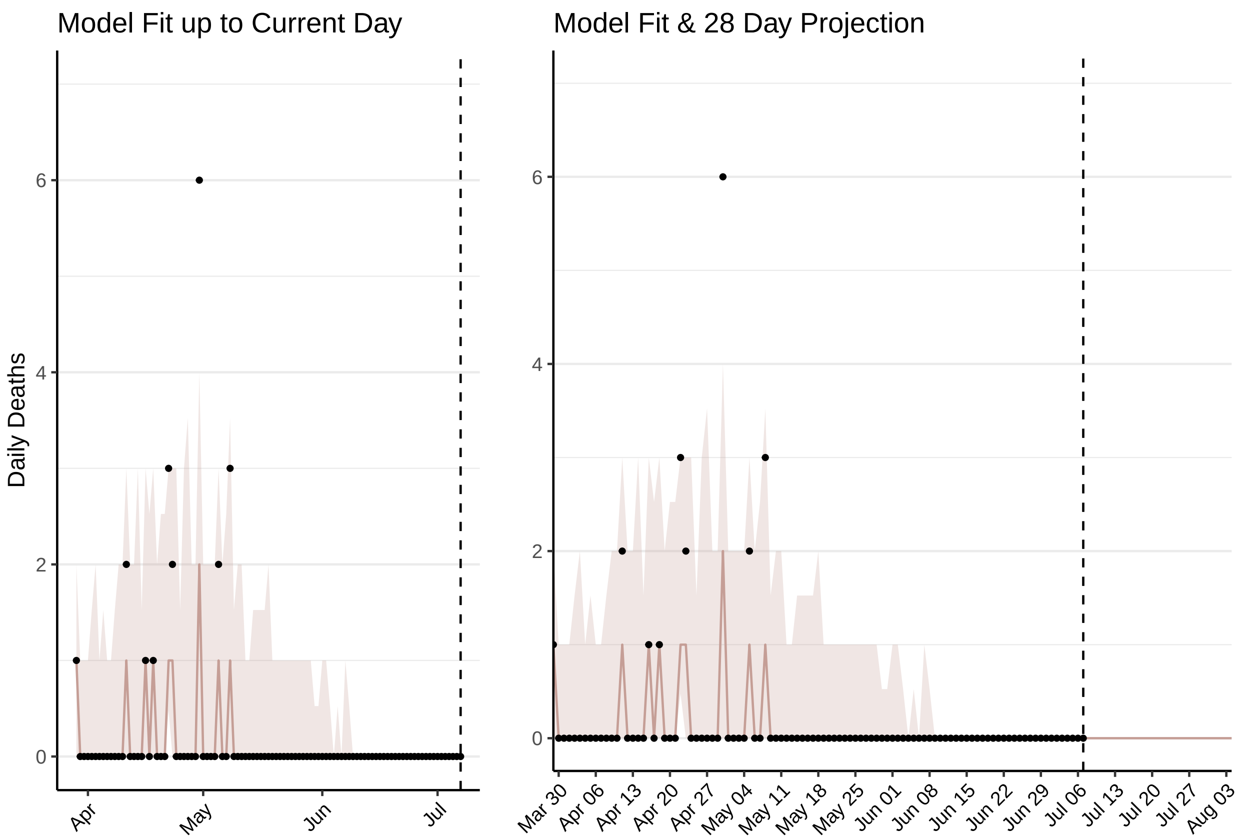

Figure 4: **Estimated daily deaths.** Projected deaths assuming the current level of interventions are maintained are shown in red (median and 95% quantile). Reported deaths are plotted in black. The plot on the left is focussed on the model fit prior to today, while the plot on the right forecasts the next 28 days.

Short-term Epidemic Scenarios

We make the following short-term projections of healthcare demand and new infections under the following three scenarios:

- **Scenario 1.** The epidemic continues to grow at the current rate.
- **Scenario 2.** Countries will further scale up interventions (either increasing current strategies or implementing new interventions) leading to a further 50% reduction in transmission.
- **Scenario 3.** Countries will relax current interventions by 50%

N.B. These scenarios currently assume that the impact of mobility on transmission will remain the same in the future as it has in the past. We are working to extend methods to estimate the impact of increases in mobility on transmission as lockdown and interventions are reversed. Consequently, projection are likely to represent an upper estimate of the healthcare demand and case load for each scenario

We estimate that over the next 4 weeks demand for hospital beds will change from 0 (95% CI: 0-0) patients requiring treatment with high-pressure oxygen at the current date to 1 (95% CI: 0-2) hospital beds being required on 2020-08-04 if no further interventions are introduced (Scenario 1). Similarly, we estimate that over the next 4 weeks demand for critical care (ICU) beds will change from 0 (95% CI: 0-0) patients requiring treatment with mechanical ventilation at the current date to 0 (95% CI: 0-0) by 2020-08-04. These projections assume that approximately 5% of all infections will require treatment with high-pressure oxygen and that approximately 30% of hospitalised cases will require treatment with mechanical ventilation (based on analysis of ongoing epidemics in Europe). **N.B. These scenarios are unlikely to show significant differences for the first week since there is a delay of approximately 10 days between infection and hospital admission. Consequently, the effectiveness of a change in policy is likely to be better captured by hospital admission data approximately 2 weeks after the policy change is implemented.**

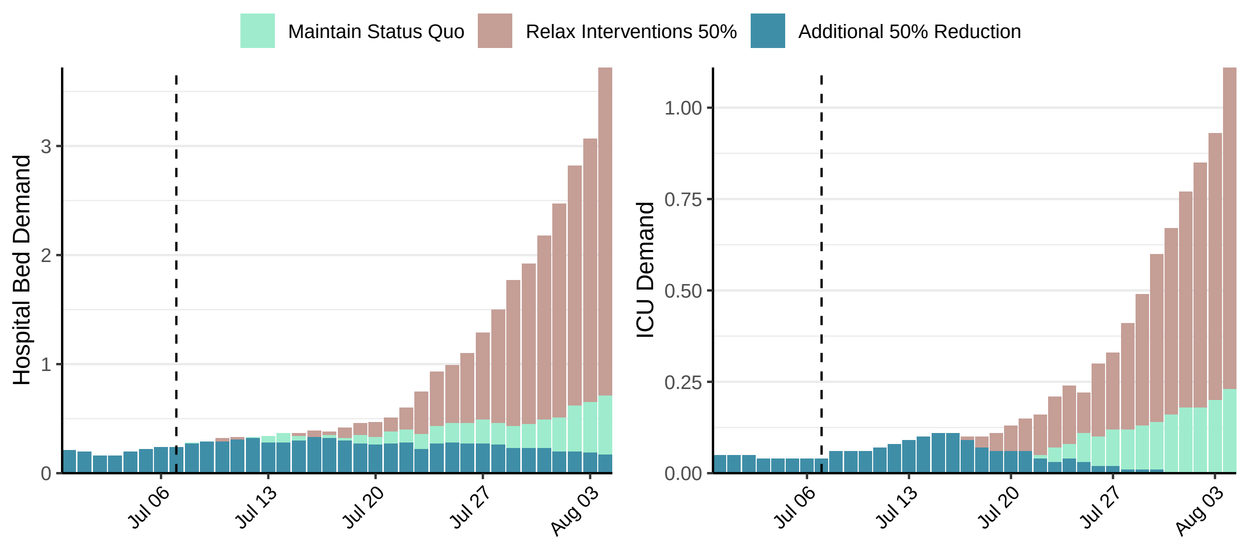

Figure 5: **Healthcare demands in the next 28 days.** Individuals needing an ICU bed are assumed to need mechanical ventilation. Projected demand for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

The impact of each scenario has a more immediate effect on the daily number of infections. The figure below shows the impact of each scenario on the estimated daily incidence of new infections. If interventions are scaled up (Scenario 2), the daily number of infections will change from 2 (95% CI: 0-5) at the current date to 1 (95% CI: 0-2) by 2020-08-04. If current interventions were relaxed by 50%, we estimate the daily number of infections will change from 2 (95% CI: 0-5) at the current date to 91 (95% CI: -28-209) by 2020-08-04.

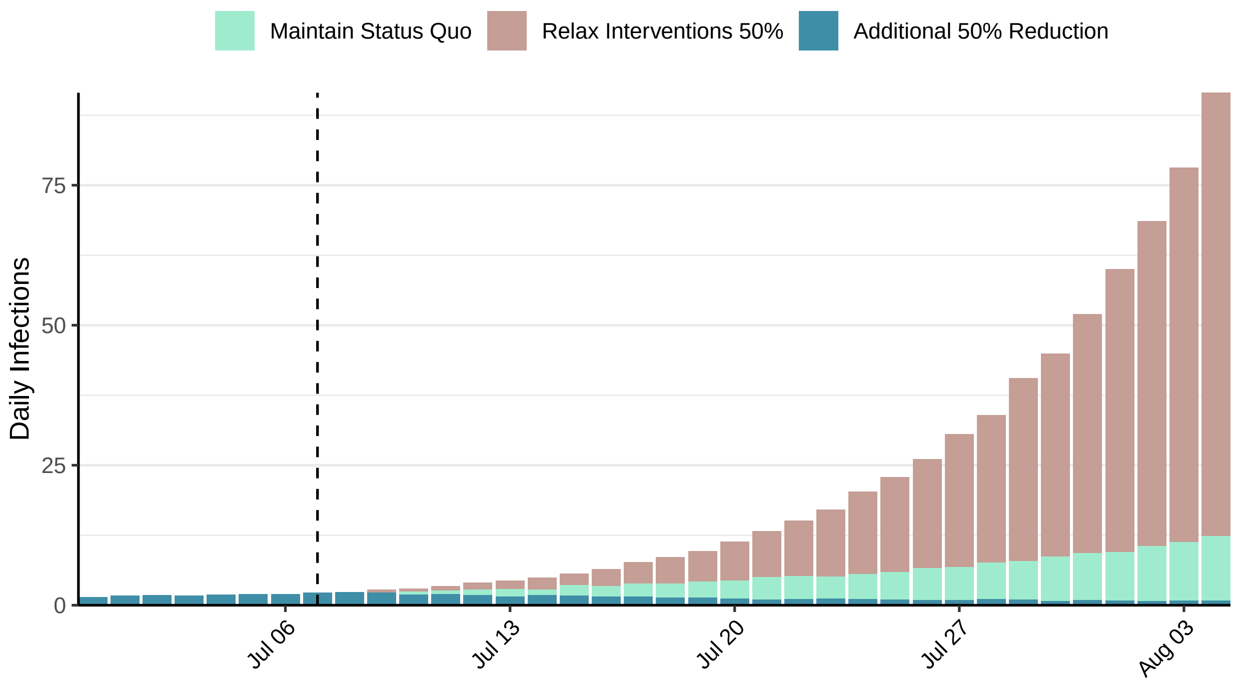

Figure 6: **Daily number of infections estimated by fitting to deaths.** Projected infections for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

To explore different scenarios, we recommend using our COVID-19 Scenario Analysis Tool - https://covidsim.org/, which can be used to simulate different intervention scenarios and explore the long term impact on healthcare demand.

Situation Report for COVID-19: Ukraine, 2020-07-07

Download the report for Ukraine, 2020-07-07 here. This report uses data from the European Centre for Disease Control. These data are updated daily and whilst there may be a short delay, they are generally consistent with Ministry reports. These data are then used to back-calculate an 'inferred number of COVID-19 infections' using mathematical modelling techniques (see Report 12 for further details) to estimate the number of people that have been infected and to make short-term projections for future healthcare needs.

Epidemiological Situation

Total Reported Cases	New Reported Cases	Total Reported Deaths	New Reported Deaths	Estimated R_t
49,607	564	1,283	21	1.08 (95% CI: 1.02-1.18)

The figure below shows the cumulative reported deaths as a function of the time since the 10th death was reported. Dashed lines show the expected trajectory for different doubling times of the epidemic. For example, with a doubling time of 3 days, if there are currently a total of 20 deaths reported, we would expect there to be 40 deaths in total reported in 3 days-time, 80 deaths in 6 days-time, 160 deaths in 9 days-time etc. For most epidemics, in the absence of interventions, we expect a doubling time of 3-4 days for this disease.

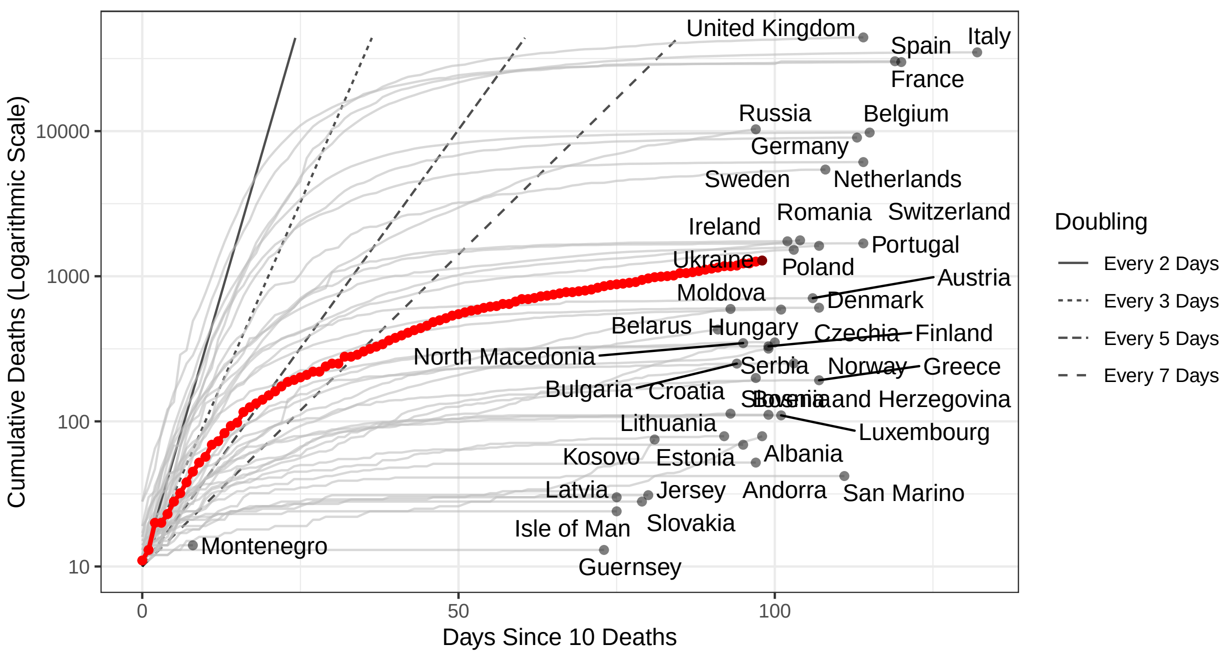

Figure 1: **Cumulative Deaths since 10 deaths.** Country not shown if fewer than 10 deaths.

COVID-19 Transmission Modelling

We assume that the deaths reported to date provide the best indication of the stage of the epidemic, as deaths are more consistently and accurately reported. Our current working estimate is that 1 death indicates that approximately 100 people will have been infected with the other 99 recovering (based on an infection fatality ratio of ~1%). These infections will have happened approximately 21 days previously – capturing a 5-day period from infection to onset of symptoms (the incubation period), 4 days from onset of symptoms to hospitalisation, and 12 days in hospital before death. With a 3-day doubling time, 100 infections that occurred 15 days ago will have generated 200 infections 12 days ago, 400 infections 9 days ago, 800 infections 6 days ago and 1,600 infections 3 days ago resulting in approximately 3,200 infections at the time the first death is observed.

To explore this, we fit our age-structured SEIR model (see Methods) to the time series of deaths in a country, in order to estimate the start date of the epidemic and the baseline R0. We assume that 100% of COVID-19 related deaths have been reported. We have also included the impact of interventions that have been put in place and their effect on human mobility and transmission based on the Google COVID-19 Community Mobility Reports. Using our mathematical model that formalises this approach, we estimate that there has been a total of 168,892 (95% CI: 154,598-183,186) infections over the past 4 weeks.

The figure below shows the estimated number of people infected over the past 4 weeks. The bar charts show, for comparison, the number of reported cases. The right-hand plot shows these data on a different scale as the estimated infections are likely to be much larger than the reported cases. **Importantly**, the estimated infections includes both asymptomatic and mild cases that would not necessarily be identified through surveillance. Consequently, the estimated infections are likely to be significantly higher than the reported cases (see our FAQ for further explanation of these differences and why the reported cases and estimated infections are unlikely to match).

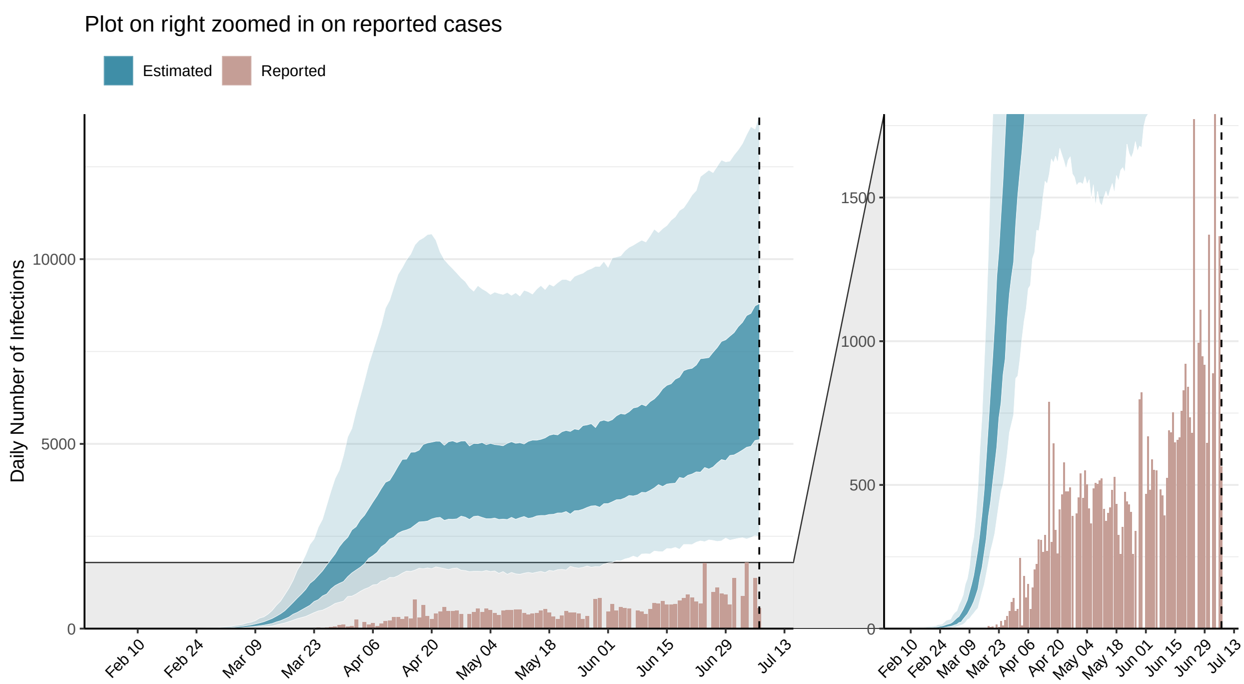

Figure 2: **Daily number of infections estimated by fitting to the current total of deaths.** Reported cases are shown in red. Model estimated infections are shown in blue (dark blue 50% interquartile range, light blue 95% quantile). The dashed line shows the current day.

By fitting to the time series of deaths, we are able to estimate a time-varying reproduction number, R_t. R_t is the the average number of secondary infections caused by a single infected person at a given time. If R_t is above 1, the rate of transmission is increasing and the number of new infections is increasing. R_t is assumed to change in relation to mobility fall in proportion. When fitting our model we assume that 100% of COVID-19 related deaths have been reported (please see our FAQ section for more information about this assumption). We also assume a fixed date at which the impact of mobility on transmission changes from pre-lockdown levels to post-lockdown levels, which may cause large changes in Rt. We are working to refine how this switch occurs and to formally calculate its shape.

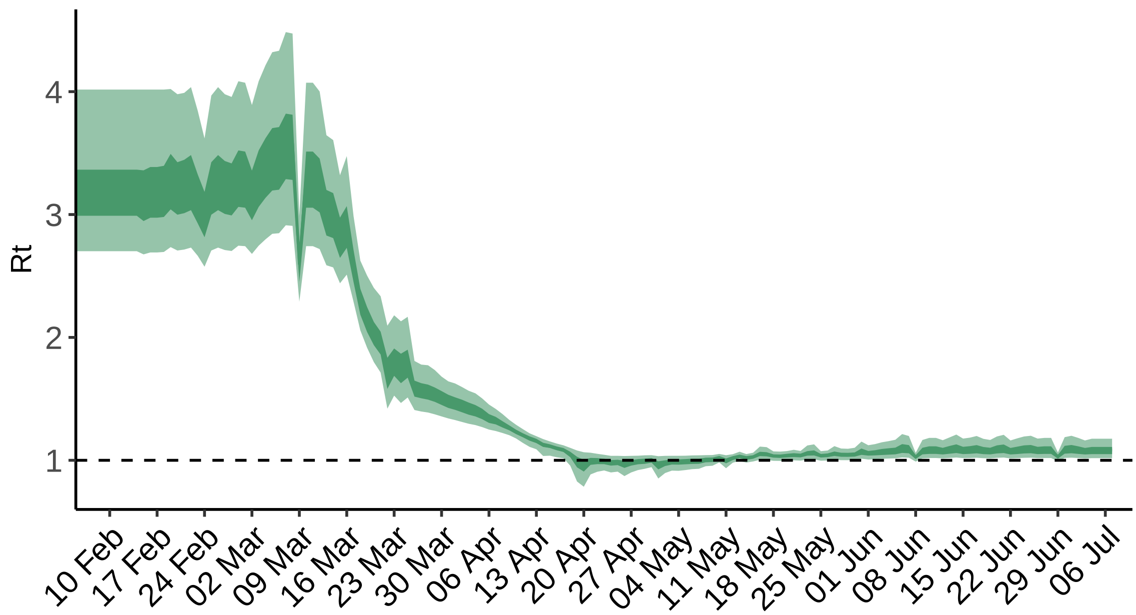

Figure 3: **Time-varying reproduction number, R_t.** R_t is the average number of secondary infections caused by a single infected person at time equal to t. $R_t < 1$ indicates a slowing epidemic in which new infections are not increasing. $R_t > 1$ indicates a growing epidemic in which new infections are increasing over time. Dark green shows the 50% CI and light green shows the 95% CI.

Using the model fit, we can forecast the expected trajectory for cumulative deaths, which is shown in the figure below. This assumes a severity pattern by age that is consistent with that observed in China, Europe and the U.S to date. This projection assumes that transmission is maintained at the current level of transmission as estimated by the final R_t value.

