COVID-19 Actuarial Modelling of the Pandemic

Prepared by NMG Consulting

► Insight Report
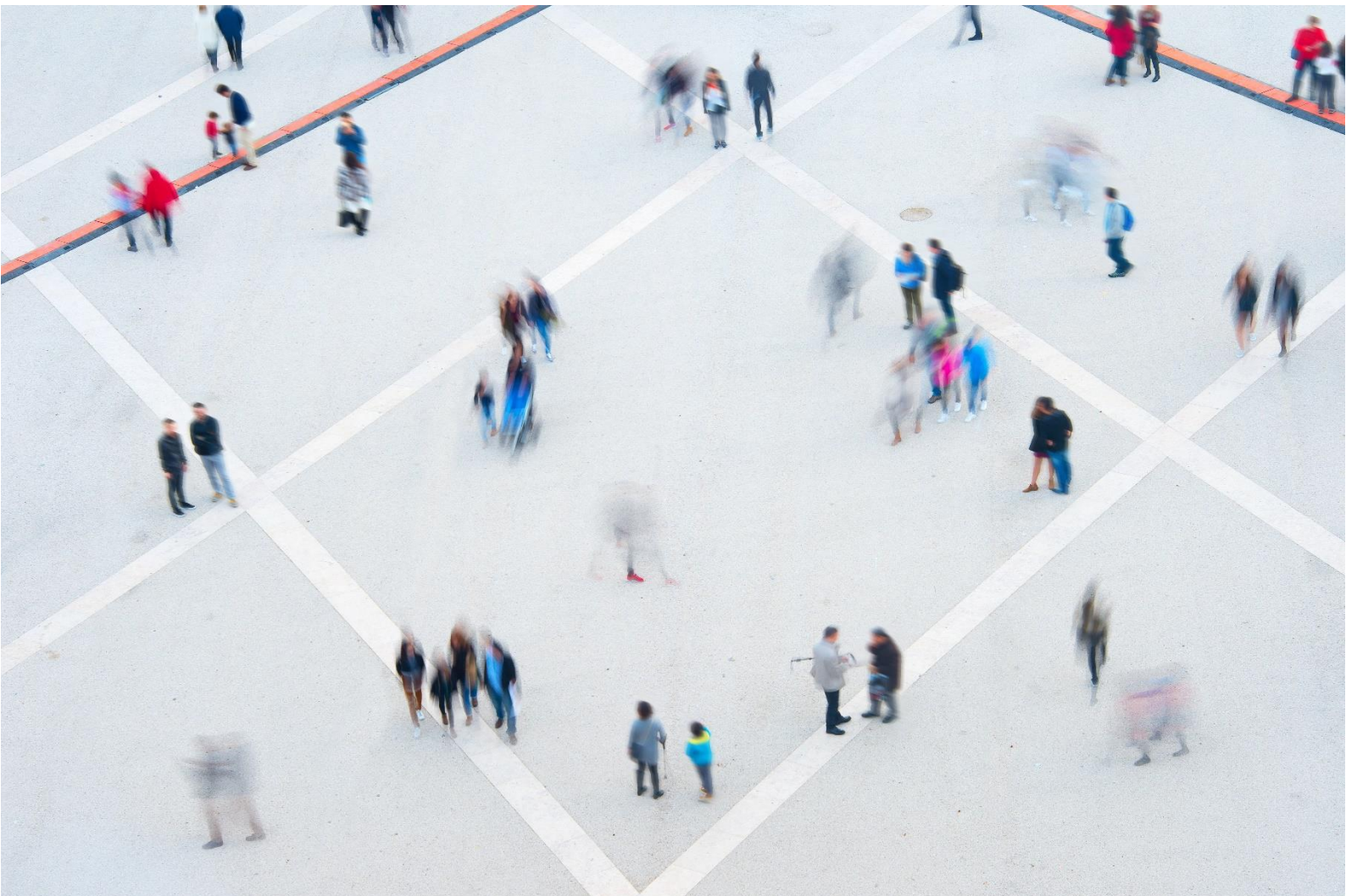

4 August 2021

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1. Multi-state actuarial model

NMG has built a multi-state actuarial model to forecast COVID-19 cases in a population and applied this model to the South African and other populations. The model can be calibrated to the latest reported South Africa experience to better understand how changes in the reported experience might impact on the longer-term outlook for the pandemic.