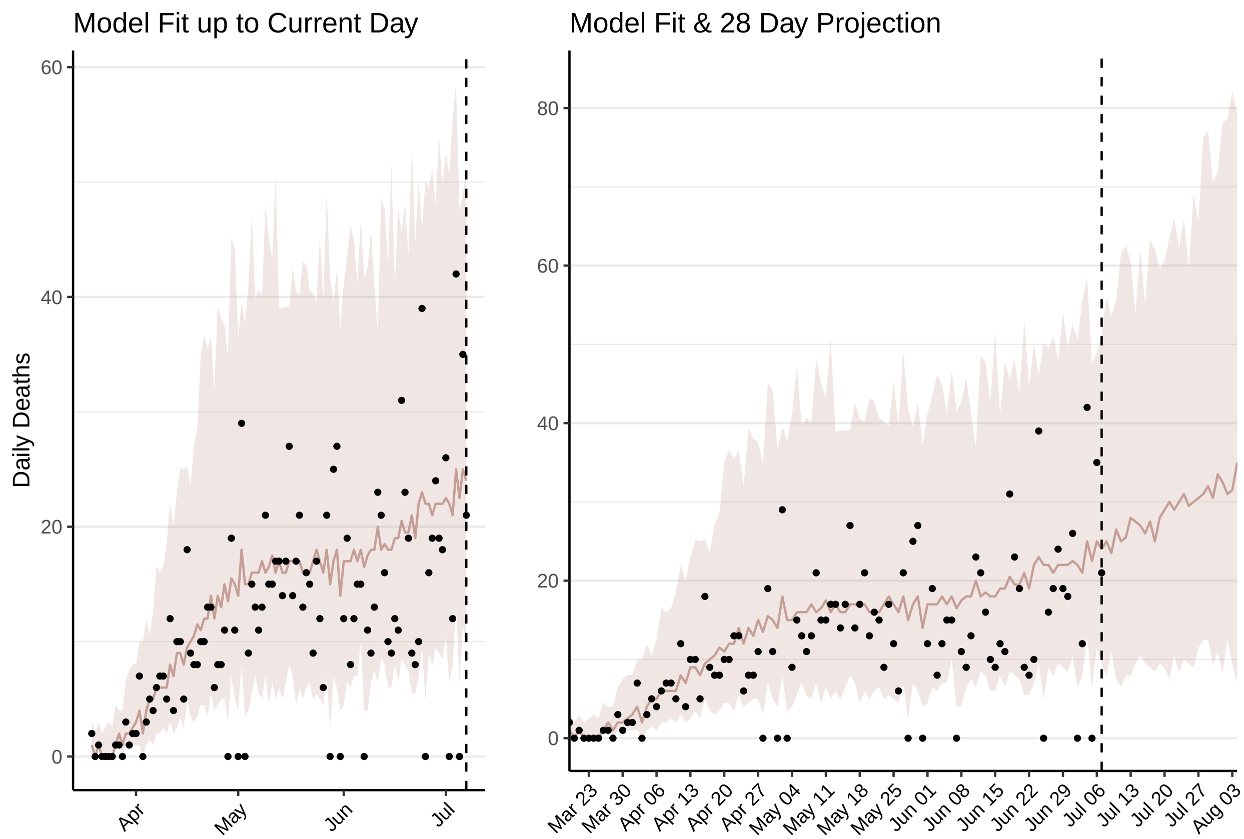

Figure 4: **Estimated daily deaths.** Projected deaths assuming the current level of interventions are maintained are shown in red (median and 95% quantile). Reported deaths are plotted in black. The plot on the left is focussed on the model fit prior to today, while the plot on the right forecasts the next 28 days.

Short-term Epidemic Scenarios

We make the following short-term projections of healthcare demand and new infections under the following three scenarios:

- **Scenario 1.** The epidemic continues to grow at the current rate.
- **Scenario 2.** Countries will further scale up interventions (either increasing current strategies or implementing new interventions) leading to a further 50% reduction in transmission.
- **Scenario 3.** Countries will relax current interventions by 50%

N.B. These scenarios currently assume that the impact of mobility on transmission will remain the same in the future as it has in the past. We are working to extend methods to estimate the impact of increases in mobility on transmission as lockdown and interventions are reversed. Consequently, projection are likely to represent an upper estimate of the healthcare demand and case load for each scenario

We estimate that over the next 4 weeks demand for hospital beds will change from 1,332 (95% CI: 1,219-1,444) patients requiring treatment with high-pressure oxygen at the current date to 1,835 (95% CI: 1,662-2,008) hospital beds being required on 2020-08-04 if no further interventions are introduced (Scenario 1). Similarly, we estimate that over the next 4 weeks demand for critical care (ICU) beds will change from 390 (95% CI: 356-424) patients requiring treatment with mechanical ventilation at the current date to 535 (95% CI: 484-586) by 2020-08-04. These projections assume that approximately 5% of all infections will require treatment with high-pressure oxygen and that approximately 30% of hospitalised cases will require treatment with mechanical ventilation (based on analysis of ongoing epidemics in Europe). **N.B. These scenarios are unlikely to show significant differences for the first week since there is a delay of approximately 10 days between infection and hospital admission. Consequently, the effectiveness of a change in policy is likely to be better captured by hospital admission data approximately 2 weeks after the policy change is implemented.**

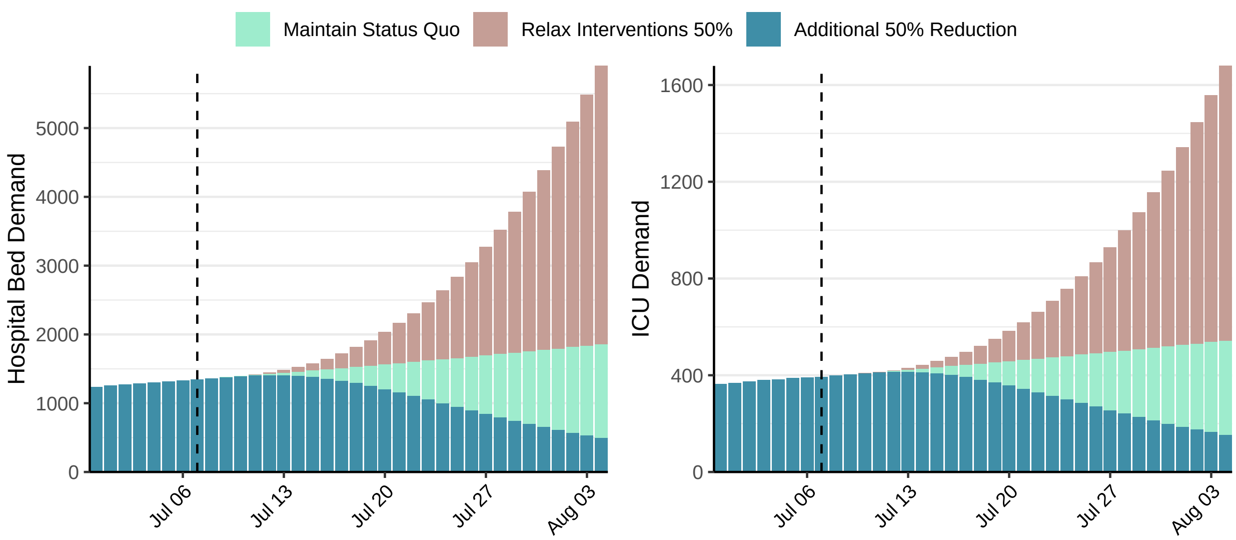

Figure 5: **Healthcare demands in the next 28 days.** Individuals needing an ICU bed are assumed to need mechanical ventilation. Projected demand for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

The impact of each scenario has a more immediate effect on the daily number of infections. The figure below shows the impact of each scenario on the estimated daily incidence of new infections. If interventions are scaled up (Scenario 2), the daily number of infections will change from 7,010 (95% CI: 6,410-7,611) at the current date to 769 (95% CI: 694-844) by 2020-08-04. If current interventions were relaxed by 50%, we estimate the daily number of infections will change from 7,010 (95% CI: 6,410-7,611) at the current date to 55,634 (95% CI: 50,074-61,195) by 2020-08-04.

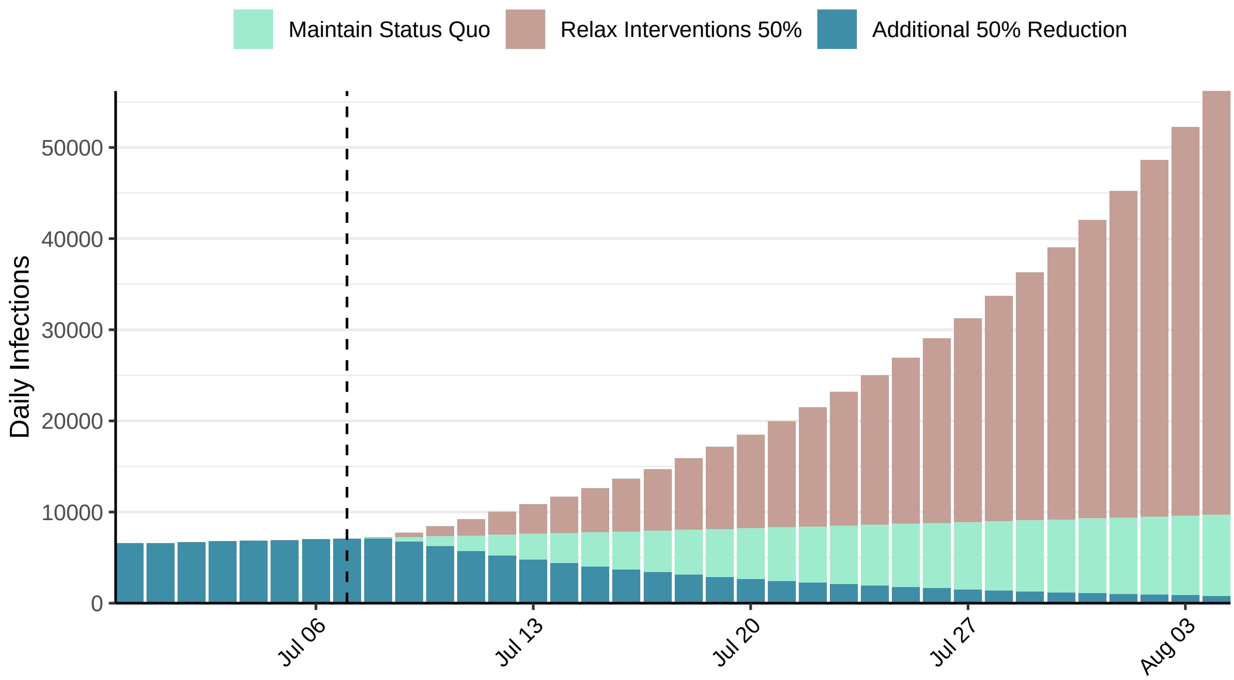

Figure 6: **Daily number of infections estimated by fitting to deaths.** Projected infections for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

To explore different scenarios, we recommend using our COVID-19 Scenario Analysis Tool - https://covidsim.org/, which can be used to simulate different intervention scenarios and explore the long term impact on healthcare demand.

Situation Report for COVID-19: Uruguay, 2020-07-07

Download the report for Uruguay, 2020-07-07 here. This report uses data from the European Centre for Disease Control. These data are updated daily and whilst there may be a short delay, they are generally consistent with Ministry reports. These data are then used to back-calculate an 'inferred number of COVID-19 infections' using mathematical modelling techniques (see Report 12 for further details) to estimate the number of people that have been infected and to make short-term projections for future healthcare needs.

Epidemiological Situation

Total Reported Cases	New Reported Cases	Total Reported Deaths	New Reported Deaths	Estimated R_t
960	4	29	1	1.08 (95% CI: 0.87-1.29)

The figure below shows the cumulative reported deaths as a function of the time since the 10th death was reported. Dashed lines show the expected trajectory for different doubling times of the epidemic. For example, with a doubling time of 3 days, if there are currently a total of 20 deaths reported, we would expect there to be 40 deaths in total reported in 3 days-time, 80 deaths in 6 days-time, 160 deaths in 9 days-time etc. For most epidemics, in the absence of interventions, we expect a doubling time of 3-4 days for this disease.

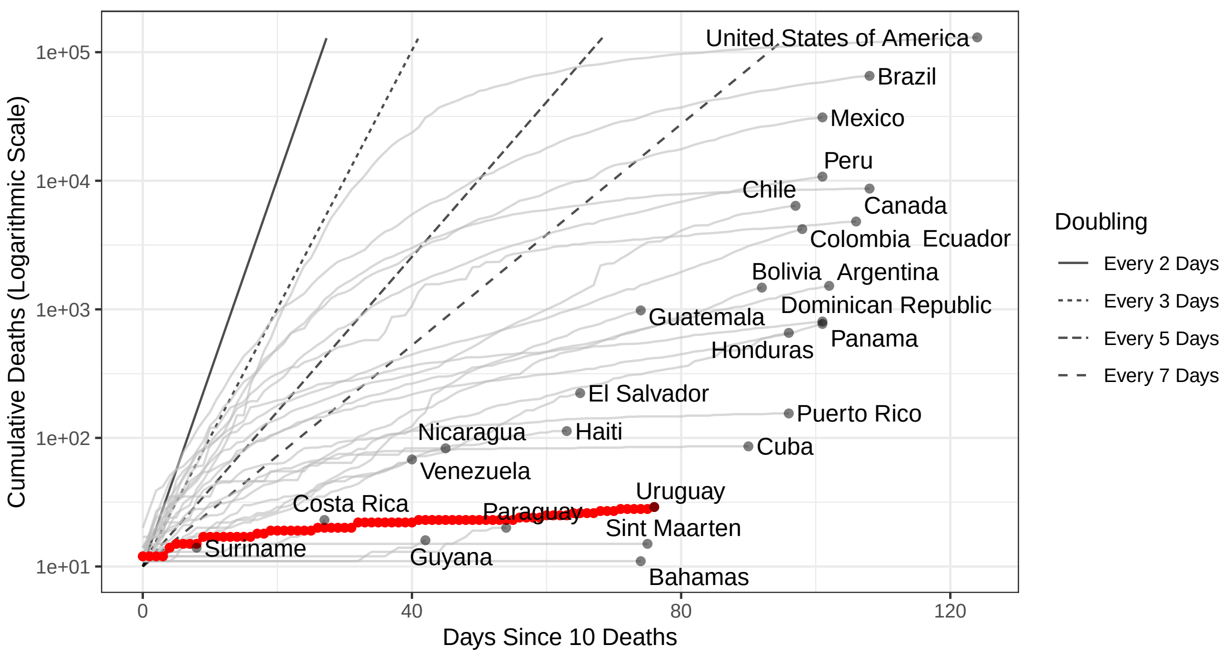

Figure 1: **Cumulative Deaths since 10 deaths.** Country not shown if fewer than 10 deaths.

COVID-19 Transmission Modelling

We assume that the deaths reported to date provide the best indication of the stage of the epidemic, as deaths are more consistently and accurately reported. Our current working estimate is that 1 death indicates that approximately 100 people will have been infected with the other 99 recovering (based on an infection fatality ratio of ~1%). These infections will have happened approximately 21 days previously – capturing a 5-day period from infection to onset of symptoms (the incubation period), 4 days from onset of symptoms to hospitalisation, and 12 days in hospital before death. With a 3-day doubling time, 100 infections that occurred 15 days ago will have generated 200 infections 12 days ago, 400 infections 9 days ago, 800 infections 6 days ago and 1,600 infections 3 days ago resulting in approximately 3,200 infections at the time the first death is observed.

To explore this, we fit our age-structured SEIR model (see Methods) to the time series of deaths in a country, in order to estimate the start date of the epidemic and the baseline R0. We assume that 100% of COVID-19 related deaths have been reported. We have also included the impact of interventions that have been put in place and their effect on human mobility and transmission based on the Google COVID-19 Community Mobility Reports. Using our mathematical model that formalises this approach, we estimate that there has been a total of 2,198 (95% CI: 1,861-2,535) infections over the past 4 weeks.

The figure below shows the estimated number of people infected over the past 4 weeks. The bar charts show, for comparison, the number of reported cases. The right-hand plot shows these data on a different scale as the estimated infections are likely to be much larger than the reported cases. **Importantly**, the estimated infections includes both asymptomatic and mild cases that would not necessarily be identified through surveillance. Consequently, the estimated infections are likely to be significantly higher than the reported cases (see our FAQ for further explanation of these differences and why the reported cases and estimated infections are unlikely to match).

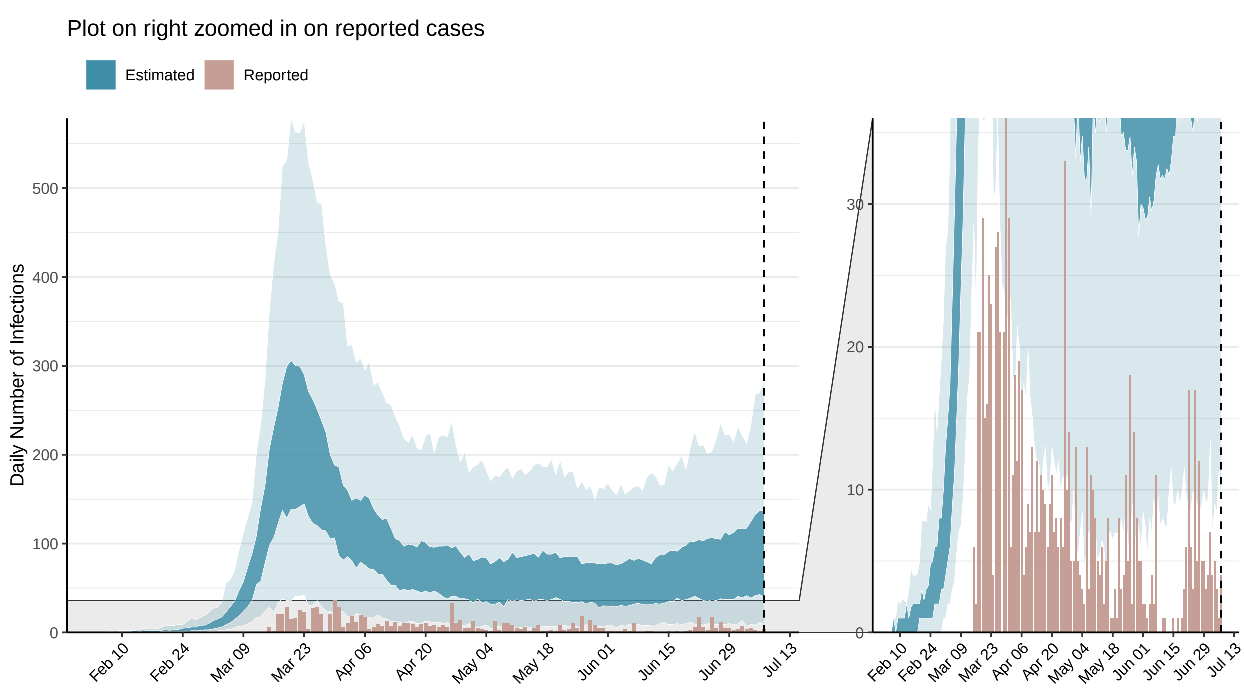

Figure 2: **Daily number of infections estimated by fitting to the current total of deaths.** Reported cases are shown in red. Model estimated infections are shown in blue (dark blue 50% interquartile range, light blue 95% quantile). The dashed line shows the current day.

By fitting to the time series of deaths, we are able to estimate a time-varying reproduction number, R_t. R_t is the the average number of secondary infections caused by a single infected person at a given time. If R_t is above 1, the rate of transmission is increasing and the number of new infections is increasing. R_t is assumed to change in relation to mobility fall in proportion. When fitting our model we assume that 100% of COVID-19 related deaths have been reported (please see our FAQ section for more information about this assumption). We also assume a fixed date at which the impact of mobility on transmission changes from pre-lockdown levels to post-lockdown levels, which may cause large changes in Rt. We are working to refine how this switch occurs and to formally calculate its shape.

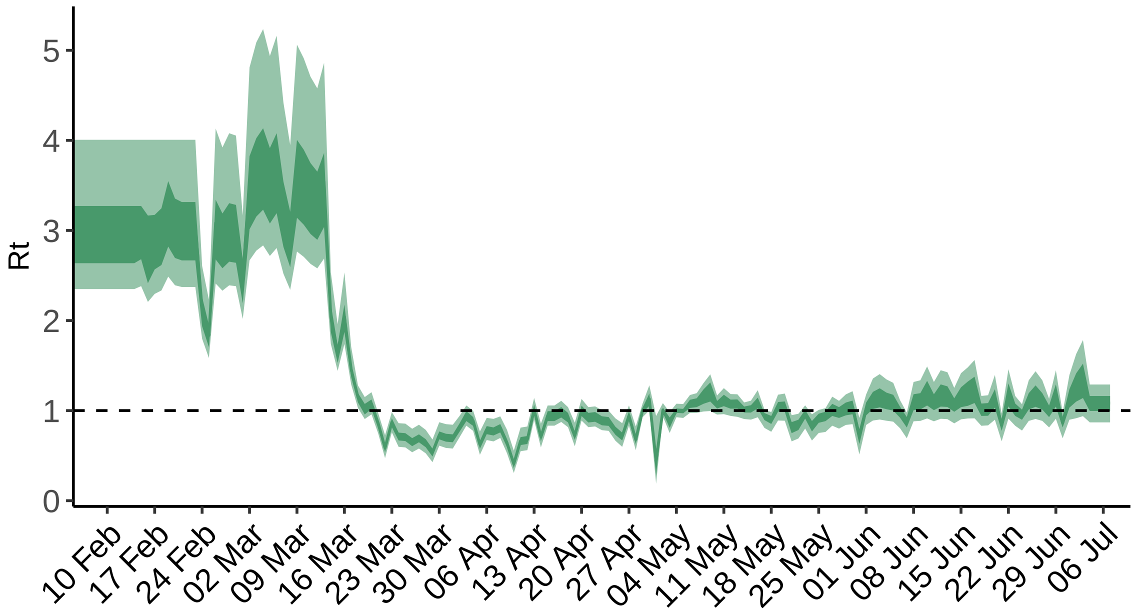

Figure 3: **Time-varying reproduction number, R_t.** R_t is the average number of secondary infections caused by a single infected person at time equal to t. $R_t < 1$ indicates a slowing epidemic in which new infections are not increasing. $R_t > 1$ indicates a growing epidemic in which new infections are increasing over time. Dark green shows the 50% CI and light green shows the 95% CI.

Using the model fit, we can forecast the expected trajectory for cumulative deaths, which is shown in the figure below. This assumes a severity pattern by age that is consistent with that observed in China, Europe and the U.S to date. This projection assumes that transmission is maintained at the current level of transmission as estimated by the final R_t value.

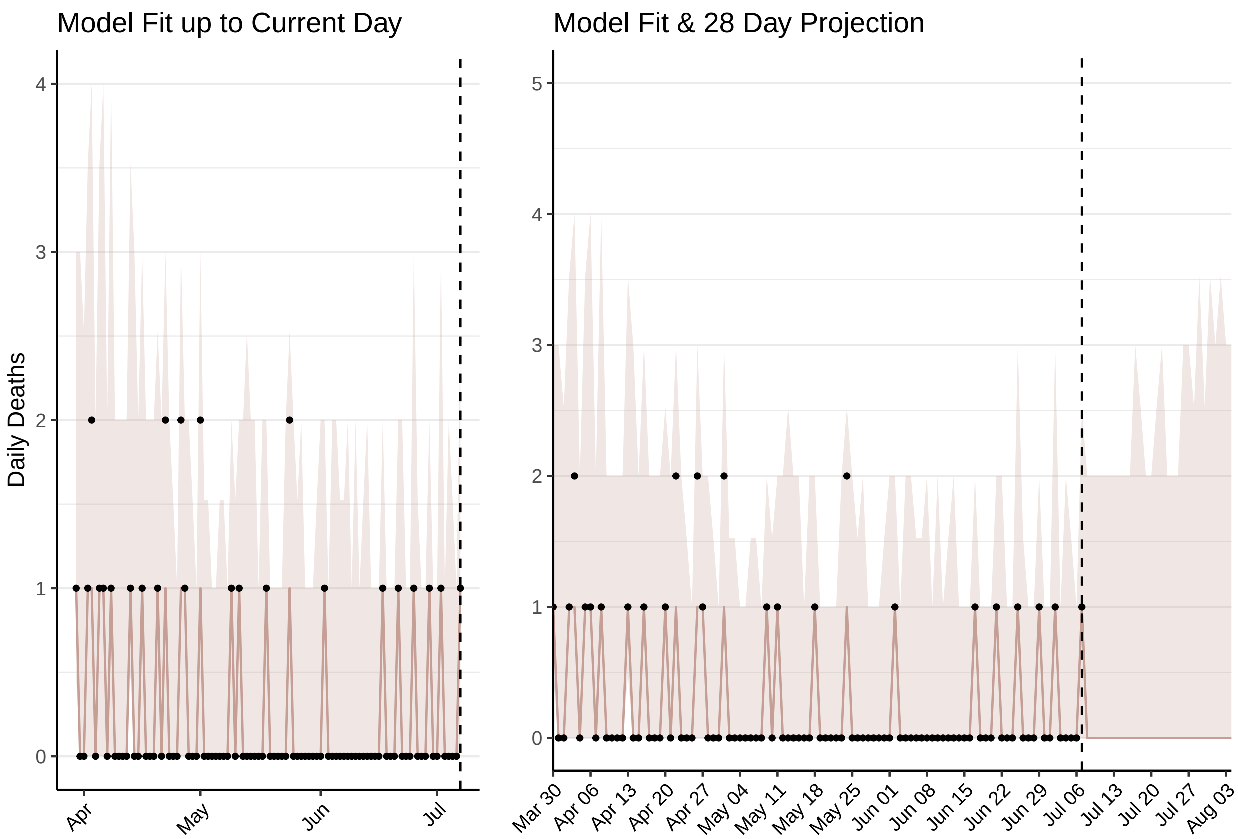

Figure 4: **Estimated daily deaths.** Projected deaths assuming the current level of interventions are maintained are shown in red (median and 95% quantile). Reported deaths are plotted in black. The plot on the left is focussed on the model fit prior to today, while the plot on the right forecasts the next 28 days.

Short-term Epidemic Scenarios

We make the following short-term projections of healthcare demand and new infections under the following three scenarios:

- **Scenario 1.** The epidemic continues to grow at the current rate.
- **Scenario 2.** Countries will further scale up interventions (either increasing current strategies or implementing new interventions) leading to a further 50% reduction in transmission.
- **Scenario 3.** Countries will relax current interventions by 50%

N.B. These scenarios currently assume that the impact of mobility on transmission will remain the same in the future as it has in the past. We are working to extend methods to estimate the impact of increases in mobility on transmission as lockdown and interventions are reversed. Consequently, projection are likely to represent an upper estimate of the healthcare demand and case load for each scenario

We estimate that over the next 4 weeks demand for hospital beds will change from 14 (95% CI: 11-16) patients requiring treatment with high-pressure oxygen at the current date to 25 (95% CI: 20-30) hospital beds being required on 2020-08-04 if no further interventions are introduced (Scenario 1). Similarly, we estimate that over the next 4 weeks demand for critical care (ICU) beds will change from 5 (95% CI: 4-7) patients requiring treatment with mechanical ventilation at the current date to 10 (95% CI: 8-12) by 2020-08-04. These projections assume that approximately 5% of all infections will require treatment with high-pressure oxygen and that approximately 30% of hospitalised cases will require treatment with mechanical ventilation (based on analysis of ongoing epidemics in Europe). **N.B. These scenarios are unlikely to show significant differences for the first week since there is a delay of approximately 10 days between infection and hospital admission. Consequently, the effectiveness of a change in policy is likely to be better captured by hospital admission data approximately 2 weeks after the policy change is implemented.**

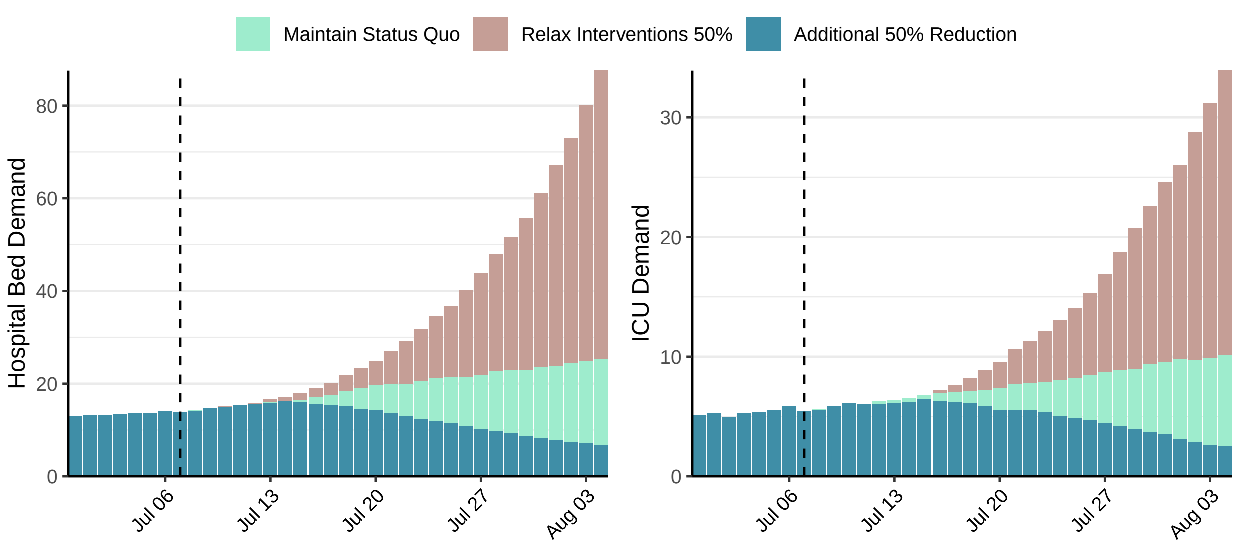

Figure 5: **Healthcare demands in the next 28 days.** Individuals needing an ICU bed are assumed to need mechanical ventilation. Projected demand for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

The impact of each scenario has a more immediate effect on the daily number of infections. The figure below shows the impact of each scenario on the estimated daily incidence of new infections. If interventions are scaled up (Scenario 2), the daily number of infections will change from 101 (95% CI: 83-119) at the current date to 13 (95% CI: 10-17) by 2020-08-04. If current interventions were relaxed by 50%, we estimate the daily number of infections will change from 101 (95% CI: 83-119) at the current date to 1,124 (95% CI: 864-1,385) by 2020-08-04.

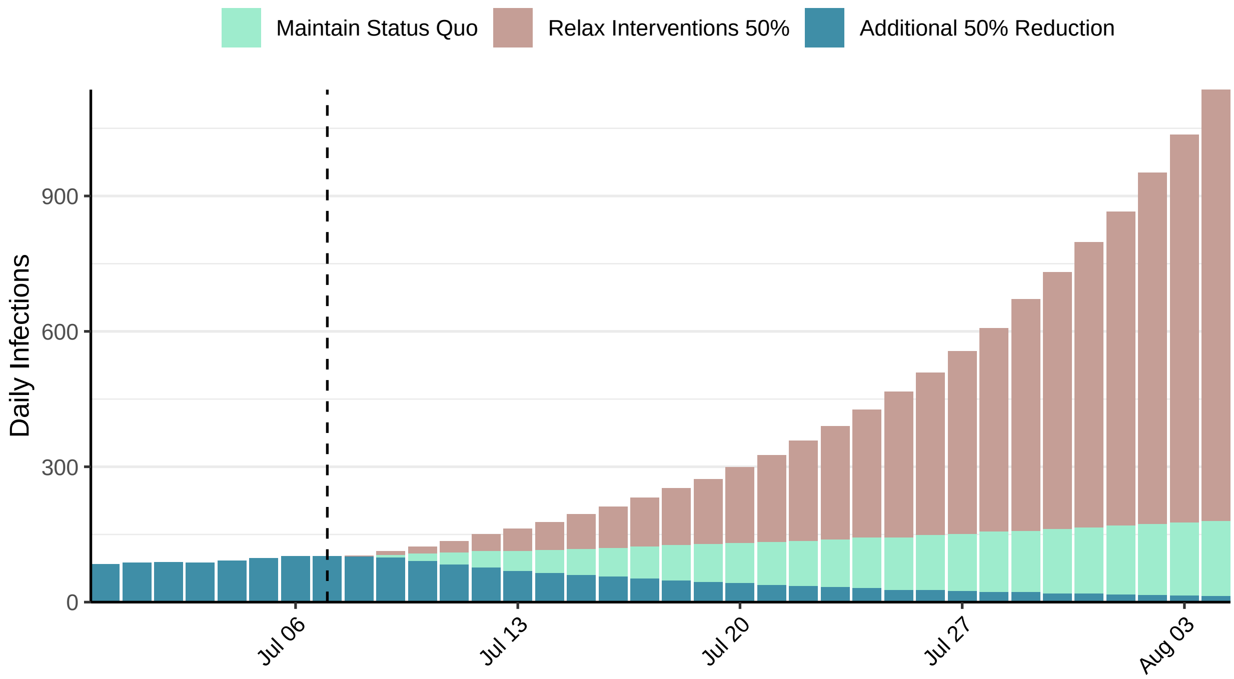

Figure 6: **Daily number of infections estimated by fitting to deaths.** Projected infections for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

To explore different scenarios, we recommend using our COVID-19 Scenario Analysis Tool - https://covidsim.org/, which can be used to simulate different intervention scenarios and explore the long term impact on healthcare demand.

Situation Report for COVID-19: Uzbekistan, 2020-07-07

Download the report for Uzbekistan, 2020-07-07 here. This report uses data from the European Centre for Disease Control. These data are updated daily and whilst there may be a short delay, they are generally consistent with Ministry reports. These data are then used to back-calculate an 'inferred number of COVID-19 infections' using mathematical modelling techniques (see Report 12 for further details) to estimate the number of people that have been infected and to make short-term projections for future healthcare needs.

Epidemiological Situation

Total Reported Cases	New Reported Cases	Total Reported Deaths	New Reported Deaths	Estimated R_t
10,459	316	38	3	1.11 (95% CI: 1-1.24)

The figure below shows the cumulative reported deaths as a function of the time since the 10th death was reported. Dashed lines show the expected trajectory for different doubling times of the epidemic. For example, with a doubling time of 3 days, if there are currently a total of 20 deaths reported, we would expect there to be 40 deaths in total reported in 3 days-time, 80 deaths in 6 days-time, 160 deaths in 9 days-time etc. For most epidemics, in the absence of interventions, we expect a doubling time of 3-4 days for this disease.

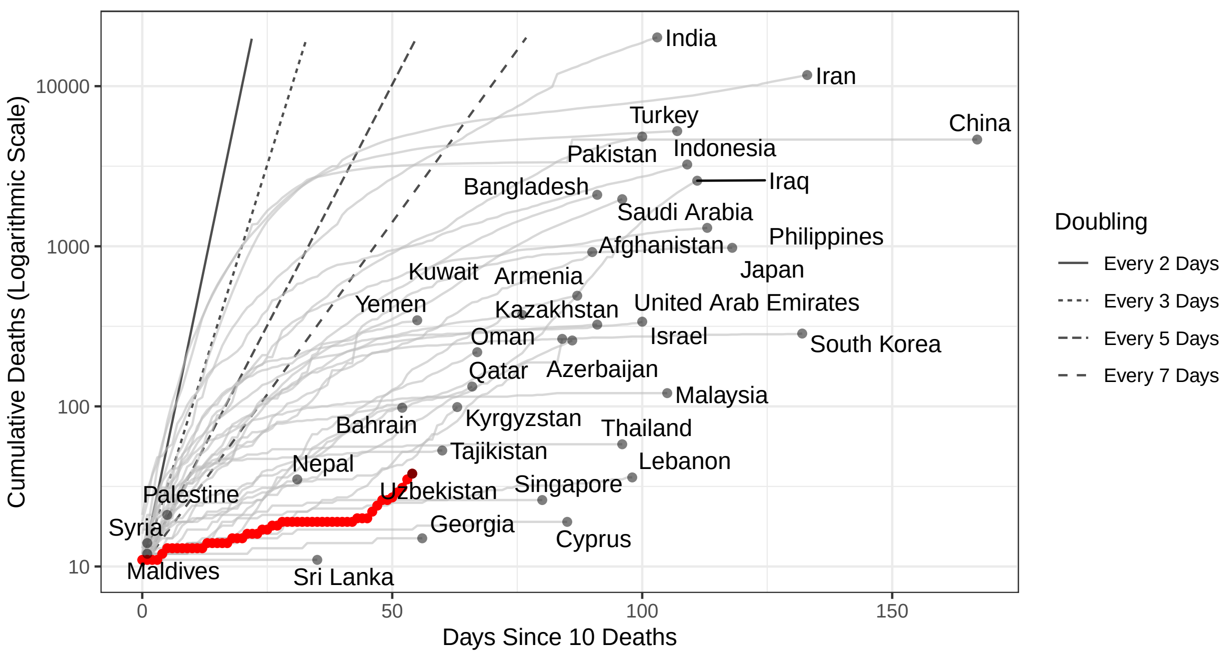

Figure 1: **Cumulative Deaths since 10 deaths.** Country not shown if fewer than 10 deaths.

COVID-19 Transmission Modelling

We assume that the deaths reported to date provide the best indication of the stage of the epidemic, as deaths are more consistently and accurately reported. Our current working estimate is that 1 death indicates that approximately 100 people will have been infected with the other 99 recovering (based on an infection fatality ratio of ~1%). These infections will have happened approximately 21 days previously – capturing a 5-day period from infection to onset of symptoms (the incubation period), 4 days from onset of symptoms to hospitalisation, and 12 days in hospital before death. With a 3-day doubling time, 100 infections that occurred 15 days ago will have generated 200 infections 12 days ago, 400 infections 9 days ago, 800 infections 6 days ago and 1,600 infections 3 days ago resulting in approximately 3,200 infections at the time the first death is observed.

To explore this, we fit our age-structured SEIR model (see Methods) to the time series of deaths in a country, in order to estimate the start date of the epidemic and the baseline R0. We assume that 100% of COVID-19 related deaths have been reported. We have also included the impact of interventions that have been put in place and their effect on human mobility and transmission based on the Google COVID-19 Community Mobility Reports. Using our mathematical model that formalises this approach, we estimate that there has been a total of 15,205 (95% CI: 12,787-17,623) infections over the past 4 weeks.

The figure below shows the estimated number of people infected over the past 4 weeks. The bar charts show, for comparison, the number of reported cases. The right-hand plot shows these data on a different scale as the estimated infections are likely to be much larger than the reported cases. **Importantly**, the estimated infections includes both asymptomatic and mild cases that would not necessarily be identified through surveillance. Consequently, the estimated infections are likely to be significantly higher than the reported cases (see our FAQ for further explanation of these differences and why the reported cases and estimated infections are unlikely to match).

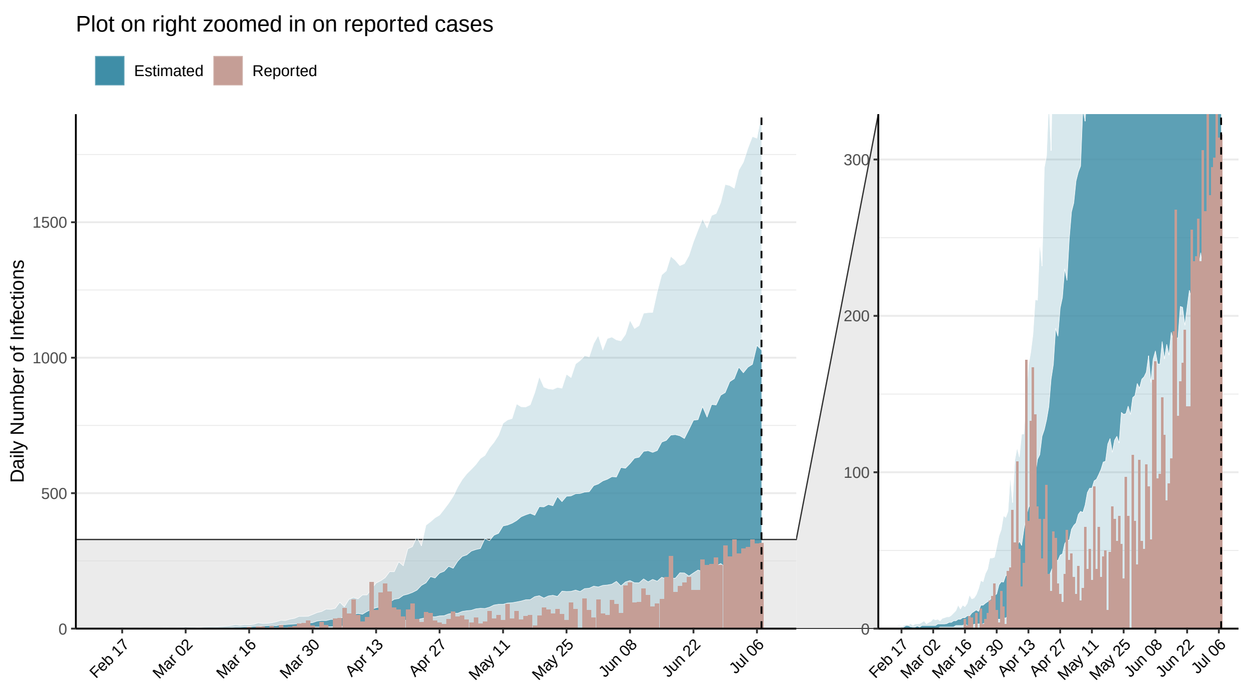

Figure 2: **Daily number of infections estimated by fitting to the current total of deaths.** Reported cases are shown in red. Model estimated infections are shown in blue (dark blue 50% interquartile range, light blue 95% quantile). The dashed line shows the current day.

By fitting to the time series of deaths, we are able to estimate a time-varying reproduction number, R_t. R_t is the the average number of secondary infections caused by a single infected person at a given time. If R_t is above 1, the rate of transmission is increasing and the number of new infections is increasing. R_t is assumed to change in relation to mobility fall in proportion. When fitting our model we assume that 100% of COVID-19 related deaths have been reported (please see our FAQ section for more information about this assumption). We also assume a fixed date at which the impact of mobility on transmission changes from pre-lockdown levels to post-lockdown levels, which may cause large changes in Rt. We are working to refine how this switch occurs and to formally calculate its shape.

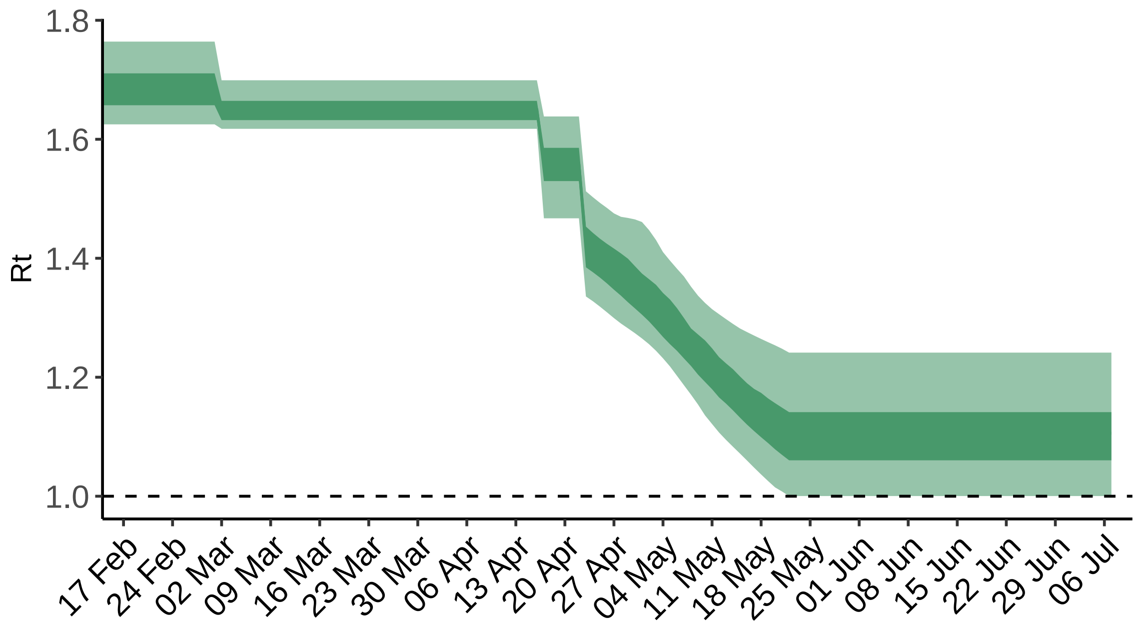

Figure 3: **Time-varying reproduction number, R_t.** R_t is the average number of secondary infections caused by a single infected person at time equal to t. $R_t < 1$ indicates a slowing epidemic in which new infections are not increasing. $R_t > 1$ indicates a growing epidemic in which new infections are increasing over time. Dark green shows the 50% CI and light green shows the 95% CI.

Using the model fit, we can forecast the expected trajectory for cumulative deaths, which is shown in the figure below. This assumes a severity pattern by age that is consistent with that observed in China, Europe and the U.S to date. This projection assumes that transmission is maintained at the current level of transmission as estimated by the final R_t value.

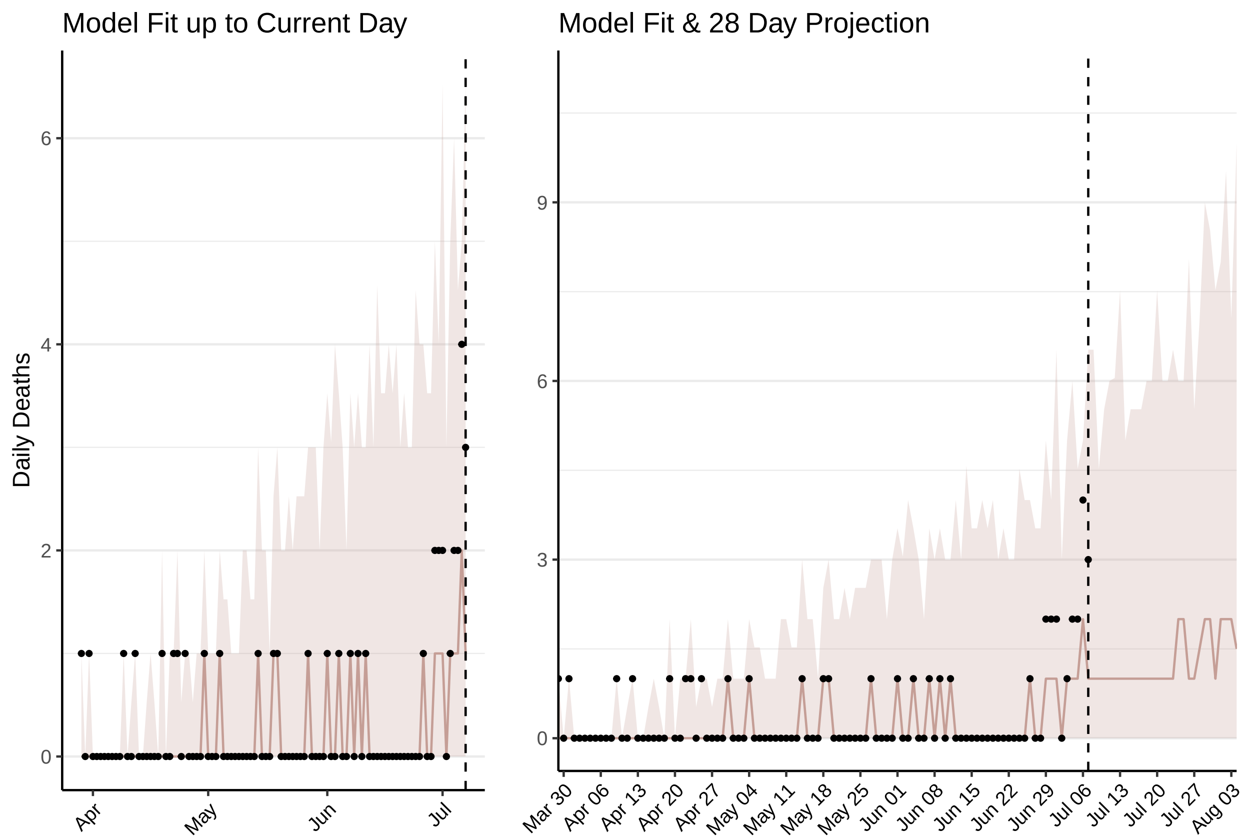

Figure 4: **Estimated daily deaths.** Projected deaths assuming the current level of interventions are maintained are shown in red (median and 95% quantile). Reported deaths are plotted in black. The plot on the left is focussed on the model fit prior to today, while the plot on the right forecasts the next 28 days.