1.1 Workings of the model

The model assumes that the virus will move through a population where all individuals are initially equally susceptible to infection. In terms of the model, some individuals will come into contact with individuals infected with the virus and themselves become infected. Certain of these infected individuals will be hospitalised and some will die.

The model simulates how the virus moves through the South African population using parameters derived from international studies and local experience. The model is fit using the COVID-19 deaths reported for each of the nine provinces by using seed values for the starting infected population in each province as at 22 March 2020 and by adjusting the parameter that informs the speed of viral propagation in the population. The reported COVID-19 deaths are adjusted for underreporting using the Medical Research Council (MRC) data on all cause natural deaths as a guide.

A second fit was added to the model using COVID-19 hospital admissions reported to the National Institute for Communicable Diseases. The reporting on COVID-19 hospital admissions currently covers 99% of public and 100% of private hospital admissions.

1.2   Reported data

The reported COVID-19 deaths and hospital admissions used to fit the NMG model are graphed together in Figure 1.
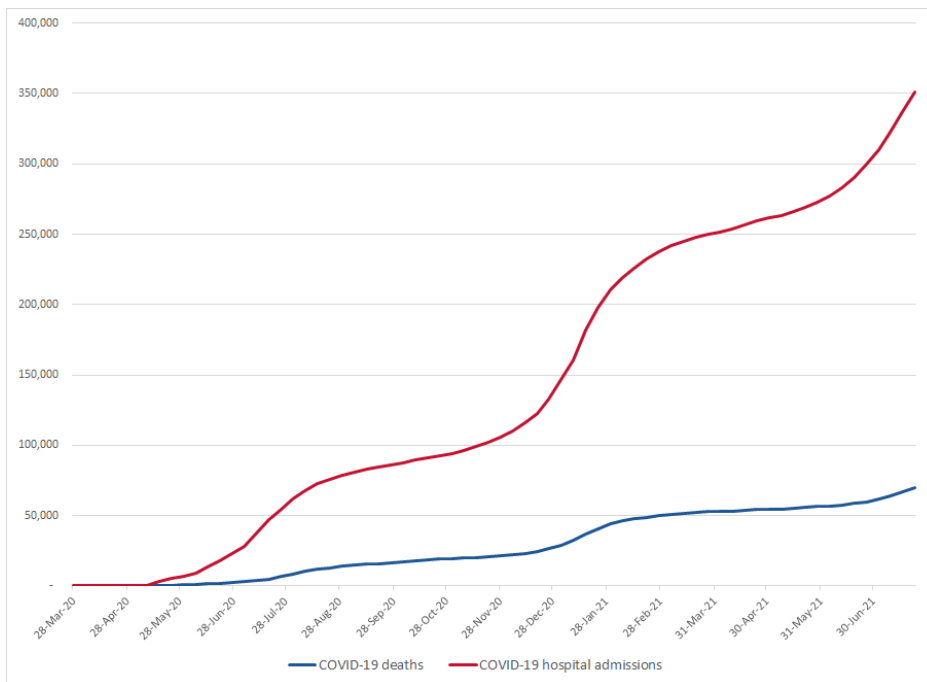

Figure 1   Cumulative reported COVID-19 and hospital admissions – South Africa

The reported COVID-19 hospital admissions provide a useful indicator for identifying the start of a wave of COVID-19 infections, especially for those provinces where the reporting of COVID-19 deaths may be unreliable.

1.3   Model recalibration

NMG has updated the model to reflect the impact that the Delta variant of the SARS-CoV-2 virus is having in Gauteng. The speed and duration of propagation of the variant in Gauteng has been used to forecast the third wave of infections in the other provinces. The different shapes of the third wave reflect the different levels of assumed population immunity having been attained in each of the provinces.

The recalibration of the NMG model is a dynamic process and will be revisited weekly as the third wave reaches maturity in Gauteng and continues to develop in the other provinces.

2. Forecast results

NMG has updated its web-based version of the multi-state actuarial model that will allow interested parties to generate different COVID-19 forecast scenarios for the third wave in South Africa. The model can be accessed at https://nmg-covid-19.sctechnology.co.za/

2.1 Results for Gauteng

The NMG model was recalibrated for the third wave using the reported SARS-CoV-2 infections in Gauteng. The graph below compares the reported infections against output from the recalibrated NMG model.
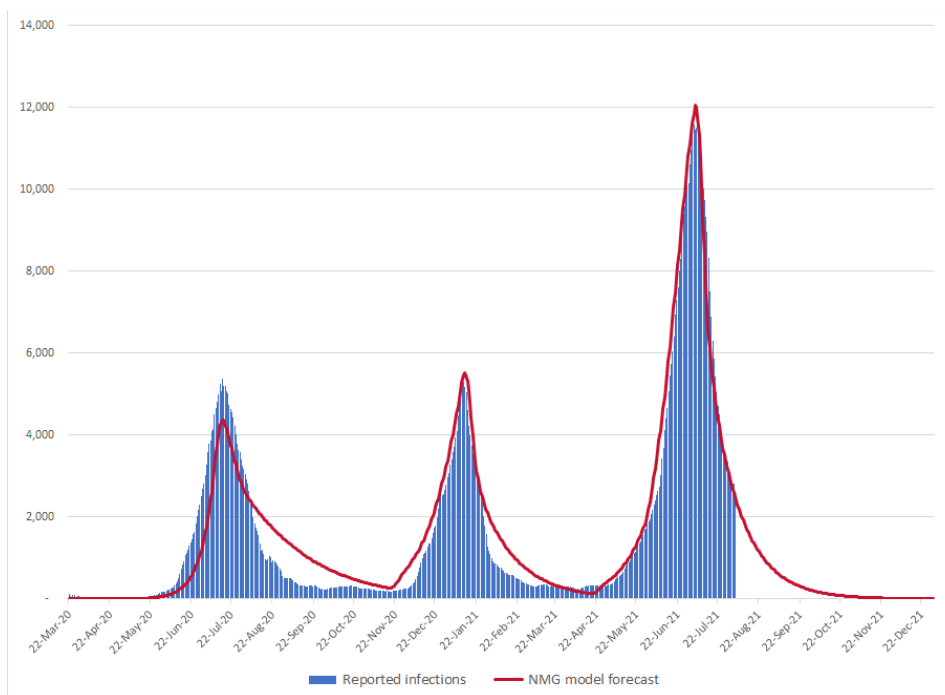
Figure 2   Forecast daily reported SARS-CoV-2 infections (7-day moving average) – Gauteng

The third wave in Gauteng was modelled in two parts to fit the reported infections. The first part of the wave had a lower speed of propagation than the second part of the wave when the Delta variant of the SARS-CoV-2 virus was more prevalent.

The NMG model recalibration assumes that reported infections have reached a peak in Gauteng. To the extent that this is not the case, the third wave will need to be extended in the calibration.