Short-term Epidemic Scenarios

We make the following short-term projections of healthcare demand and new infections under the following three scenarios:

- **Scenario 1.** The epidemic continues to grow at the current rate.
- **Scenario 2.** Countries will further scale up interventions (either increasing current strategies or implementing new interventions) leading to a further 50% reduction in transmission.
- **Scenario 3.** Countries will relax current interventions by 50%

N.B. These scenarios currently assume that the impact of mobility on transmission will remain the same in the future as it has in the past. We are working to extend methods to estimate the impact of increases in mobility on transmission as lockdown and interventions are reversed. Consequently, projection are likely to represent an upper estimate of the healthcare demand and case load for each scenario

We estimate that over the next 4 weeks demand for hospital beds will change from 95 (95% CI: 79-110) patients requiring treatment with high-pressure oxygen at the current date to 158 (95% CI: 127-189) hospital beds being required on 2020-08-04 if no further interventions are introduced (Scenario 1). Similarly, we estimate that over the next 4 weeks demand for critical care (ICU) beds will change from 20 (95% CI: 16-23) patients requiring treatment with mechanical ventilation at the current date to 36 (95% CI: 29-43) by 2020-08-04. These projections assume that approximately 5% of all infections will require treatment with high-pressure oxygen and that approximately 30% of hospitalised cases will require treatment with mechanical ventilation (based on analysis of ongoing epidemics in Europe). **N.B. These scenarios are unlikely to show significant differences for the first week since there is a delay of approximately 10 days between infection and hospital admission. Consequently, the effectiveness of a change in policy is likely to be better captured by hospital admission data approximately 2 weeks after the policy change is implemented.**

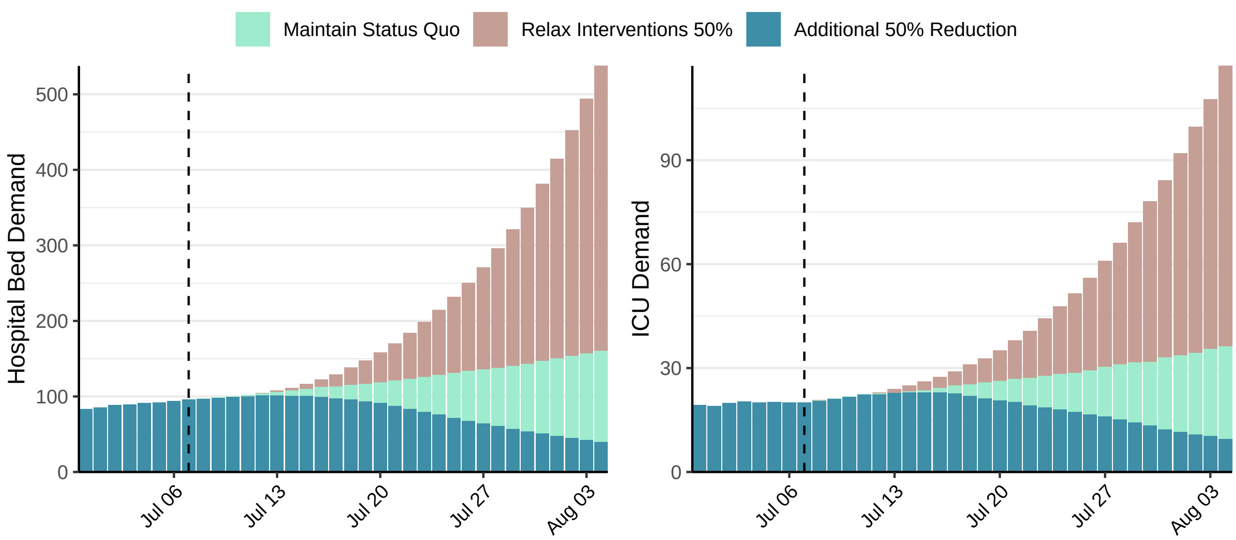

Figure 5: **Healthcare demands in the next 28 days.** Individuals needing an ICU bed are assumed to need mechanical ventilation. Projected demand for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

The impact of each scenario has a more immediate effect on the daily number of infections. The figure below shows the impact of each scenario on the estimated daily incidence of new infections. If interventions are scaled up (Scenario 2), the daily number of infections will change from 688 (95% CI: 572-805) at the current date to 88 (95% CI: 70-106) by 2020-08-04. If current interventions were relaxed by 50%, we estimate the daily number of infections will change from 688 (95% CI: 572-805) at the current date to 7,378 (95% CI: 5,744-9,012) by 2020-08-04.

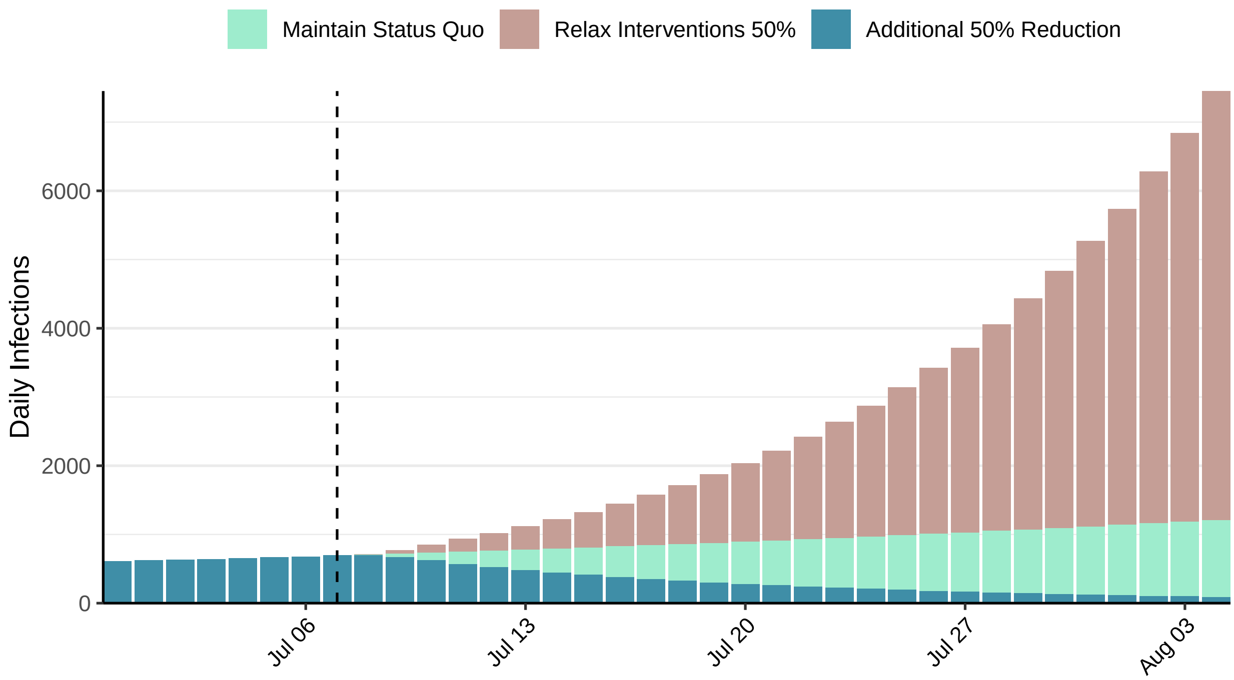

Figure 6: **Daily number of infections estimated by fitting to deaths.** Projected infections for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

To explore different scenarios, we recommend using our COVID-19 Scenario Analysis Tool - https://covidsim.org/, which can be used to simulate different intervention scenarios and explore the long term impact on healthcare demand.

Situation Report for COVID-19: Venezuela, 2020-07-07

Download the report for Venezuela, 2020-07-07 here. This report uses data from the European Centre for Disease Control. These data are updated daily and whilst there may be a short delay, they are generally consistent with Ministry reports. These data are then used to back-calculate an 'inferred number of COVID-19 infections' using mathematical modelling techniques (see Report 12 for further details) to estimate the number of people that have been infected and to make short-term projections for future healthcare needs.

Epidemiological Situation

Total Reported Cases	New Reported Cases	Total Reported Deaths	New Reported Deaths	Estimated R_t
7,411	242	68	4	1.53 (95% CI: 1.42-1.67)

The figure below shows the cumulative reported deaths as a function of the time since the 10th death was reported. Dashed lines show the expected trajectory for different doubling times of the epidemic. For example, with a doubling time of 3 days, if there are currently a total of 20 deaths reported, we would expect there to be 40 deaths in total reported in 3 days-time, 80 deaths in 6 days-time, 160 deaths in 9 days-time etc. For most epidemics, in the absence of interventions, we expect a doubling time of 3-4 days for this disease.

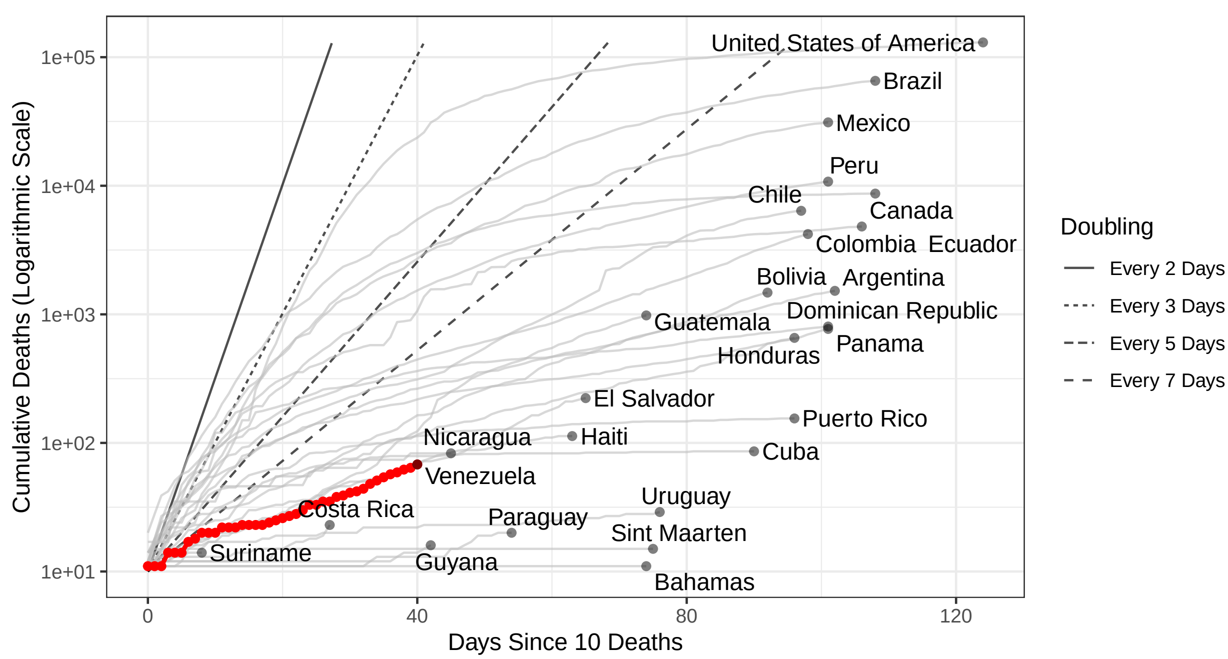

Figure 1: **Cumulative Deaths since 10 deaths.** Country not shown if fewer than 10 deaths.

COVID-19 Transmission Modelling

We assume that the deaths reported to date provide the best indication of the stage of the epidemic, as deaths are more consistently and accurately reported. Our current working estimate is that 1 death indicates that approximately 100 people will have been infected with the other 99 recovering (based on an infection fatality ratio of ~1%). These infections will have happened approximately 21 days previously – capturing a 5-day period from infection to onset of symptoms (the incubation period), 4 days from onset of symptoms to hospitalisation, and 12 days in hospital before death. With a 3-day doubling time, 100 infections that occurred 15 days ago will have generated 200 infections 12 days ago, 400 infections 9 days ago, 800 infections 6 days ago and 1,600 infections 3 days ago resulting in approximately 3,200 infections at the time the first death is observed.

To explore this, we fit our age-structured SEIR model (see Methods) to the time series of deaths in a country, in order to estimate the start date of the epidemic and the baseline R0. We assume that 100% of COVID-19 related deaths have been reported. We have also included the impact of interventions that have been put in place and their effect on human mobility and transmission based on the Google COVID-19 Community Mobility Reports. Using our mathematical model that formalises this approach, we estimate that there has been a total of 55,576 (95% CI: 47,904-63,247) infections over the past 4 weeks.

The figure below shows the estimated number of people infected over the past 4 weeks. The bar charts show, for comparison, the number of reported cases. The right-hand plot shows these data on a different scale as the estimated infections are likely to be much larger than the reported cases. **Importantly**, the estimated infections includes both asymptomatic and mild cases that would not necessarily be identified through surveillance. Consequently, the estimated infections are likely to be significantly higher than the reported cases (see our FAQ for further explanation of these differences and why the reported cases and estimated infections are unlikely to match).

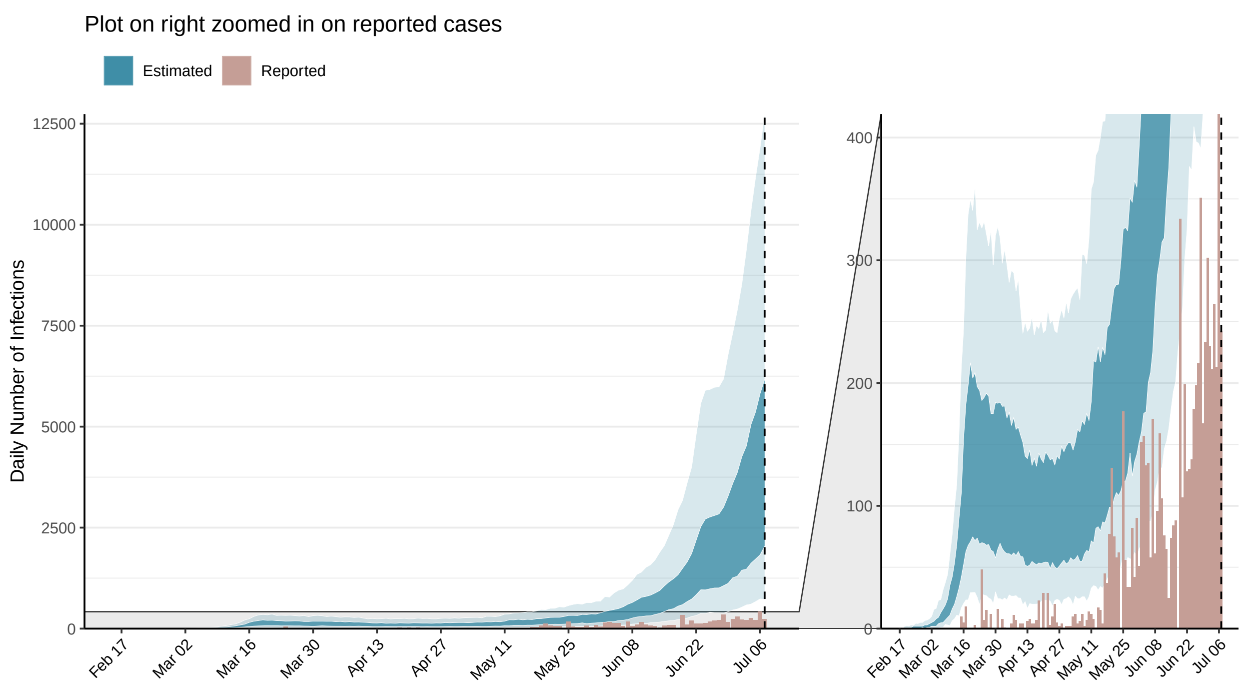

Figure 2: **Daily number of infections estimated by fitting to the current total of deaths.** Reported cases are shown in red. Model estimated infections are shown in blue (dark blue 50% interquartile range, light blue 95% quantile). The dashed line shows the current day.

By fitting to the time series of deaths, we are able to estimate a time-varying reproduction number, R_t. R_t is the the average number of secondary infections caused by a single infected person at a given time. If R_t is above 1, the rate of transmission is increasing and the number of new infections is increasing. R_t is assumed to change in relation to mobility fall in proportion. When fitting our model we assume that 100% of COVID-19 related deaths have been reported (please see our FAQ section for more information about this assumption). We also assume a fixed date at which the impact of mobility on transmission changes from pre-lockdown levels to post-lockdown levels, which may cause large changes in Rt. We are working to refine how this switch occurs and to formally calculate its shape.

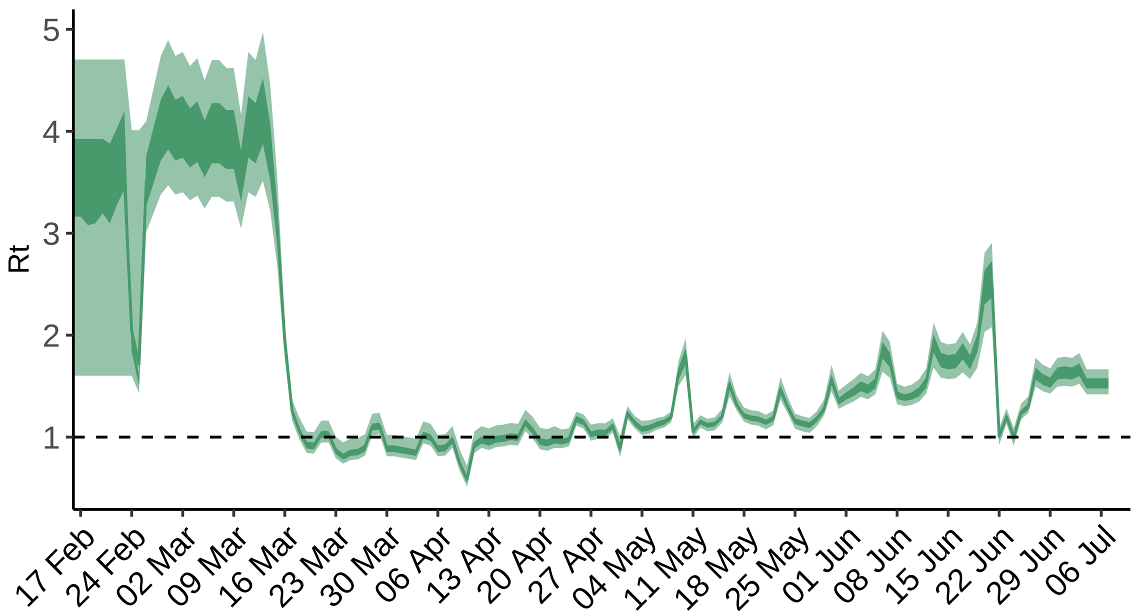

Figure 3: **Time-varying reproduction number, R_t.** R_t is the average number of secondary infections caused by a single infected person at time equal to t. $R_t < 1$ indicates a slowing epidemic in which new infections are not increasing. $R_t > 1$ indicates a growing epidemic in which new infections are increasing over time. Dark green shows the 50% CI and light green shows the 95% CI.

Using the model fit, we can forecast the expected trajectory for cumulative deaths, which is shown in the figure below. This assumes a severity pattern by age that is consistent with that observed in China, Europe and the U.S to date. This projection assumes that transmission is maintained at the current level of transmission as estimated by the final R_t value.

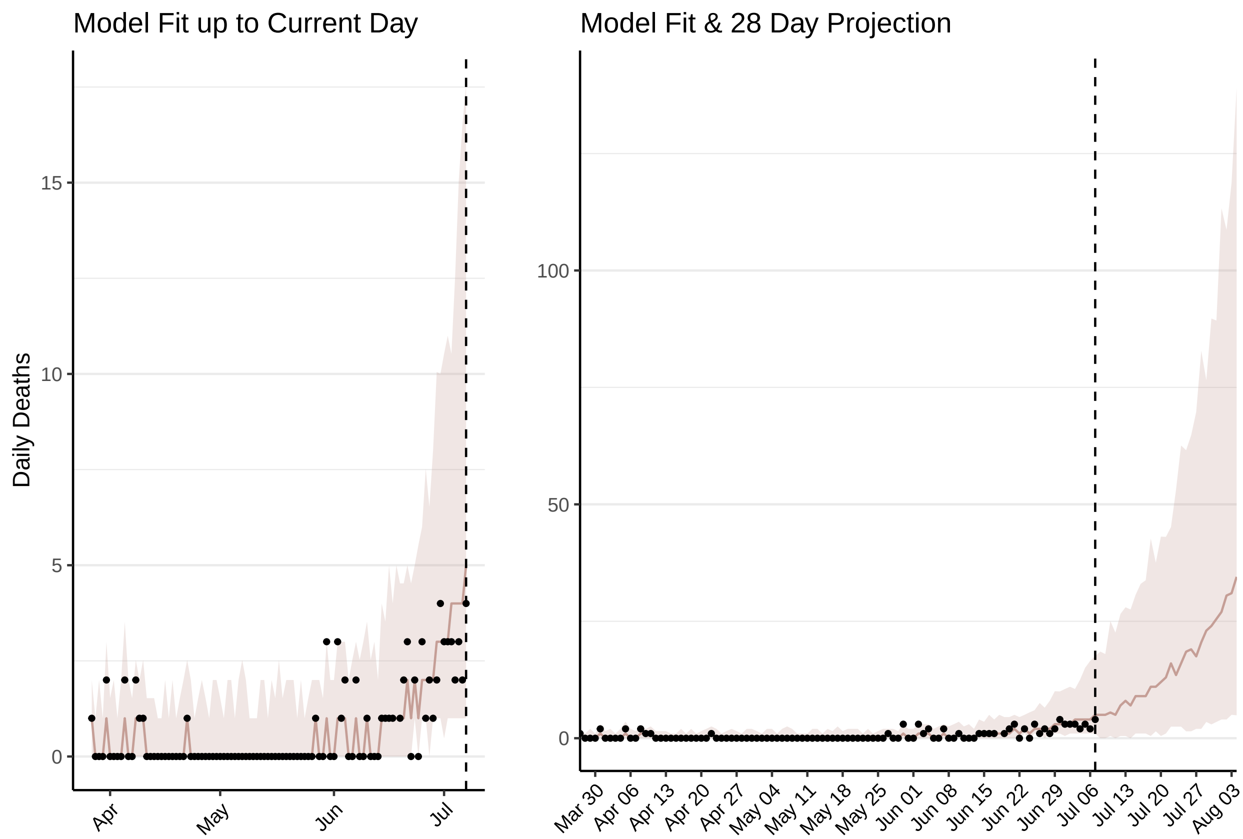

Figure 4: **Estimated daily deaths.** Projected deaths assuming the current level of interventions are maintained are shown in red (median and 95% quantile). Reported deaths are plotted in black. The plot on the left is focussed on the model fit prior to today, while the plot on the right forecasts the next 28 days.