The reported COVID-19 admissions are compared against the recalibrated NMG model forecast in the graph below. The model forecast is not constrained by hospital capacity and this explains the poor fit at the peak of the third wave.
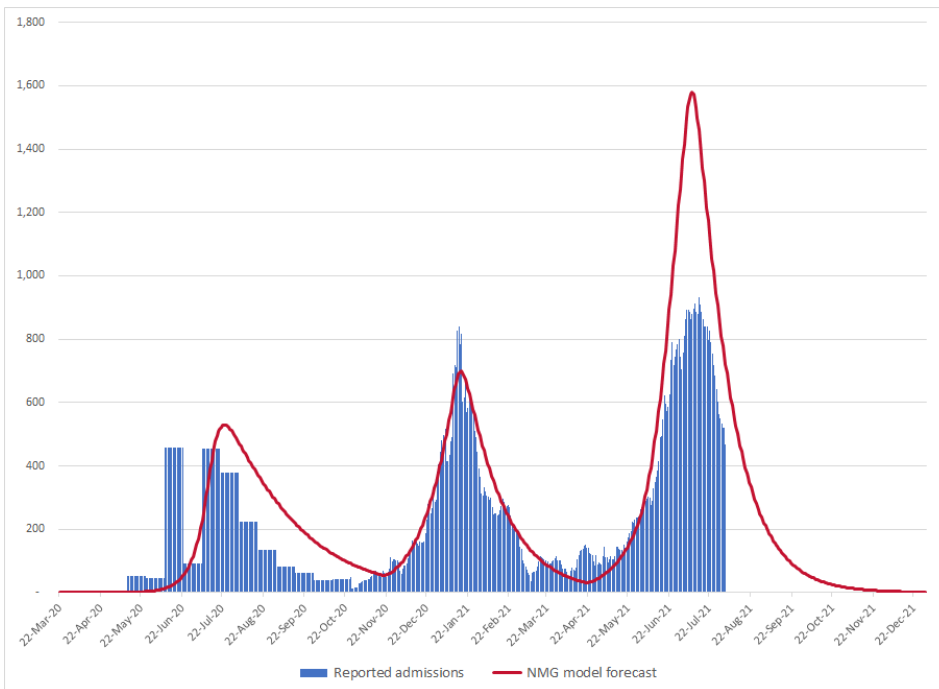

Figure 3   Forecast daily COVID-19 hospital admissions (7-day moving average) – Gauteng

The reported and unreported COVID-19 deaths are compared against the recalibrated NMG model forecast in the graph below. The death rate due to COVID-19 appears to be lower than in the first two waves. The NMG model will be recalibrated to reflect this improvement as soon as we can be sure that it is not due to reporting delays.
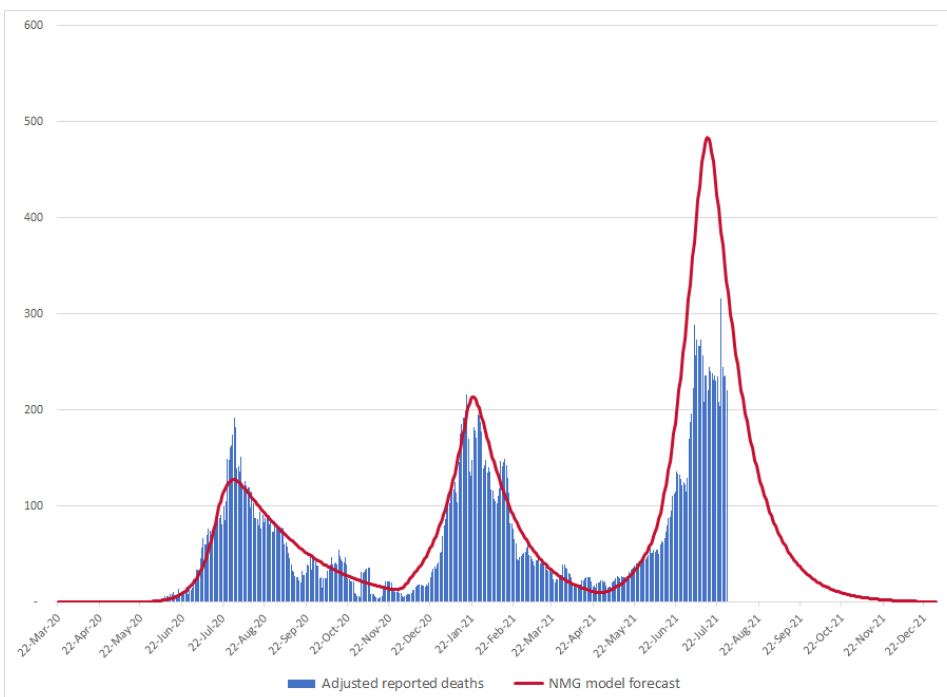

Figure 4   Forecast daily COVID-19 deaths (7-day moving average) – Gauteng

2.2 Results for the Western Cape

The third wave is modelled for the Western Cape using the speed and duration of viral propagation reported in Gauteng. The reported and unreported COVID-19 deaths in the Western Cape are compared against the recalibrated NMG model in the graph below. The more muted third wave is due to the higher levels of infection in the Western Cape than Gauteng.
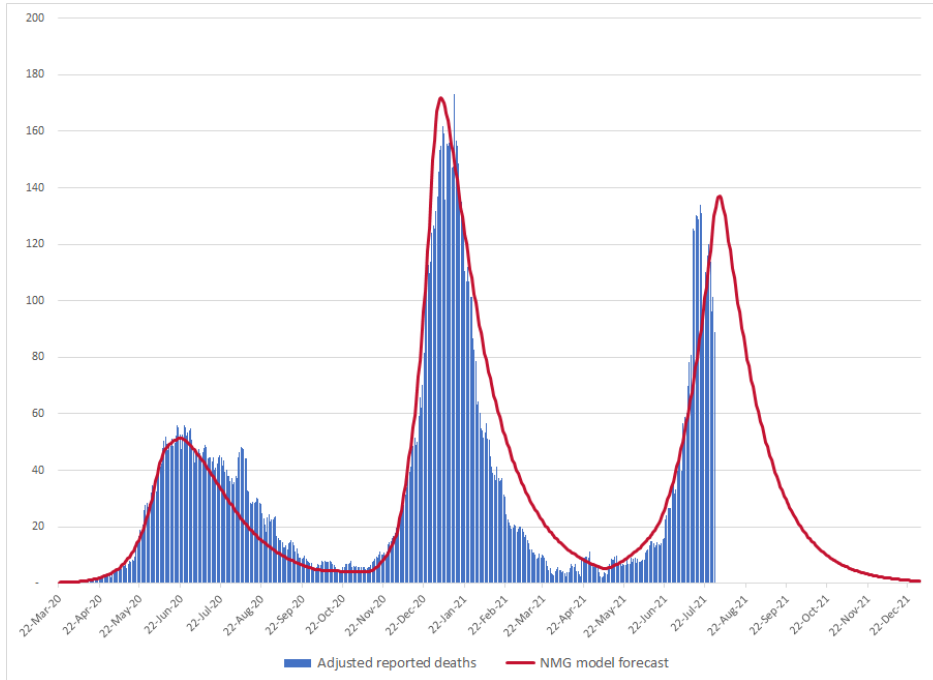

Figure 5   Forecast daily COVID-19 deaths (7-day moving average) – Western Cape

The reported COVID-19 hospital admissions in the Western Cape are compared against the same recalibrated model in the graph below.
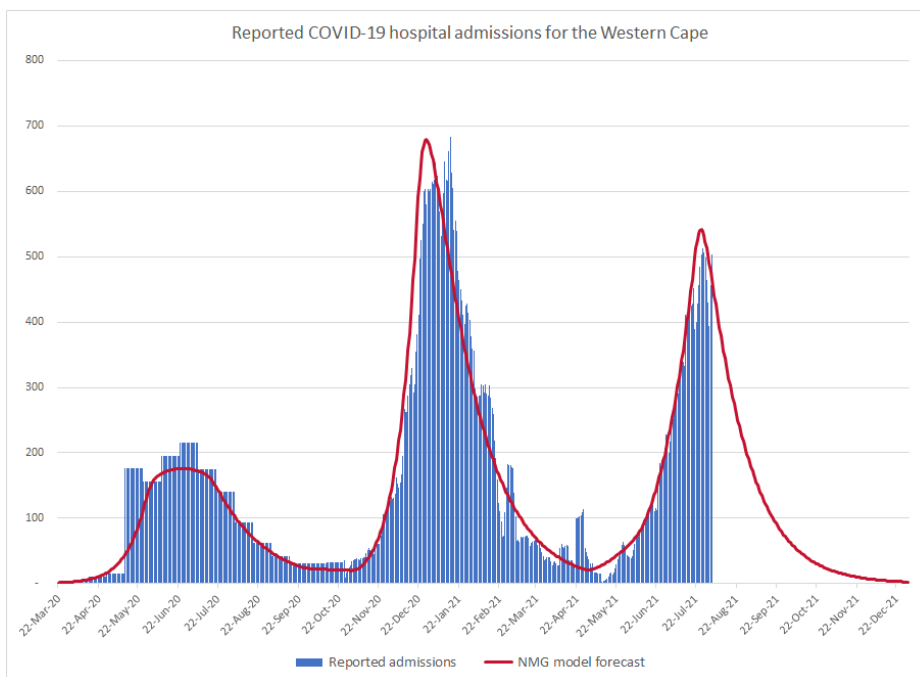