Short-term Epidemic Scenarios

We make the following short-term projections of healthcare demand and new infections under the following three scenarios:

- **Scenario 1.** The epidemic continues to grow at the current rate.
- **Scenario 2.** Countries will further scale up interventions (either increasing current strategies or implementing new interventions) leading to a further 50% reduction in transmission.
- **Scenario 3.** Countries will relax current interventions by 50%

N.B. These scenarios currently assume that the impact of mobility on transmission will remain the same in the future as it has in the past. We are working to extend methods to estimate the impact of increases in mobility on transmission as lockdown and interventions are reversed. Consequently, projection are likely to represent an upper estimate of the healthcare demand and case load for each scenario

We estimate that over the next 4 weeks demand for hospital beds will change from 326 (95% CI: 282-371) patients requiring treatment with high-pressure oxygen at the current date to 2,334 (95% CI: 1,970-2,699) hospital beds being required on 2020-08-04 if no further interventions are introduced (Scenario 1). Similarly, we estimate that over the next 4 weeks demand for critical care (ICU) beds will change from 95 (95% CI: 81-108) patients requiring treatment with mechanical ventilation at the current date to 677 (95% CI: 576-778) by 2020-08-04. These projections assume that approximately 5% of all infections will require treatment with high-pressure oxygen and that approximately 30% of hospitalised cases will require treatment with mechanical ventilation (based on analysis of ongoing epidemics in Europe). **N.B. These scenarios are unlikely to show significant differences for the first week since there is a delay of approximately 10 days between infection and hospital admission. Consequently, the effectiveness of a change in policy is likely to be better captured by hospital admission data approximately 2 weeks after the policy change is implemented.**

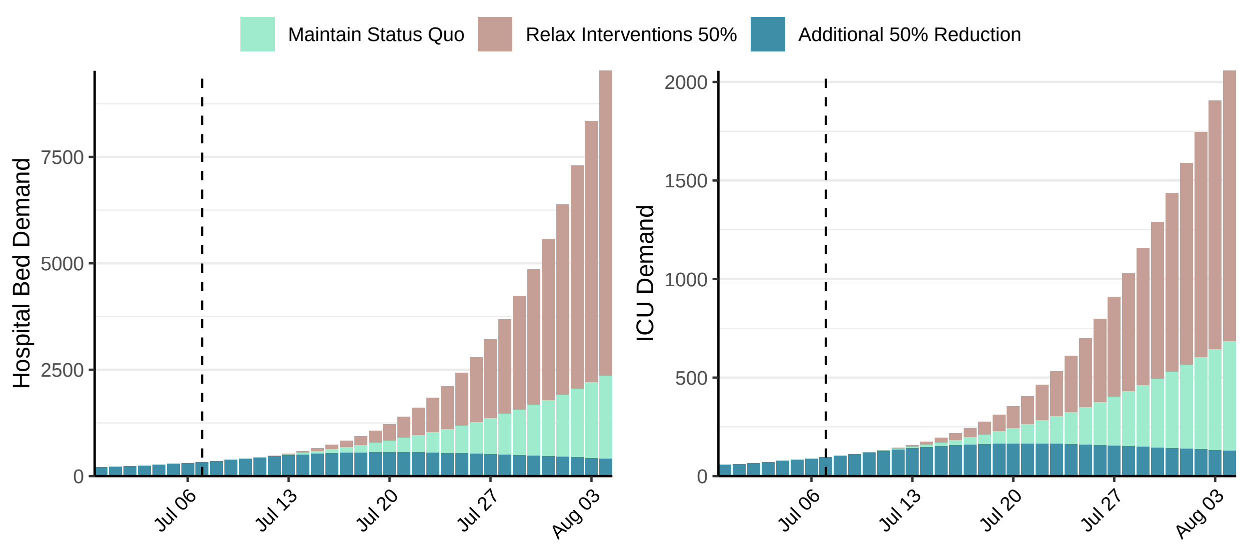

Figure 5: **Healthcare demands in the next 28 days.** Individuals needing an ICU bed are assumed to need mechanical ventilation. Projected demand for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

The impact of each scenario has a more immediate effect on the daily number of infections. The figure below shows the impact of each scenario on the estimated daily incidence of new infections. If interventions are scaled up (Scenario 2), the daily number of infections will change from 4,510 (95% CI: 3,867-5,153) at the current date to 1,822 (95% CI: 1,532-2,111) by 2020-08-04. If current interventions were relaxed by 50%, we estimate the daily number of infections will change from 4,510 (95% CI: 3,867-5,153) at the current date to 190,722 (95% CI: 165,381-216,064) by 2020-08-04.

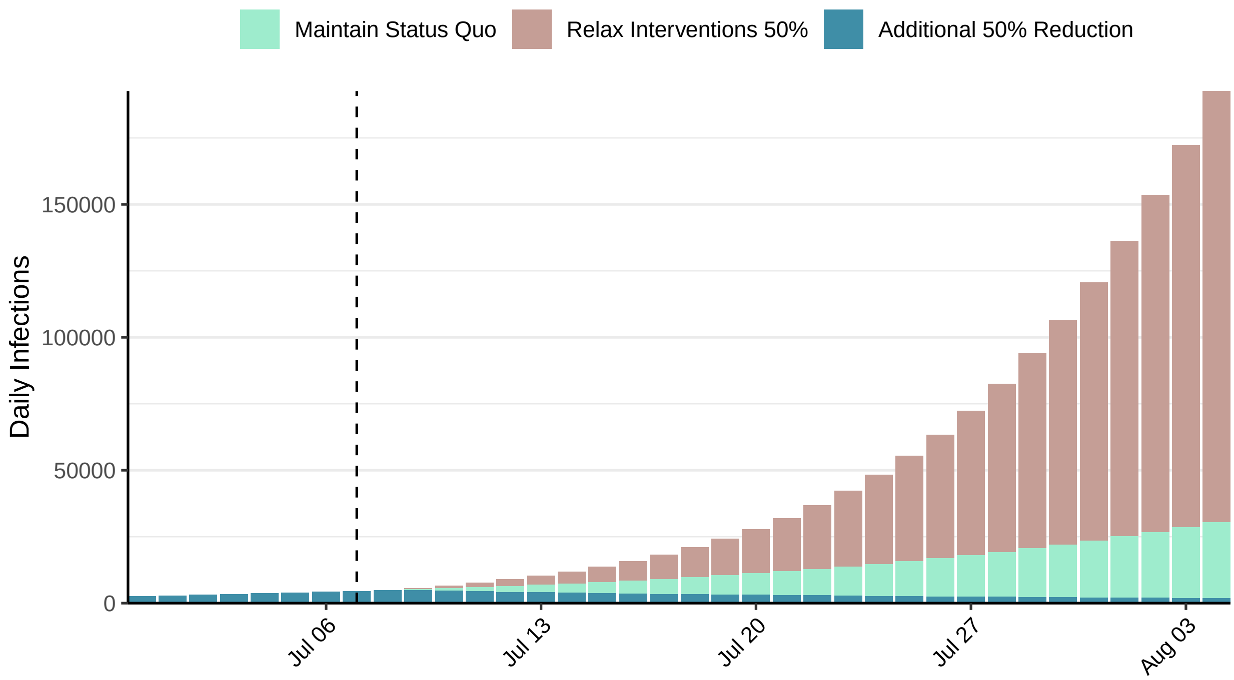

Figure 6: **Daily number of infections estimated by fitting to deaths.** Projected infections for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

To explore different scenarios, we recommend using our COVID-19 Scenario Analysis Tool - https://covidsim.org/, which can be used to simulate different intervention scenarios and explore the long term impact on healthcare demand.

Situation Report for COVID-19: Yemen, 2020-07-07

Download the report for Yemen, 2020-07-07 here. This report uses data from the European Centre for Disease Control. These data are updated daily and whilst there may be a short delay, they are generally consistent with Ministry reports. These data are then used to back-calculate an 'inferred number of COVID-19 infections' using mathematical modelling techniques (see Report 12 for further details) to estimate the number of people that have been infected and to make short-term projections for future healthcare needs.

Epidemiological Situation

Total Reported Cases	New Reported Cases	Total Reported Deaths	New Reported Deaths	Estimated R_t
1,290	25	345	7	1.27 (95% CI: 1.16-1.44)

The figure below shows the cumulative reported deaths as a function of the time since the 10th death was reported. Dashed lines show the expected trajectory for different doubling times of the epidemic. For example, with a doubling time of 3 days, if there are currently a total of 20 deaths reported, we would expect there to be 40 deaths in total reported in 3 days-time, 80 deaths in 6 days-time, 160 deaths in 9 days-time etc. For most epidemics, in the absence of interventions, we expect a doubling time of 3-4 days for this disease.

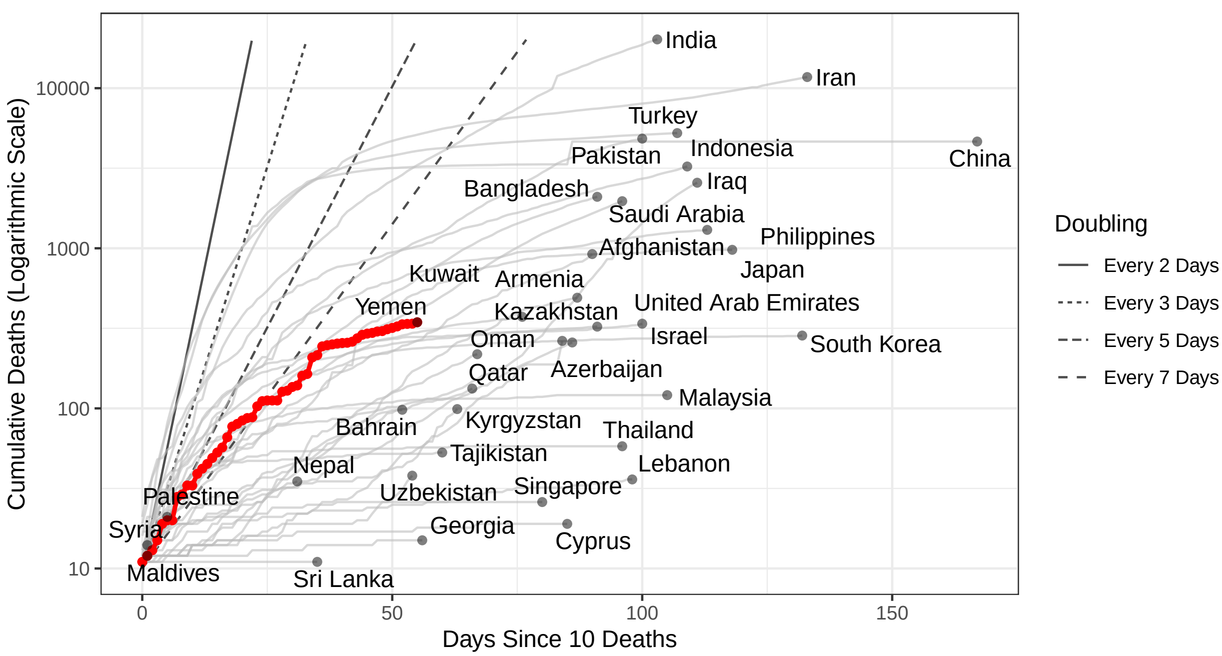

Figure 1: **Cumulative Deaths since 10 deaths.** Country not shown if fewer than 10 deaths.

COVID-19 Transmission Modelling

We assume that the deaths reported to date provide the best indication of the stage of the epidemic, as deaths are more consistently and accurately reported. Our current working estimate is that 1 death indicates that approximately 100 people will have been infected with the other 99 recovering (based on an infection fatality ratio of ~1%). These infections will have happened approximately 21 days previously – capturing a 5-day period from infection to onset of symptoms (the incubation period), 4 days from onset of symptoms to hospitalisation, and 12 days in hospital before death. With a 3-day doubling time, 100 infections that occurred 15 days ago will have generated 200 infections 12 days ago, 400 infections 9 days ago, 800 infections 6 days ago and 1,600 infections 3 days ago resulting in approximately 3,200 infections at the time the first death is observed.

To explore this, we fit our age-structured SEIR model (see Methods) to the time series of deaths in a country, in order to estimate the start date of the epidemic and the baseline R0. We assume that 100% of COVID-19 related deaths have been reported. We have also included the impact of interventions that have been put in place and their effect on human mobility and transmission based on the Google COVID-19 Community Mobility Reports. Using our mathematical model that formalises this approach, we estimate that there has been a total of 141,483 (95% CI: 129,577-153,389) infections over the past 4 weeks.

The figure below shows the estimated number of people infected over the past 4 weeks. The bar charts show, for comparison, the number of reported cases. The right-hand plot shows these data on a different scale as the estimated infections are likely to be much larger than the reported cases. **Importantly**, the estimated infections includes both asymptomatic and mild cases that would not necessarily be identified through surveillance. Consequently, the estimated infections are likely to be significantly higher than the reported cases (see our FAQ for further explanation of these differences and why the reported cases and estimated infections are unlikely to match).

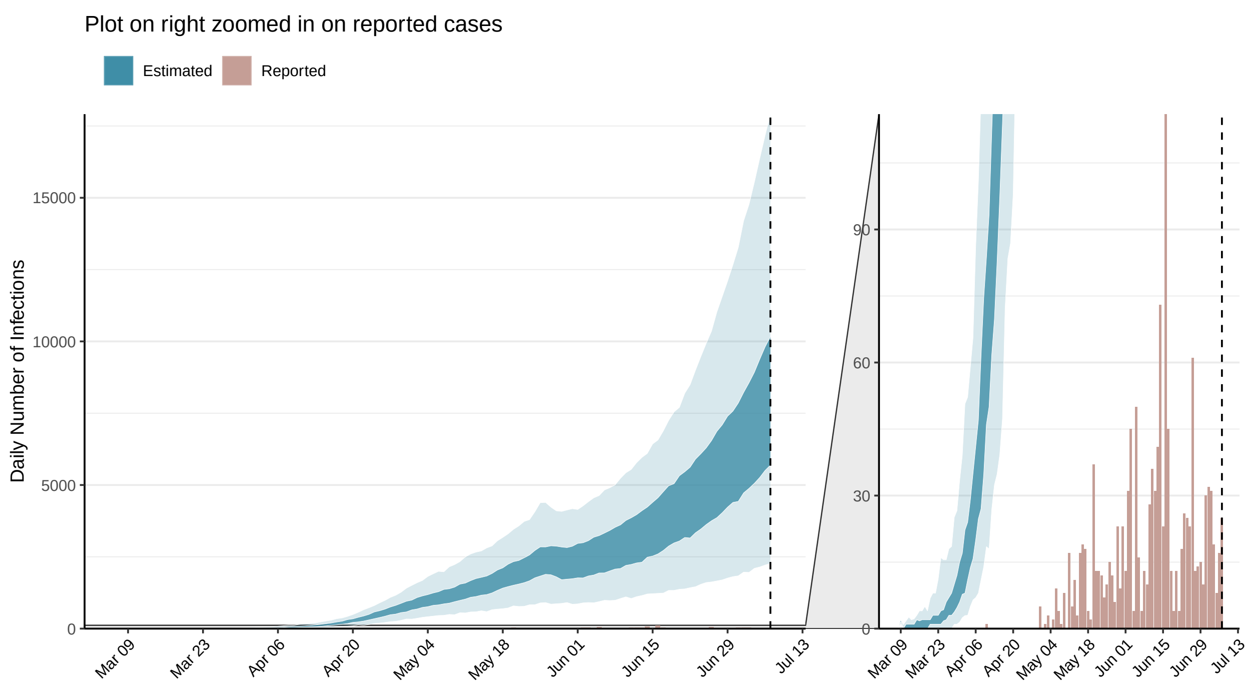

Figure 2: **Daily number of infections estimated by fitting to the current total of deaths.** Reported cases are shown in red. Model estimated infections are shown in blue (dark blue 50% interquartile range, light blue 95% quantile). The dashed line shows the current day.

By fitting to the time series of deaths, we are able to estimate a time-varying reproduction number, R_t. R_t is the the average number of secondary infections caused by a single infected person at a given time. If R_t is above 1, the rate of transmission is increasing and the number of new infections is increasing. R_t is assumed to change in relation to mobility fall in proportion. When fitting our model we assume that 100% of COVID-19 related deaths have been reported (please see our FAQ section for more information about this assumption). We also assume a fixed date at which the impact of mobility on transmission changes from pre-lockdown levels to post-lockdown levels, which may cause large changes in Rt. We are working to refine how this switch occurs and to formally calculate its shape.

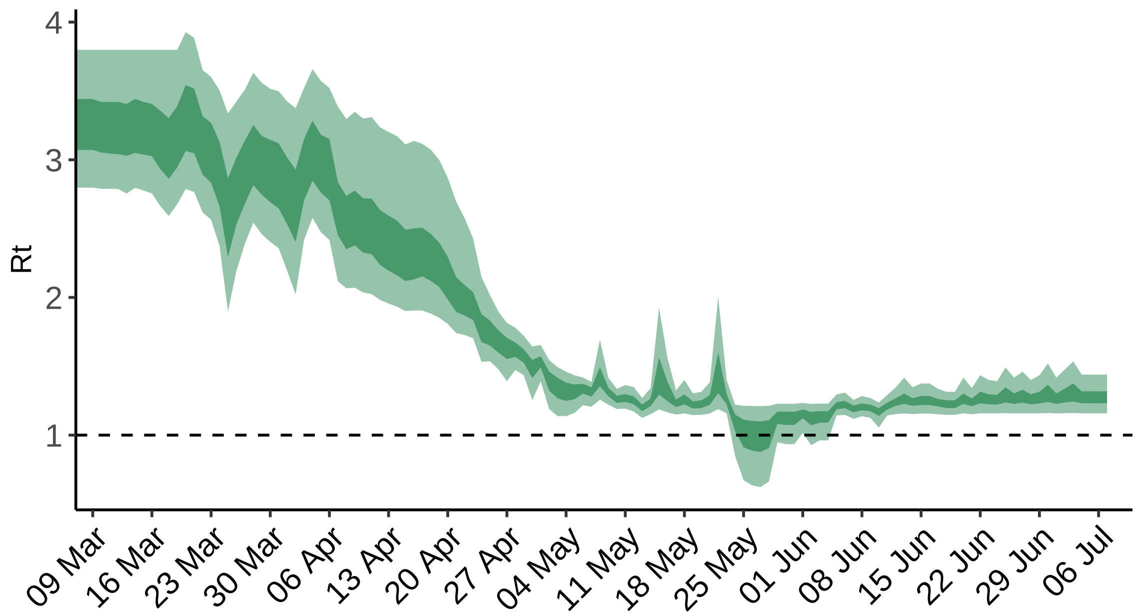

Figure 3: **Time-varying reproduction number, R_t.** R_t is the average number of secondary infections caused by a single infected person at time equal to t. $R_t < 1$ indicates a slowing epidemic in which new infections are not increasing. $R_t > 1$ indicates a growing epidemic in which new infections are increasing over time. Dark green shows the 50% CI and light green shows the 95% CI.

Using the model fit, we can forecast the expected trajectory for cumulative deaths, which is shown in the figure below. This assumes a severity pattern by age that is consistent with that observed in China, Europe and the U.S to date. This projection assumes that transmission is maintained at the current level of transmission as estimated by the final R_t value.

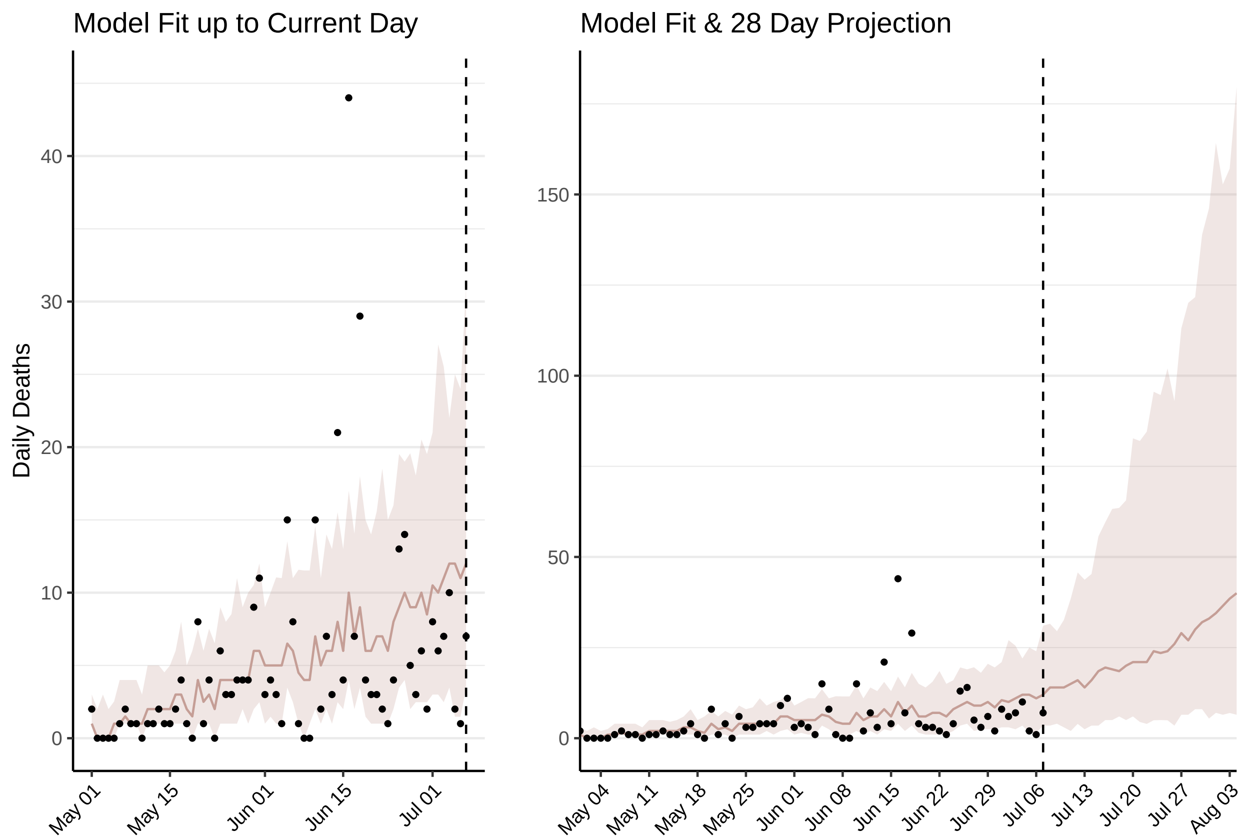

Figure 4: **Estimated daily deaths.** Projected deaths assuming the current level of interventions are maintained are shown in red (median and 95% quantile). Reported deaths are plotted in black. The plot on the left is focussed on the model fit prior to today, while the plot on the right forecasts the next 28 days.

Short-term Epidemic Scenarios

We make the following short-term projections of healthcare demand and new infections under the following three scenarios:

- **Scenario 1.** The epidemic continues to grow at the current rate.
- **Scenario 2.** Countries will further scale up interventions (either increasing current strategies or implementing new interventions) leading to a further 50% reduction in transmission.
- **Scenario 3.** Countries will relax current interventions by 50%

N.B. These scenarios currently assume that the impact of mobility on transmission will remain the same in the future as it has in the past. We are working to extend methods to estimate the impact of increases in mobility on transmission as lockdown and interventions are reversed. Consequently, projection are likely to represent an upper estimate of the healthcare demand and case load for each scenario

We estimate that over the next 4 weeks demand for hospital beds will change from 791 (95% CI: 724-858) patients requiring treatment with high-pressure oxygen at the current date to 2,334 (95% CI: 2,083-2,586) hospital beds being required on 2020-08-04 if no further interventions are introduced (Scenario 1). Similarly, we estimate that over the next 4 weeks demand for critical care (ICU) beds will change from 211 (95% CI: 193-230) patients requiring treatment with mechanical ventilation at the current date to 494 (95% CI: 461-527) by 2020-08-04. These projections assume that approximately 5% of all infections will require treatment with high-pressure oxygen and that approximately 30% of hospitalised cases will require treatment with mechanical ventilation (based on analysis of ongoing epidemics in Europe). **N.B. These scenarios are unlikely to show significant differences for the first week since there is a delay of approximately 10 days between infection and hospital admission. Consequently, the effectiveness of a change in policy is likely to be better captured by hospital admission data approximately 2 weeks after the policy change is implemented.**

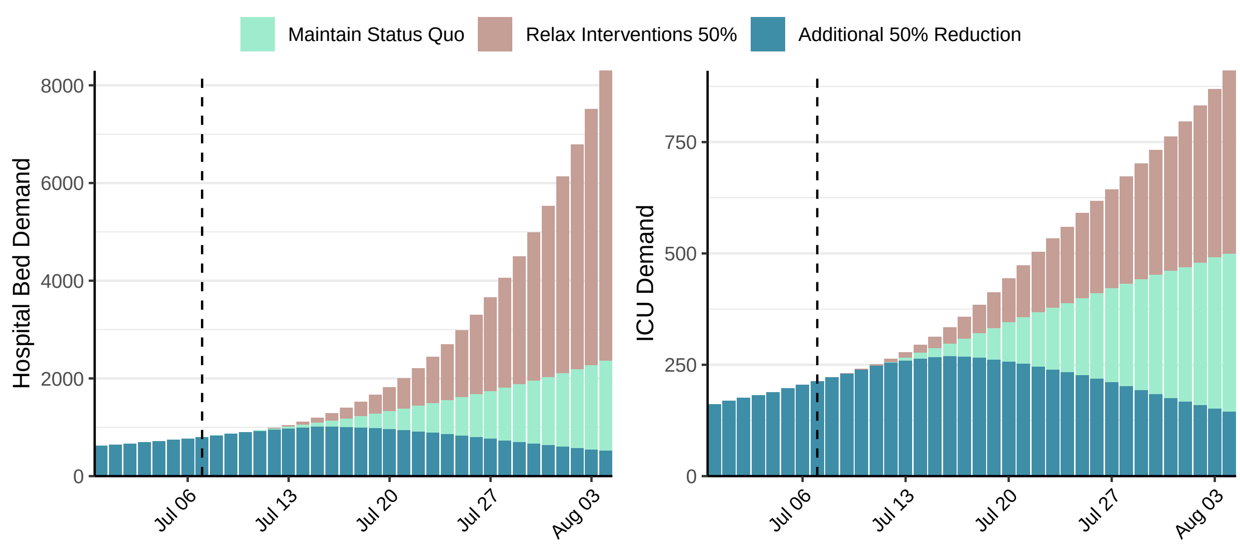

Figure 5: **Healthcare demands in the next 28 days.** Individuals needing an ICU bed are assumed to need mechanical ventilation. Projected demand for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

The impact of each scenario has a more immediate effect on the daily number of infections. The figure below shows the impact of each scenario on the estimated daily incidence of new infections. If interventions are scaled up (Scenario 2), the daily number of infections will change from 8,120 (95% CI: 7,379-8,861) at the current date to 1,661 (95% CI: 1,468-1,855) by 2020-08-04. If current interventions were relaxed by 50%, we estimate the daily number of infections will change from 8,120 (95% CI: 7,379-8,861) at the current date to 144,223 (95% CI: 127,446-161,000) by 2020-08-04.