Figure 6   Forecast daily COVID-19 hospital admissions (7-day moving average) – Western Cape

2.3 Results for KwaZulu Natal

The reported and unreported COVID-19 deaths in KwaZulu Natal are compared against the recalibrated NMG model forecast in the graph below. The more muted third wave is due to the higher levels of infection in the KwaZulu Natal than Gauteng.
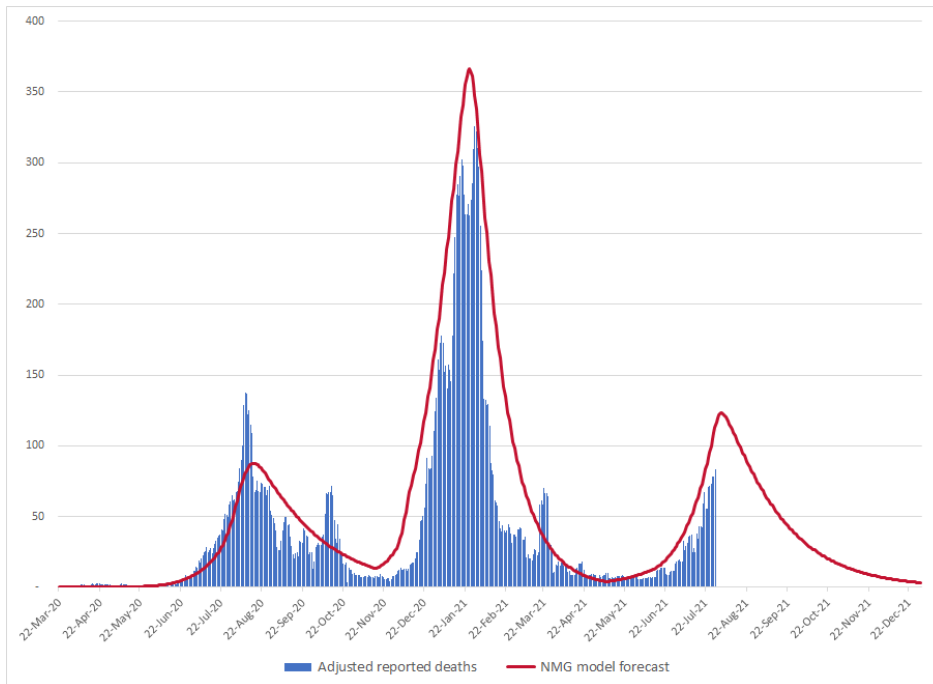

Figure 7 Forecast daily COVID-19 deaths (7-day moving average) – KwaZulu Natal

The reported COVID-19 hospital admissions in KwaZulu Natal are compared against the same recalibrated model in the graph below.
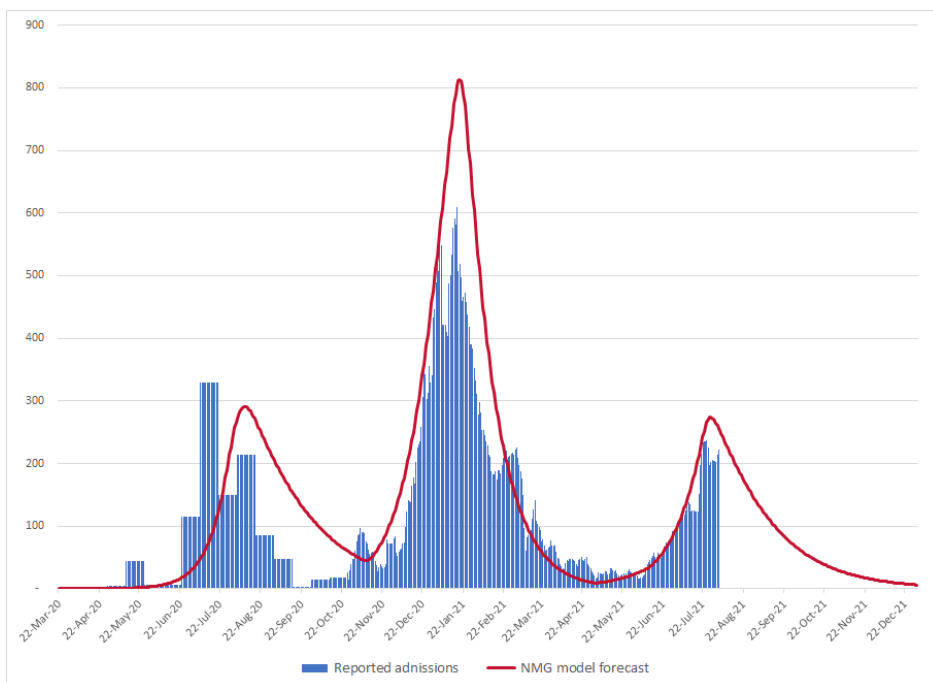