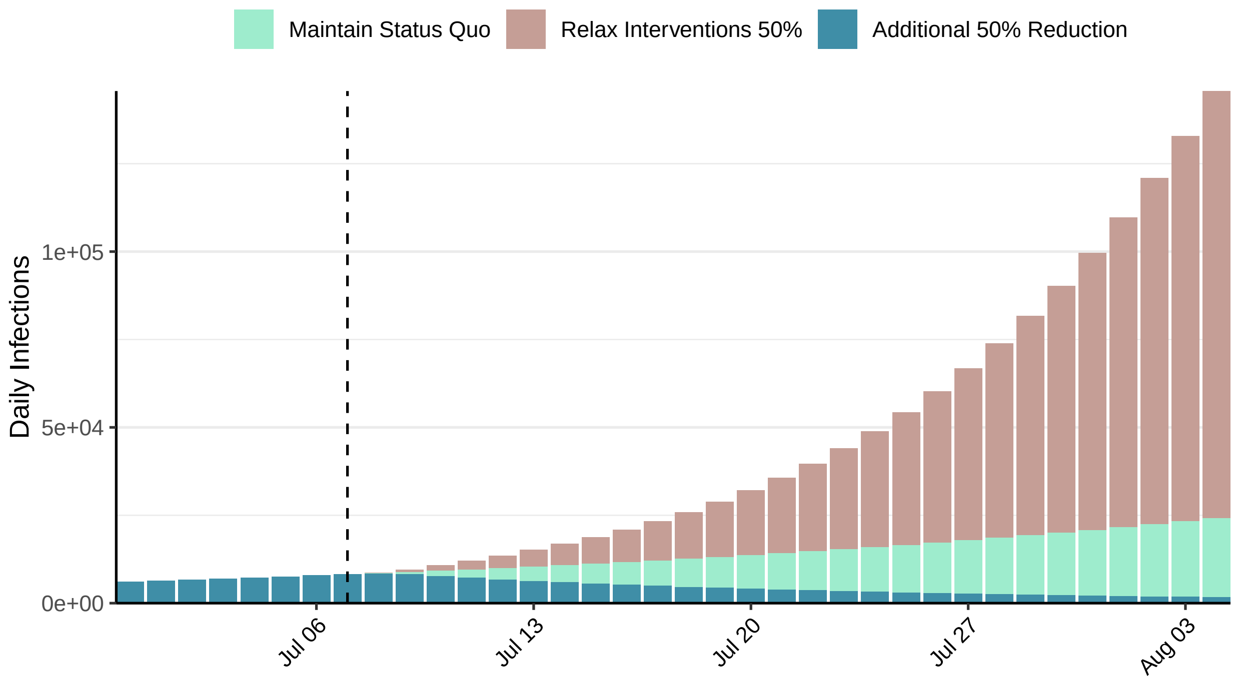

Figure 6: **Daily number of infections estimated by fitting to deaths.** Projected infections for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

To explore different scenarios, we recommend using our COVID-19 Scenario Analysis Tool - https://covidsim.org/, which can be used to simulate different intervention scenarios and explore the long term impact on healthcare demand.

Situation Report for COVID-19: South Africa, 2020-07-07

Download the report for South Africa, 2020-07-07 here. This report uses data from the European Centre for Disease Control. These data are updated daily and whilst there may be a short delay, they are generally consistent with Ministry reports. These data are then used to back-calculate an 'inferred number of COVID-19 infections' using mathematical modelling techniques (see Report 12 for further details) to estimate the number of people that have been infected and to make short-term projections for future healthcare needs.

Epidemiological Situation

Total Reported Cases	New Reported Cases	Total Reported Deaths	New Reported Deaths	Estimated R_t
196,750	0	3,199	0	1.23 (95% CI: 1.11-1.36)

The figure below shows the cumulative reported deaths as a function of the time since the 10th death was reported. Dashed lines show the expected trajectory for different doubling times of the epidemic. For example, with a doubling time of 3 days, if there are currently a total of 20 deaths reported, we would expect there to be 40 deaths in total reported in 3 days-time, 80 deaths in 6 days-time, 160 deaths in 9 days-time etc. For most epidemics, in the absence of interventions, we expect a doubling time of 3-4 days for this disease.

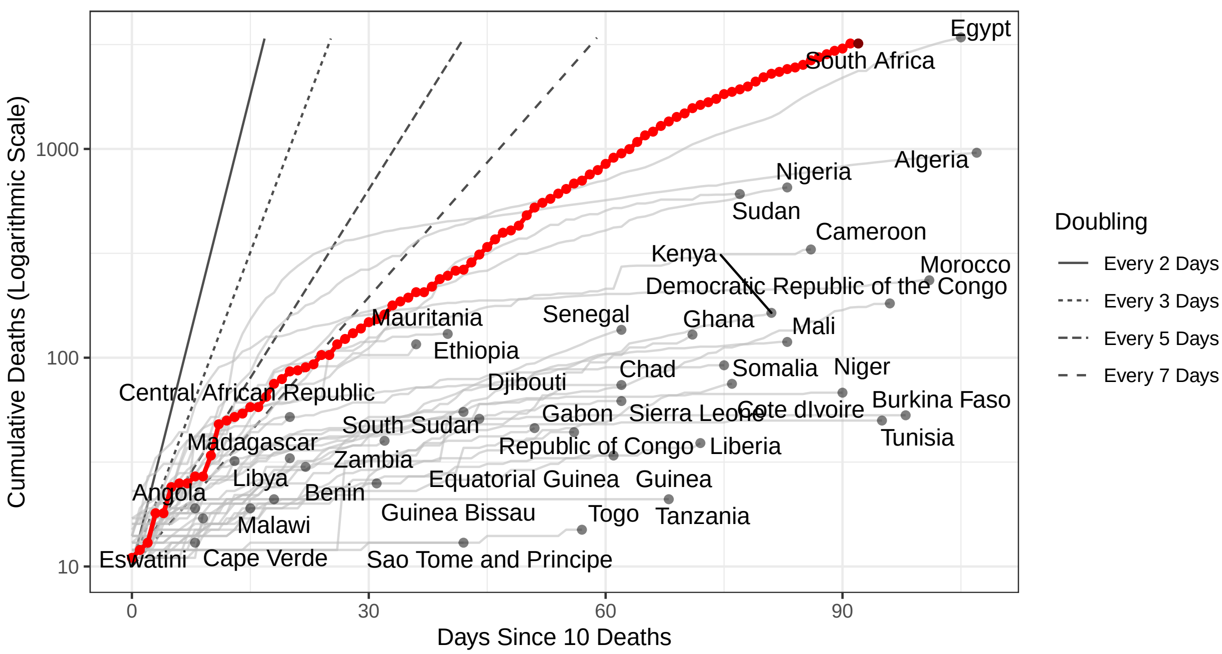

Figure 1: **Cumulative Deaths since 10 deaths.** Country not shown if fewer than 10 deaths.

COVID-19 Transmission Modelling

We assume that the deaths reported to date provide the best indication of the stage of the epidemic, as deaths are more consistently and accurately reported. Our current working estimate is that 1 death indicates that approximately 100 people will have been infected with the other 99 recovering (based on an infection fatality ratio of ~1%). These infections will have happened approximately 21 days previously – capturing a 5-day period from infection to onset of symptoms (the incubation period), 4 days from onset of symptoms to hospitalisation, and 12 days in hospital before death. With a 3-day doubling time, 100 infections that occurred 15 days ago will have generated 200 infections 12 days ago, 400 infections 9 days ago, 800 infections 6 days ago and 1,600 infections 3 days ago resulting in approximately 3,200 infections at the time the first death is observed.

To explore this, we fit our age-structured SEIR model (see Methods) to the time series of deaths in a country, in order to estimate the start date of the epidemic and the baseline R0. We assume that 100% of COVID-19 related deaths have been reported. We have also included the impact of interventions that have been put in place and their effect on human mobility and transmission based on the Google COVID-19 Community Mobility Reports. Using our mathematical model that formalises this approach, we estimate that there has been a total of 983,814 (95% CI: 912,089-1,055,539) infections over the past 4 weeks.

The figure below shows the estimated number of people infected over the past 4 weeks. The bar charts show, for comparison, the number of reported cases. The right-hand plot shows these data on a different scale as the estimated infections are likely to be much larger than the reported cases. **Importantly**, the estimated infections includes both asymptomatic and mild cases that would not necessarily be identified through surveillance. Consequently, the estimated infections are likely to be significantly higher than the reported cases (see our FAQ for further explanation of these differences and why the reported cases and estimated infections are unlikely to match).

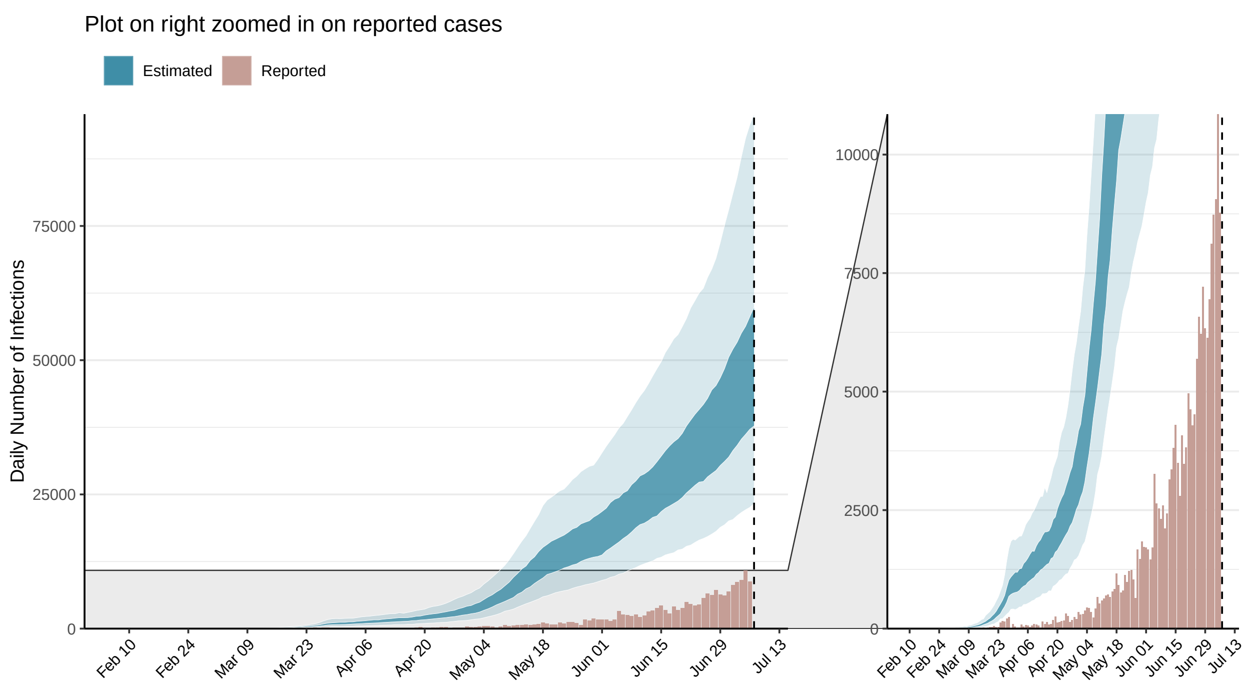

Figure 2: **Daily number of infections estimated by fitting to the current total of deaths.** Reported cases are shown in red. Model estimated infections are shown in blue (dark blue 50% interquartile range, light blue 95% quantile). The dashed line shows the current day.

By fitting to the time series of deaths, we are able to estimate a time-varying reproduction number, R_t. R_t is the the average number of secondary infections caused by a single infected person at a given time. If R_t is above 1, the rate of transmission is increasing and the number of new infections is increasing. R_t is assumed to change in relation to mobility fall in proportion. When fitting our model we assume that 100% of COVID-19 related deaths have been reported (please see our FAQ section for more information about this assumption). We also assume a fixed date at which the impact of mobility on transmission changes from pre-lockdown levels to post-lockdown levels, which may cause large changes in Rt. We are working to refine how this switch occurs and to formally calculate its shape.

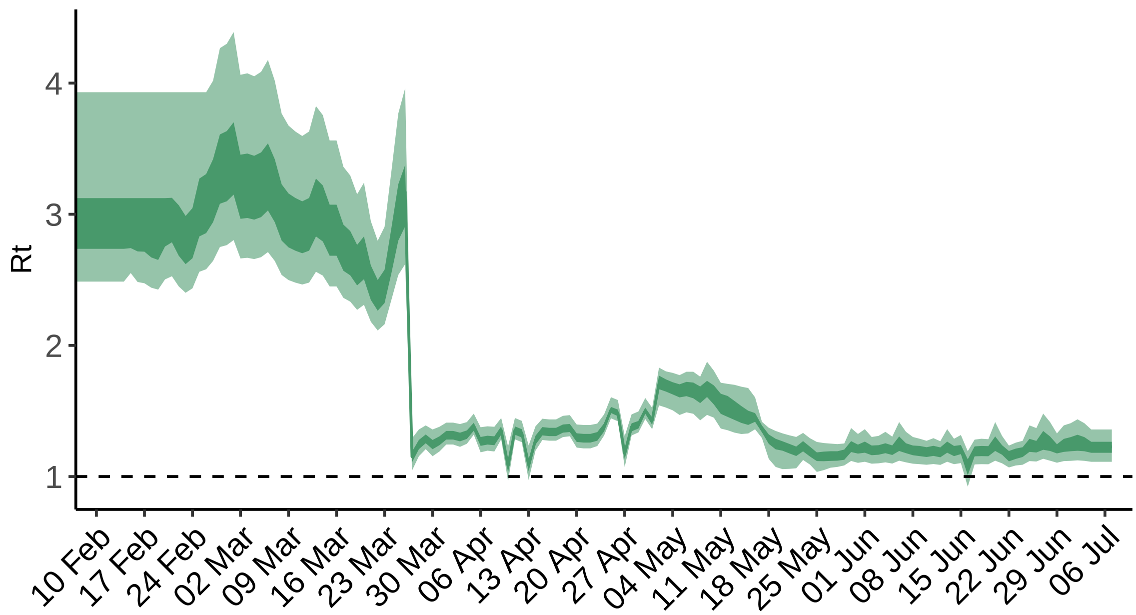

Figure 3: **Time-varying reproduction number, R_t.** R_t is the average number of secondary infections caused by a single infected person at time equal to t. $R_t < 1$ indicates a slowing epidemic in which new infections are not increasing. $R_t > 1$ indicates a growing epidemic in which new infections are increasing over time. Dark green shows the 50% CI and light green shows the 95% CI.

Using the model fit, we can forecast the expected trajectory for cumulative deaths, which is shown in the figure below. This assumes a severity pattern by age that is consistent with that observed in China, Europe and the U.S to date. This projection assumes that transmission is maintained at the current level of transmission as estimated by the final R_t value.

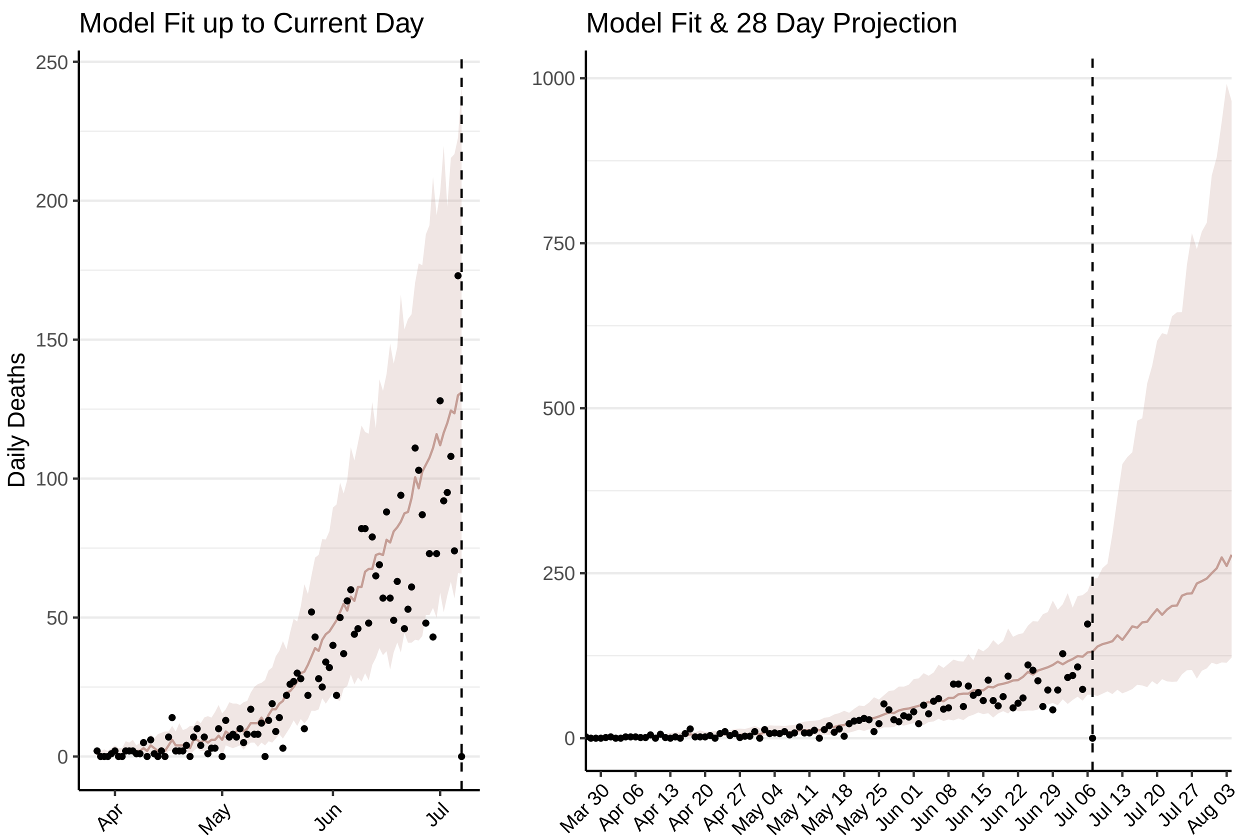

Figure 4: **Estimated daily deaths.** Projected deaths assuming the current level of interventions are maintained are shown in red (median and 95% quantile). Reported deaths are plotted in black. The plot on the left is focussed on the model fit prior to today, while the plot on the right forecasts the next 28 days.

Short-term Epidemic Scenarios

We make the following short-term projections of healthcare demand and new infections under the following three scenarios:

- **Scenario 1.** The epidemic continues to grow at the current rate.
- **Scenario 2.** Countries will further scale up interventions (either increasing current strategies or implementing new interventions) leading to a further 50% reduction in transmission.
- **Scenario 3.** Countries will relax current interventions by 50%

N.B. These scenarios currently assume that the impact of mobility on transmission will remain the same in the future as it has in the past. We are working to extend methods to estimate the impact of increases in mobility on transmission as lockdown and interventions are reversed. Consequently, projection are likely to represent an upper estimate of the healthcare demand and case load for each scenario

We estimate that over the next 4 weeks demand for hospital beds will change from 8,155 (95% CI: 7,553-8,757) patients requiring treatment with high-pressure oxygen at the current date to 17,537 (95% CI: 15,812-19,263) hospital beds being required on 2020-08-04 if no further interventions are introduced (Scenario 1). Similarly, we estimate that over the next 4 weeks demand for critical care (ICU) beds will change from 2,080 (95% CI: 1,935-2,225) patients requiring treatment with mechanical ventilation at the current date to 3,789 (95% CI: 3,582-3,996) by 2020-08-04. These projections assume that approximately 5% of all infections will require treatment with high-pressure oxygen and that approximately 30% of hospitalised cases will require treatment with mechanical ventilation (based on analysis of ongoing epidemics in Europe). **N.B. These scenarios are unlikely to show significant differences for the first week since there is a delay of approximately 10 days between infection and hospital admission. Consequently, the effectiveness of a change in policy is likely to be better captured by hospital admission data approximately 2 weeks after the policy change is implemented.**

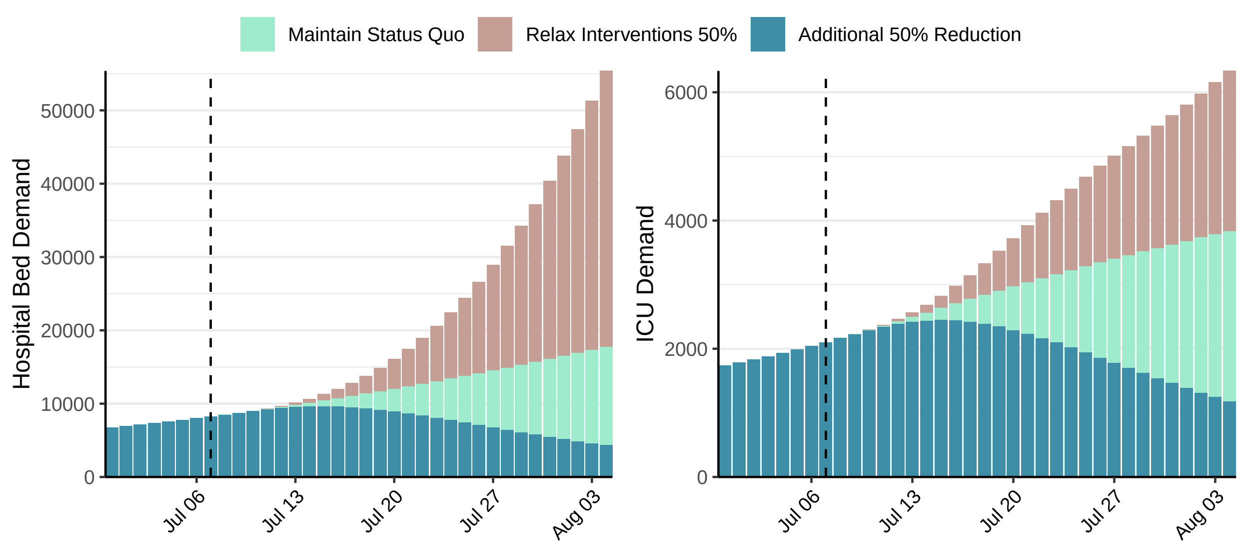

Figure 5: **Healthcare demands in the next 28 days.** Individuals needing an ICU bed are assumed to need mechanical ventilation. Projected demand for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

The impact of each scenario has a more immediate effect on the daily number of infections. The figure below shows the impact of each scenario on the estimated daily incidence of new infections. If interventions are scaled up (Scenario 2), the daily number of infections will change from 50,650 (95% CI: 46,381-54,918) at the current date to 8,100 (95% CI: 7,210-8,990) by 2020-08-04. If current interventions were relaxed by 50%, we estimate the daily number of infections will change from 50,650 (95% CI: 46,381-54,918) at the current date to 517,802 (95% CI: 473,653-561,952) by 2020-08-04.