Figure 8 Forecast daily COVID-19 hospital admissions (7-day moving average) – KwaZulu Natal

2.4   Results for the Eastern Cape

The reported and unreported COVID-19 deaths in the Eastern Cape are compared against the recalibrated NMG model projections in the graph below.
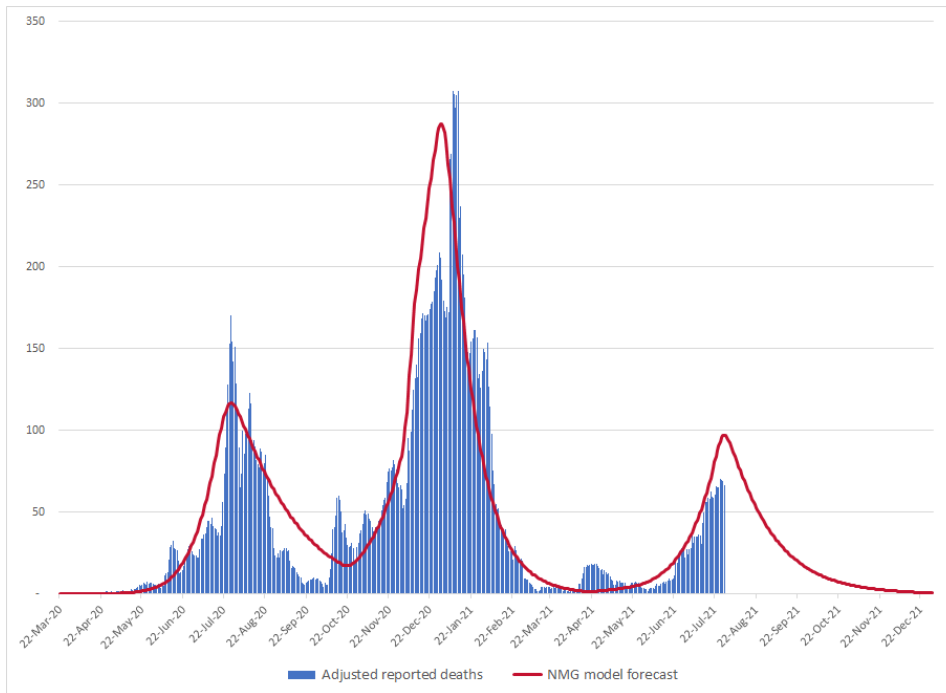