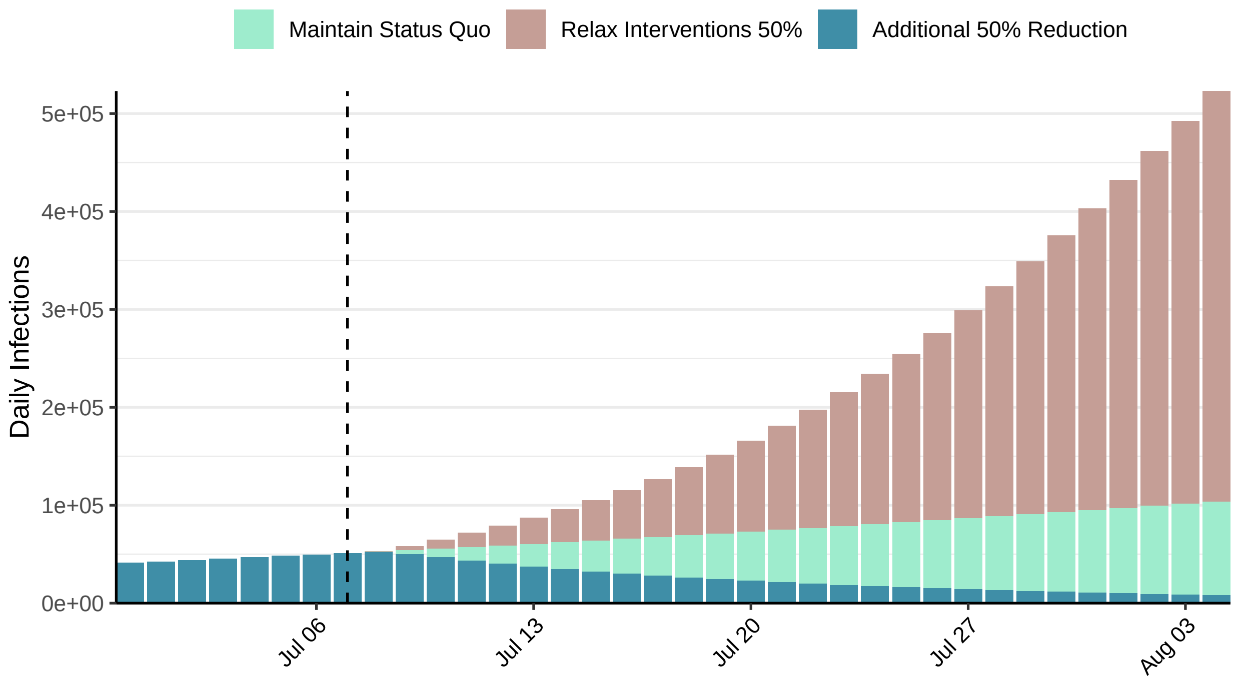

Figure 6: **Daily number of infections estimated by fitting to deaths.** Projected infections for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

To explore different scenarios, we recommend using our COVID-19 Scenario Analysis Tool - https://covidsim.org/, which can be used to simulate different intervention scenarios and explore the long term impact on healthcare demand.

Situation Report for COVID-19: Zambia, 2020-07-07

Download the report for Zambia, 2020-07-07 here. This report uses data from the European Centre for Disease Control. These data are updated daily and whilst there may be a short delay, they are generally consistent with Ministry reports. These data are then used to back-calculate an 'inferred number of COVID-19 infections' using mathematical modelling techniques (see Report 12 for further details) to estimate the number of people that have been infected and to make short-term projections for future healthcare needs.

Epidemiological Situation

Total Reported Cases	New Reported Cases	Total Reported Deaths	New Reported Deaths	Estimated R_t
1,632	0	30	0	1.55 (95% CI: 1.25-1.92)

The figure below shows the cumulative reported deaths as a function of the time since the 10th death was reported. Dashed lines show the expected trajectory for different doubling times of the epidemic. For example, with a doubling time of 3 days, if there are currently a total of 20 deaths reported, we would expect there to be 40 deaths in total reported in 3 days-time, 80 deaths in 6 days-time, 160 deaths in 9 days-time etc. For most epidemics, in the absence of interventions, we expect a doubling time of 3-4 days for this disease.

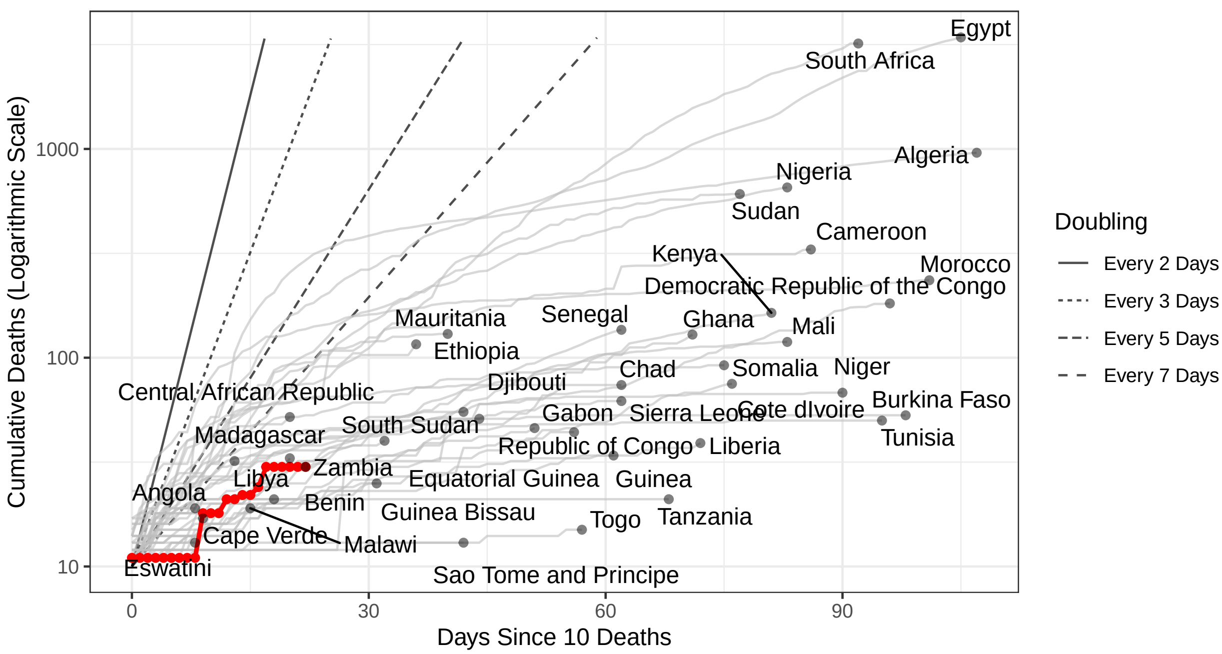

Figure 1: **Cumulative Deaths since 10 deaths.** Country not shown if fewer than 10 deaths.

COVID-19 Transmission Modelling

We assume that the deaths reported to date provide the best indication of the stage of the epidemic, as deaths are more consistently and accurately reported. Our current working estimate is that 1 death indicates that approximately 100 people will have been infected with the other 99 recovering (based on an infection fatality ratio of ~1%). These infections will have happened approximately 21 days previously – capturing a 5-day period from infection to onset of symptoms (the incubation period), 4 days from onset of symptoms to hospitalisation, and 12 days in hospital before death. With a 3-day doubling time, 100 infections that occurred 15 days ago will have generated 200 infections 12 days ago, 400 infections 9 days ago, 800 infections 6 days ago and 1,600 infections 3 days ago resulting in approximately 3,200 infections at the time the first death is observed.

To explore this, we fit our age-structured SEIR model (see Methods) to the time series of deaths in a country, in order to estimate the start date of the epidemic and the baseline R0. We assume that 100% of COVID-19 related deaths have been reported. We have also included the impact of interventions that have been put in place and their effect on human mobility and transmission based on the Google COVID-19 Community Mobility Reports. Using our mathematical model that formalises this approach, we estimate that there has been a total of 21,560 (95% CI: 17,922-25,197) infections over the past 4 weeks.

The figure below shows the estimated number of people infected over the past 4 weeks. The bar charts show, for comparison, the number of reported cases. The right-hand plot shows these data on a different scale as the estimated infections are likely to be much larger than the reported cases. **Importantly**, the estimated infections includes both asymptomatic and mild cases that would not necessarily be identified through surveillance. Consequently, the estimated infections are likely to be significantly higher than the reported cases (see our FAQ for further explanation of these differences and why the reported cases and estimated infections are unlikely to match).

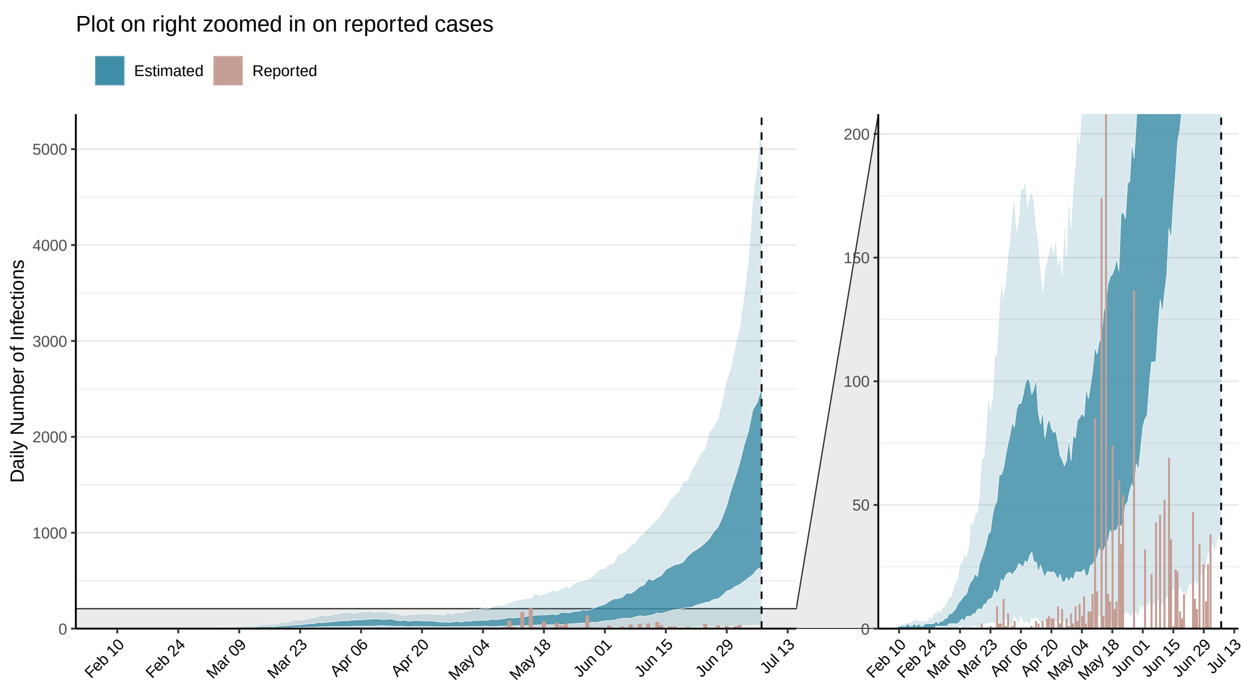

Figure 2: **Daily number of infections estimated by fitting to the current total of deaths.** Reported cases are shown in red. Model estimated infections are shown in blue (dark blue 50% interquartile range, light blue 95% quantile). The dashed line shows the current day.

By fitting to the time series of deaths, we are able to estimate a time-varying reproduction number, R_t. R_t is the the average number of secondary infections caused by a single infected person at a given time. If R_t is above 1, the rate of transmission is increasing and the number of new infections is increasing. R_t is assumed to change in relation to mobility fall in proportion. When fitting our model we assume that 100% of COVID-19 related deaths have been reported (please see our FAQ section for more information about this assumption). We also assume a fixed date at which the impact of mobility on transmission changes from pre-lockdown levels to post-lockdown levels, which may cause large changes in Rt. We are working to refine how this switch occurs and to formally calculate its shape.

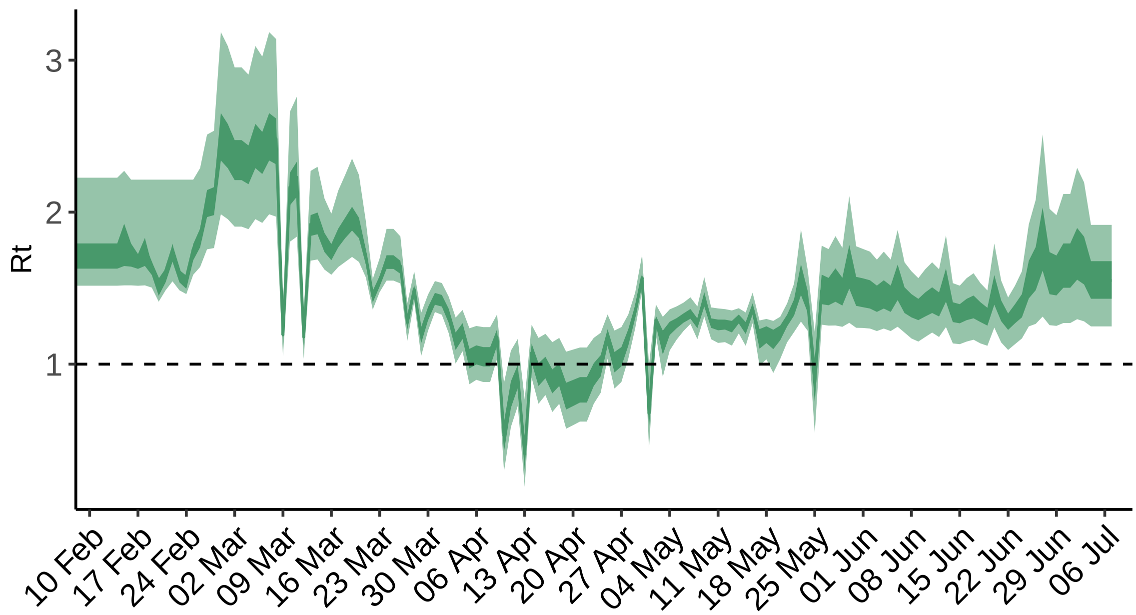

Figure 3: **Time-varying reproduction number, R_t.** R_t is the average number of secondary infections caused by a single infected person at time equal to t. $R_t < 1$ indicates a slowing epidemic in which new infections are not increasing. $R_t > 1$ indicates a growing epidemic in which new infections are increasing over time. Dark green shows the 50% CI and light green shows the 95% CI.

Using the model fit, we can forecast the expected trajectory for cumulative deaths, which is shown in the figure below. This assumes a severity pattern by age that is consistent with that observed in China, Europe and the U.S to date. This projection assumes that transmission is maintained at the current level of transmission as estimated by the final R_t value.

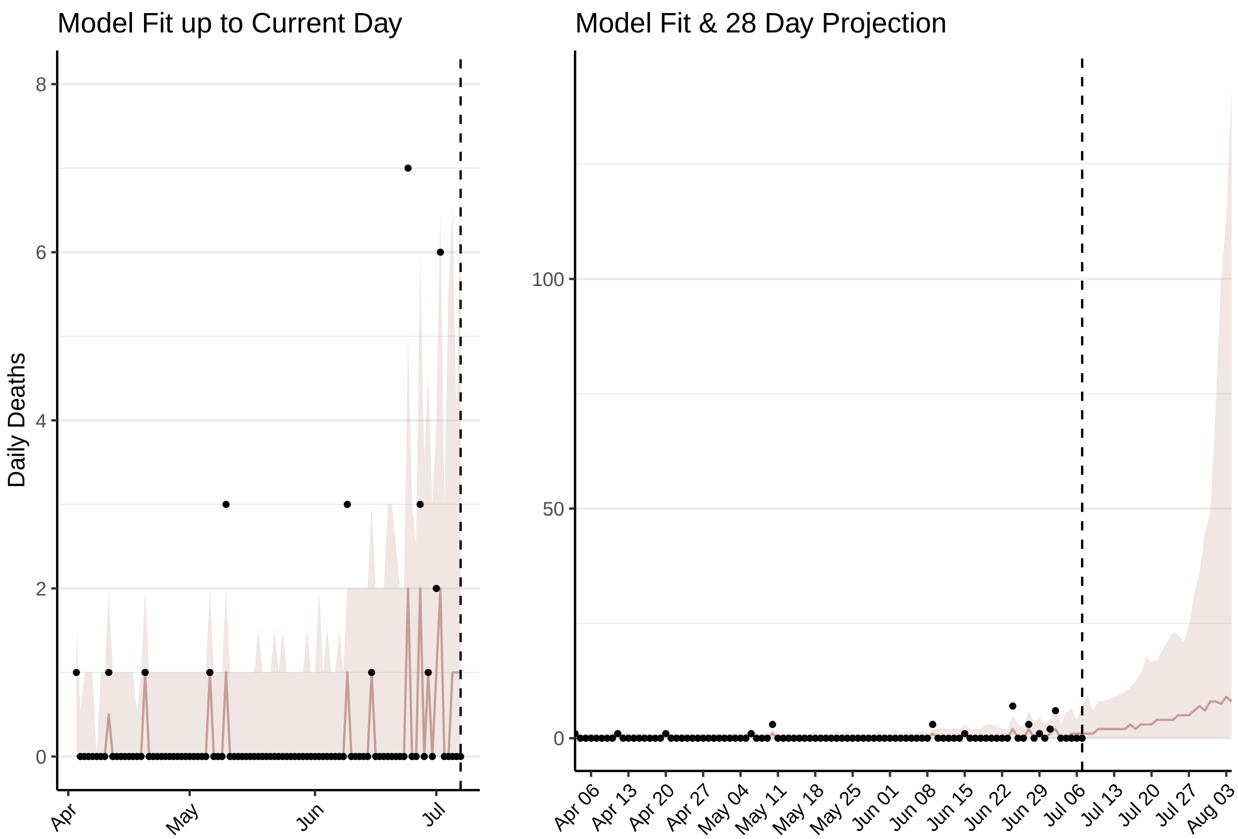

Figure 4: **Estimated daily deaths.** Projected deaths assuming the current level of interventions are maintained are shown in red (median and 95% quantile). Reported deaths are plotted in black. The plot on the left is focussed on the model fit prior to today, while the plot on the right forecasts the next 28 days.

Short-term Epidemic Scenarios

We make the following short-term projections of healthcare demand and new infections under the following three scenarios:

- **Scenario 1.** The epidemic continues to grow at the current rate.
- **Scenario 2.** Countries will further scale up interventions (either increasing current strategies or implementing new interventions) leading to a further 50% reduction in transmission.
- **Scenario 3.** Countries will relax current interventions by 50%

N.B. These scenarios currently assume that the impact of mobility on transmission will remain the same in the future as it has in the past. We are working to extend methods to estimate the impact of increases in mobility on transmission as lockdown and interventions are reversed. Consequently, projection are likely to represent an upper estimate of the healthcare demand and case load for each scenario

We estimate that over the next 4 weeks demand for hospital beds will change from 111 (95% CI: 91-130) patients requiring treatment with high-pressure oxygen at the current date to 993 (95% CI: 779-1,208) hospital beds being required on 2020-08-04 if no further interventions are introduced (Scenario 1). Similarly, we estimate that over the next 4 weeks demand for critical care (ICU) beds will change from 29 (95% CI: 24-34) patients requiring treatment with mechanical ventilation at the current date to 230 (95% CI: 186-274) by 2020-08-04. These projections assume that approximately 5% of all infections will require treatment with high-pressure oxygen and that approximately 30% of hospitalised cases will require treatment with mechanical ventilation (based on analysis of ongoing epidemics in Europe). **N.B. These scenarios are unlikely to show significant differences for the first week since there is a delay of approximately 10 days between infection and hospital admission. Consequently, the effectiveness of a change in policy is likely to be better captured by hospital admission data approximately 2 weeks after the policy change is implemented.**

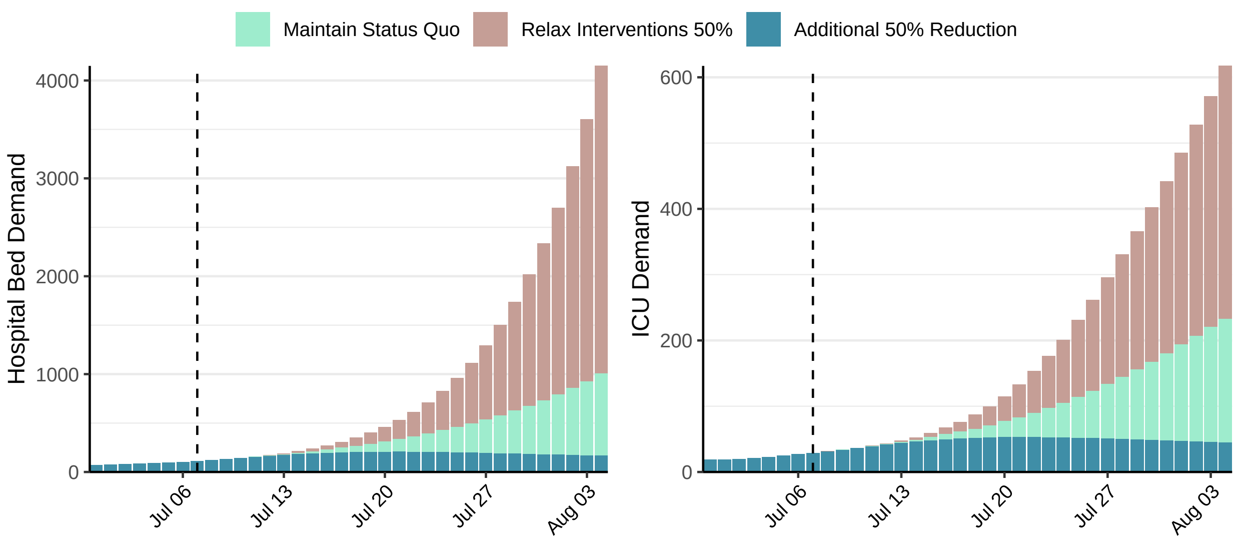

Figure 5: **Healthcare demands in the next 28 days.** Individuals needing an ICU bed are assumed to need mechanical ventilation. Projected demand for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

The impact of each scenario has a more immediate effect on the daily number of infections. The figure below shows the impact of each scenario on the estimated daily incidence of new infections. If interventions are scaled up (Scenario 2), the daily number of infections will change from 1,762 (95% CI: 1,448-2,075) at the current date to 863 (95% CI: 667-1,060) by 2020-08-04. If current interventions were relaxed by 50%, we estimate the daily number of infections will change from 1,762 (95% CI: 1,448-2,075) at the current date to 103,724 (95% CI: 80,662-126,786) by 2020-08-04.

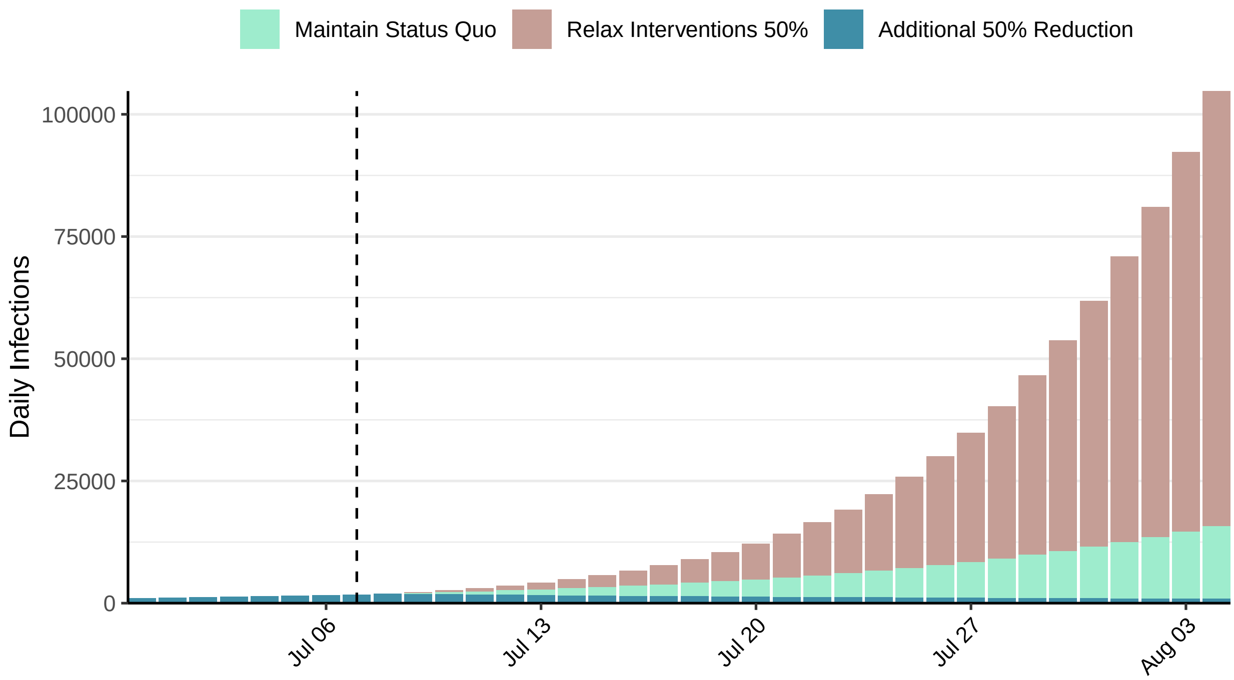

Figure 6: **Daily number of infections estimated by fitting to deaths.** Projected infections for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

To explore different scenarios, we recommend using our COVID-19 Scenario Analysis Tool - https://covidsim.org/, which can be used to simulate different intervention scenarios and explore the long term impact on healthcare demand.

Situation Report for COVID-19: Zimbabwe, 2020-07-07

Download the report for Zimbabwe, 2020-07-07 here. This report uses data from the European Centre for Disease Control. These data are updated daily and whilst there may be a short delay, they are generally consistent with Ministry reports. These data are then used to back-calculate an 'inferred number of COVID-19 infections' using mathematical modelling techniques (see Report 12 for further details) to estimate the number of people that have been infected and to make short-term projections for future healthcare needs.

Epidemiological Situation

Total Reported Cases	New Reported Cases	Total Reported Deaths	New Reported Deaths	Estimated R_t
734	18	9	1	1.88 (95% CI: 1.4-2.52)

The figure below shows the cumulative reported deaths as a function of the time since the 10th death was reported. Dashed lines show the expected trajectory for different doubling times of the epidemic. For example, with a doubling time of 3 days, if there are currently a total of 20 deaths reported, we would expect there to be 40 deaths in total reported in 3 days-time, 80 deaths in 6 days-time, 160 deaths in 9 days-time etc. For most epidemics, in the absence of interventions, we expect a doubling time of 3-4 days for this disease. **N.B. Zimbabwe is not shown in the following plot as only 9 deaths have been reported to date**

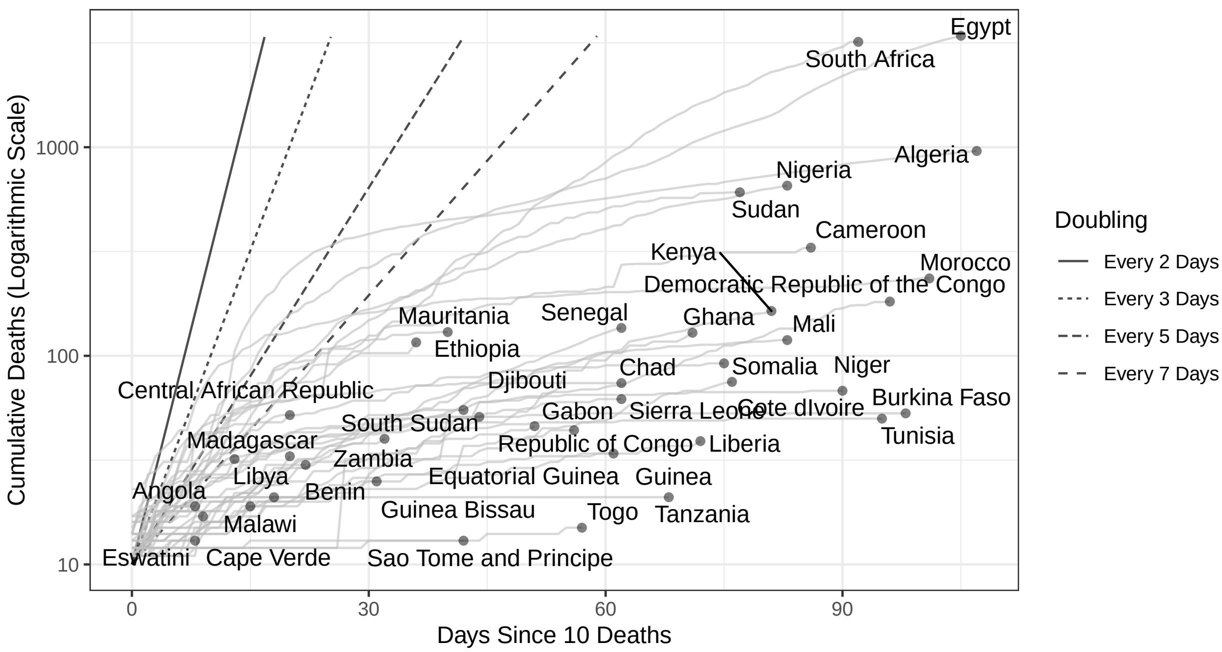

Figure 1: **Cumulative Deaths since 10 deaths.** Country not shown if fewer than 10 deaths.

COVID-19 Transmission Modelling

We assume that the deaths reported to date provide the best indication of the stage of the epidemic, as deaths are more consistently and accurately reported. Our current working estimate is that 1 death indicates that approximately 100 people will have been infected with the other 99 recovering (based on an infection fatality ratio of ~1%). These infections will have happened approximately 21 days previously – capturing a 5-day period from infection to onset of symptoms (the incubation period), 4 days from onset of symptoms to hospitalisation, and 12 days in hospital before death. With a 3-day doubling time, 100 infections that occurred 15 days ago will have generated 200 infections 12 days ago, 400 infections 9 days ago, 800 infections 6 days ago and 1,600 infections 3 days ago resulting in approximately 3,200 infections at the time the first death is observed.

To explore this, we fit our age-structured SEIR model (see Methods) to the time series of deaths in a country, in order to estimate the start date of the epidemic and the baseline R0. We assume that 100% of COVID-19 related deaths have been reported. We have also included the impact of interventions that have been put in place and their effect on human mobility and transmission based on the Google COVID-19 Community Mobility Reports. Using our mathematical model that formalises this approach, we estimate that there has been a total of 4,660 (95% CI: 3,843-5,478) infections over the past 4 weeks.

The figure below shows the estimated number of people infected over the past 4 weeks. The bar charts show, for comparison, the number of reported cases. The right-hand plot shows these data on a different scale as the estimated infections are likely to be much larger than the reported cases. **Importantly**, the estimated infections includes both asymptomatic and mild cases that would not necessarily be identified through surveillance. Consequently, the estimated infections are likely to be significantly higher than the reported cases (see our FAQ for further explanation of these differences and why the reported cases and estimated infections are unlikely to match).

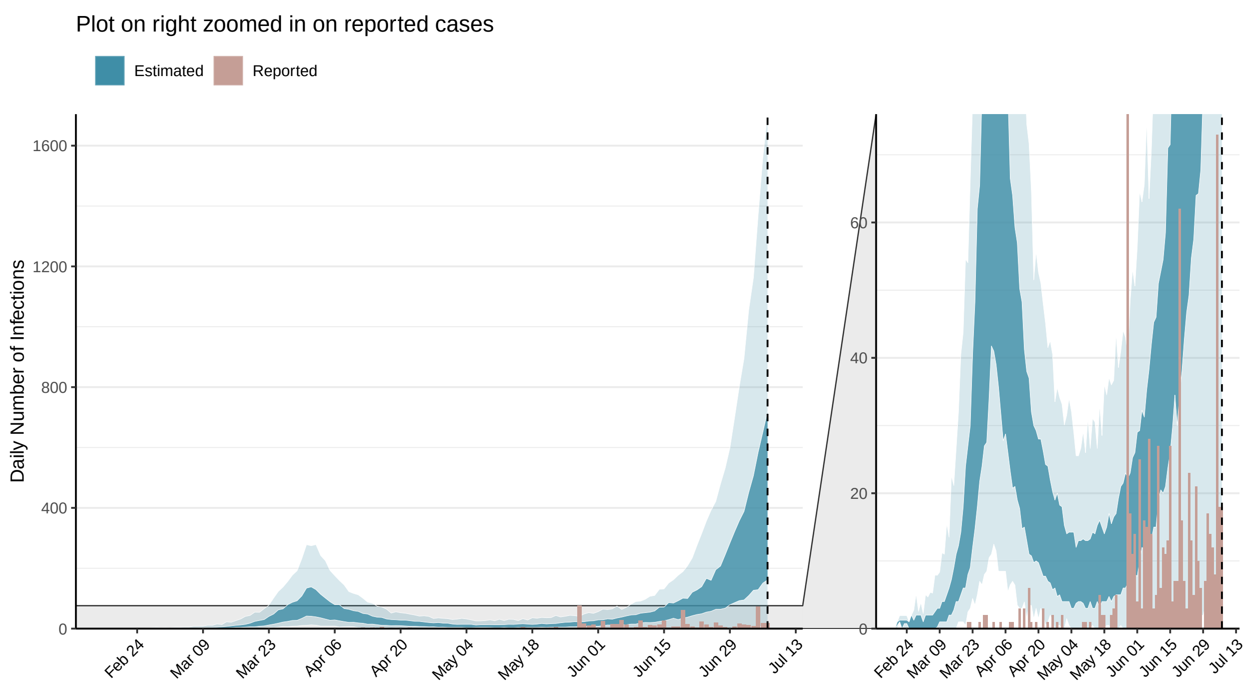

Figure 2: **Daily number of infections estimated by fitting to the current total of deaths.** Reported cases are shown in red. Model estimated infections are shown in blue (dark blue 50% interquartile range, light blue 95% quantile). The dashed line shows the current day.

By fitting to the time series of deaths, we are able to estimate a time-varying reproduction number, R_t. R_t is the the average number of secondary infections caused by a single infected person at a given time. If R_t is above 1, the rate of transmission is increasing and the number of new infections is increasing. R_t is assumed to change in relation to mobility fall in proportion. When fitting our model we assume that 100% of COVID-19 related deaths have been reported (please see our FAQ section for more information about this assumption). We also assume a fixed date at which the impact of mobility on transmission changes from pre-lockdown levels to post-lockdown levels, which may cause large changes in Rt. We are working to refine how this switch occurs and to formally calculate its shape.

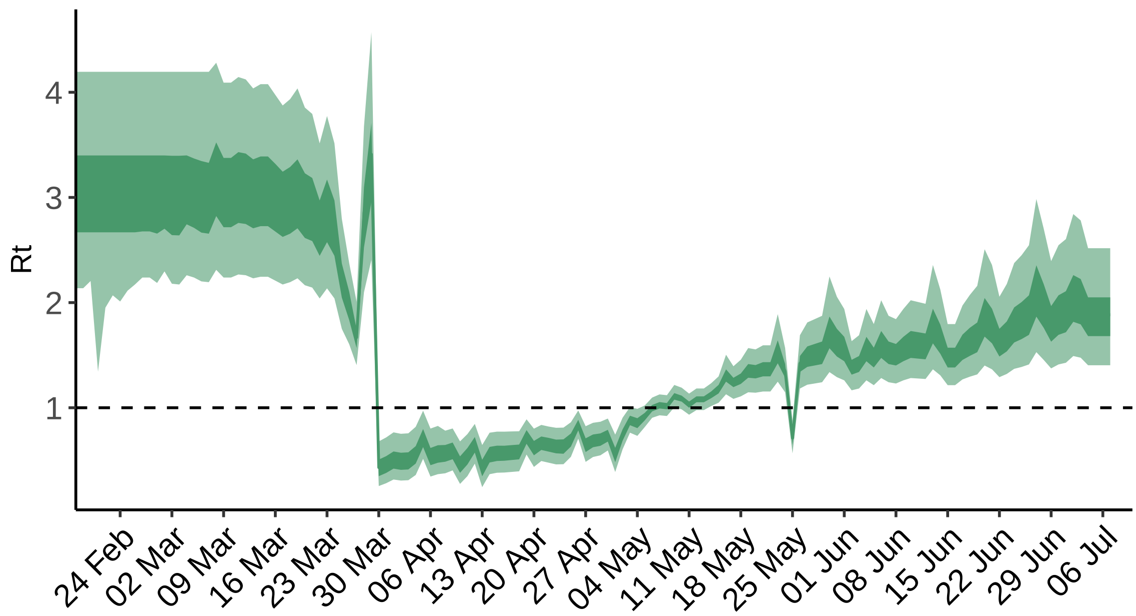

Figure 3: **Time-varying reproduction number, R_t.** R_t is the average number of secondary infections caused by a single infected person at time equal to t. $R_t < 1$ indicates a slowing epidemic in which new infections are not increasing. $R_t > 1$ indicates a growing epidemic in which new infections are increasing over time. Dark green shows the 50% CI and light green shows the 95% CI.

Using the model fit, we can forecast the expected trajectory for cumulative deaths, which is shown in the figure below. This assumes a severity pattern by age that is consistent with that observed in China, Europe and the U.S to date. This projection assumes that transmission is maintained at the current level of transmission as estimated by the final R_t value.

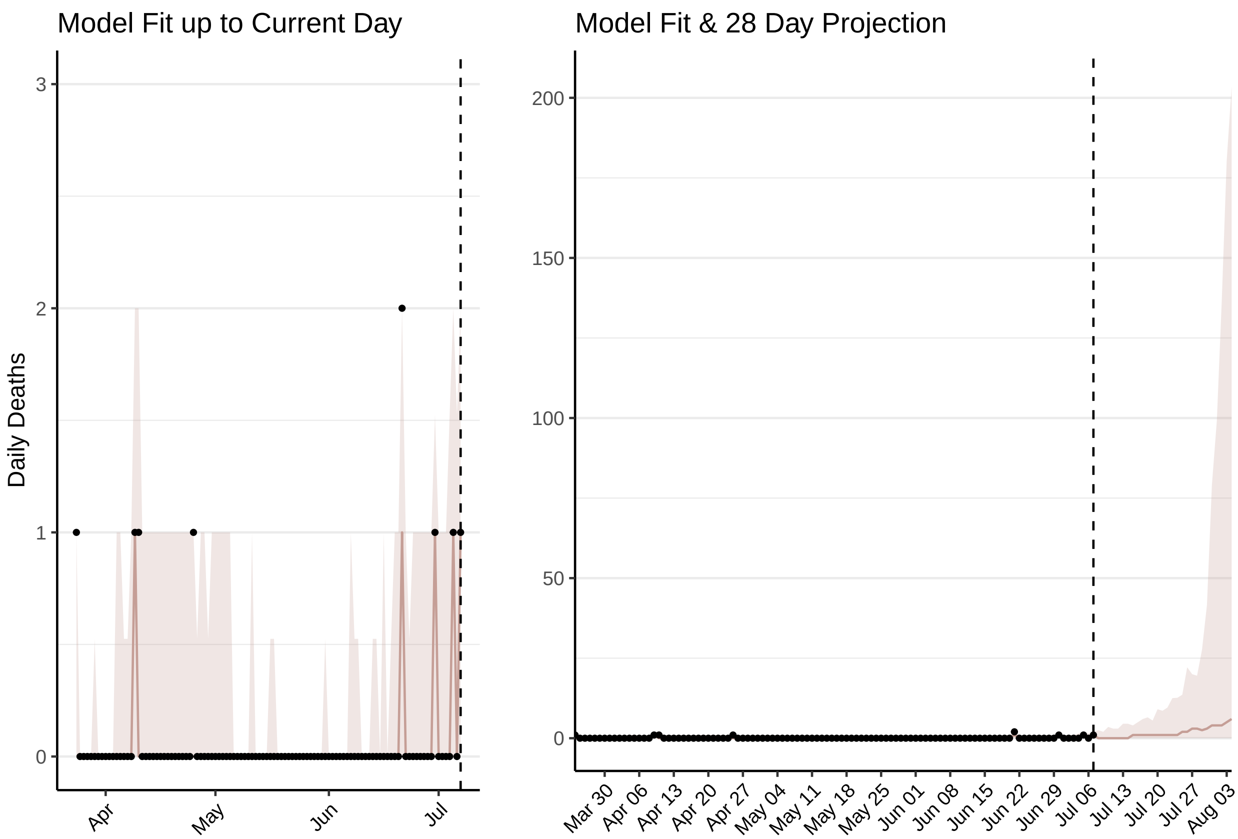

Figure 4: **Estimated daily deaths.** Projected deaths assuming the current level of interventions are maintained are shown in red (median and 95% quantile). Reported deaths are plotted in black. The plot on the left is focussed on the model fit prior to today, while the plot on the right forecasts the next 28 days.

Short-term Epidemic Scenarios

We make the following short-term projections of healthcare demand and new infections under the following three scenarios:

- **Scenario 1.** The epidemic continues to grow at the current rate.
- **Scenario 2.** Countries will further scale up interventions (either increasing current strategies or implementing new interventions) leading to a further 50% reduction in transmission.
- **Scenario 3.** Countries will relax current interventions by 50%

N.B. These scenarios currently assume that the impact of mobility on transmission will remain the same in the future as it has in the past. We are working to extend methods to estimate the impact of increases in mobility on transmission as lockdown and interventions are reversed. Consequently, projection are likely to represent an upper estimate of the healthcare demand and case load for each scenario

We estimate that over the next 4 weeks demand for hospital beds will change from 25 (95% CI: 21-30) patients requiring treatment with high-pressure oxygen at the current date to 842 (95% CI: 537-1,147) hospital beds being required on 2020-08-04 if no further interventions are introduced (Scenario 1). Similarly, we estimate that over the next 4 weeks demand for critical care (ICU) beds will change from 7 (95% CI: 5-8) patients requiring treatment with mechanical ventilation at the current date to 181 (95% CI: 135-227) by 2020-08-04. These projections assume that approximately 5% of all infections will require treatment with high-pressure oxygen and that approximately 30% of hospitalised cases will require treatment with mechanical ventilation (based on analysis of ongoing epidemics in Europe). **N.B. These scenarios are unlikely to show significant differences for the first week since there is a delay of approximately 10 days between infection and hospital admission. Consequently, the effectiveness of a change in policy is likely to be better captured by hospital admission data approximately 2 weeks after the policy change is implemented.**

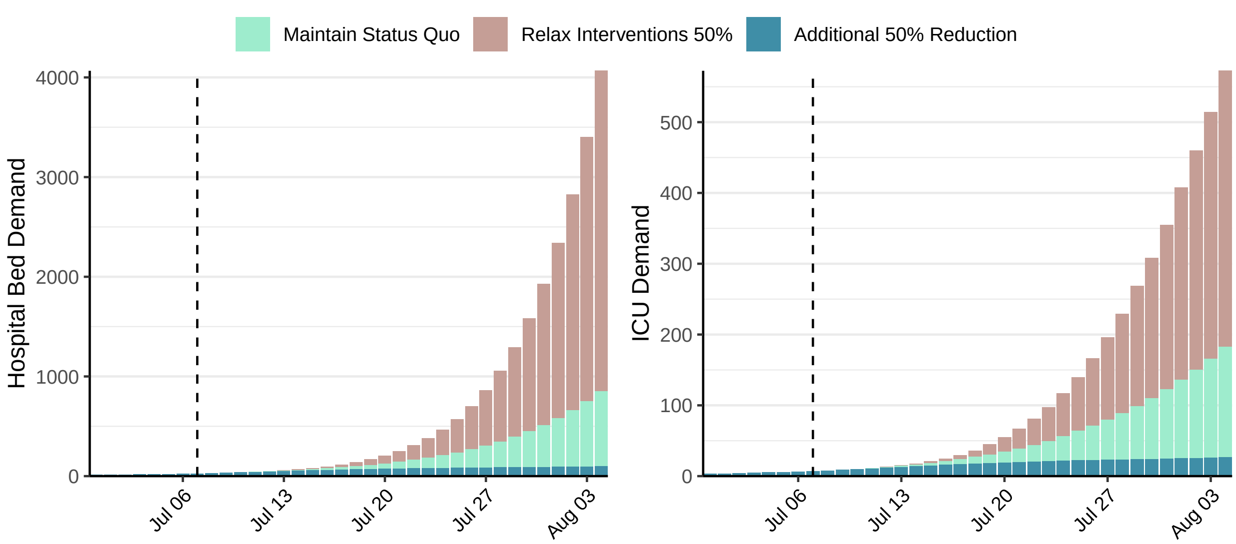

Figure 5: **Healthcare demands in the next 28 days.** Individuals needing an ICU bed are assumed to need mechanical ventilation. Projected demand for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

The impact of each scenario has a more immediate effect on the daily number of infections. The figure below shows the impact of each scenario on the estimated daily incidence of new infections. If interventions are scaled up (Scenario 2), the daily number of infections will change from 530 (95% CI: 417-643) at the current date to 781 (95% CI: 471-1,091) by 2020-08-04. If current interventions were relaxed by 50%, we estimate the daily number of infections will change from 530 (95% CI: 417-643) at the current date to 117,996 (95% CI: 83,343-152,649) by 2020-08-04.

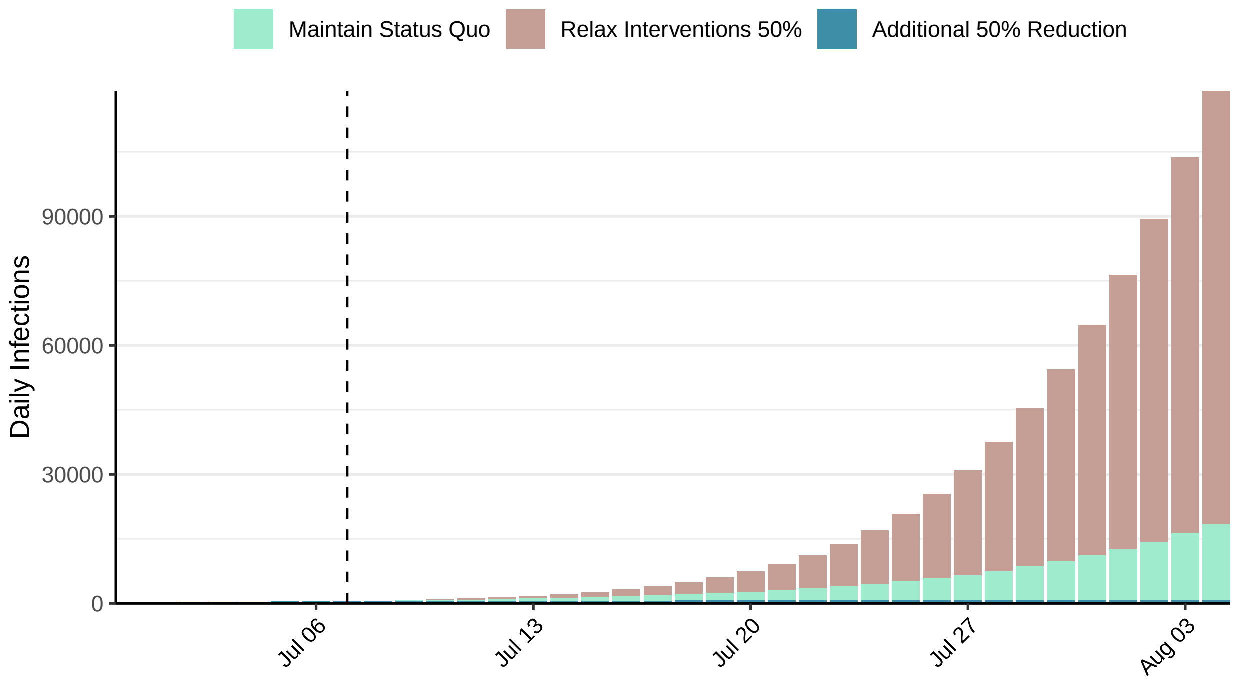

Figure 6: **Daily number of infections estimated by fitting to deaths.** Projected infections for Scenario 1 (the epidemic continues to grow at the current rate) are shown in green (Maintain status quo). Projections for Scenario 2 (a further 50% reduction in transmission) are shown in blue. Projections for Scenario 3 (relaxing interventions by 50%) are shown in red. Current date shown with dashed line.

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