Figure 9   Forecast daily COVID-19 deaths (7-day moving average) – Eastern Cape

The reported COVID-19 hospital admissions in the Eastern Cape are compared against the same recalibrated model in the graph below.
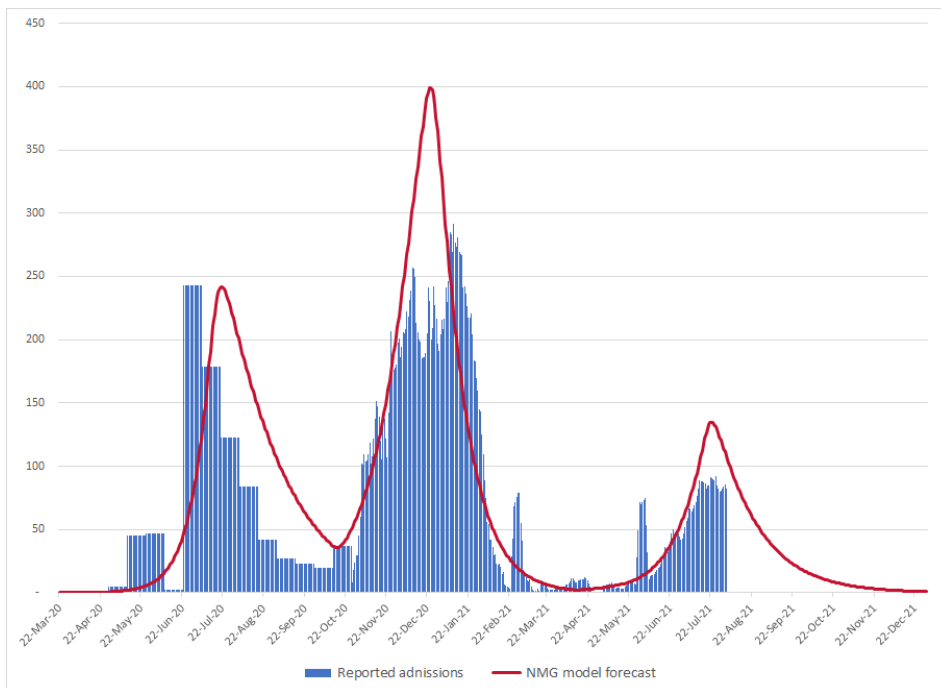

Figure 10   Forecast daily COVID-19 hospital admissions (7-day moving average) – Eastern Cape

2.5　Combined results for South Africa

The reported and unreported COVID-19 deaths in South Africa as a whole are compared against the recalibrated NMG model projections in the graph below.
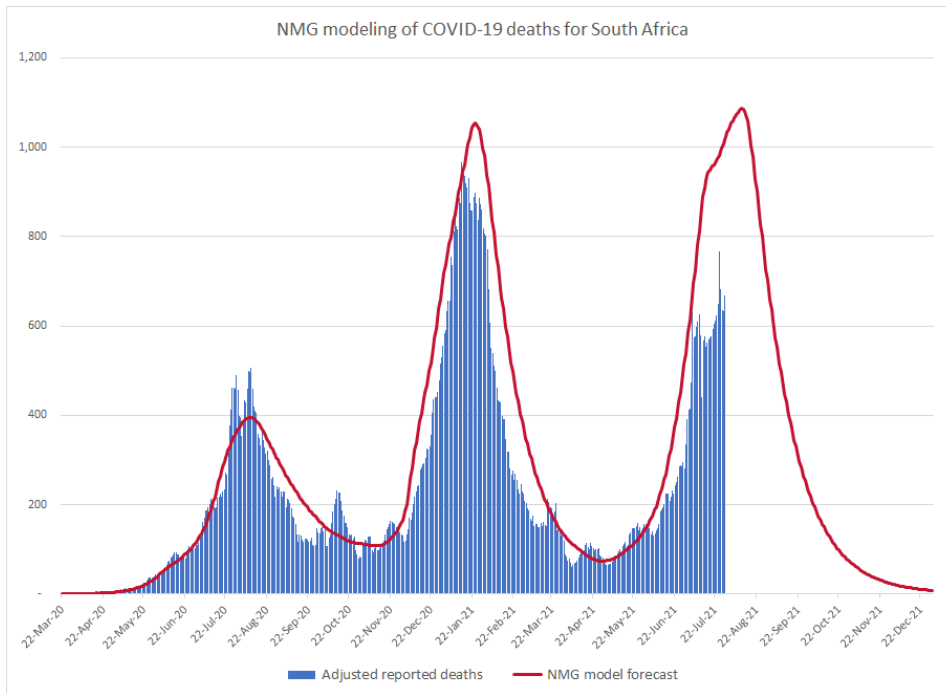

Figure 11　Forecast daily COVID-19 deaths (7-day moving average) – South Africa

The reported COVID-19 hospital admissions in South Africa are compared against the same recalibrated model in the graph below.
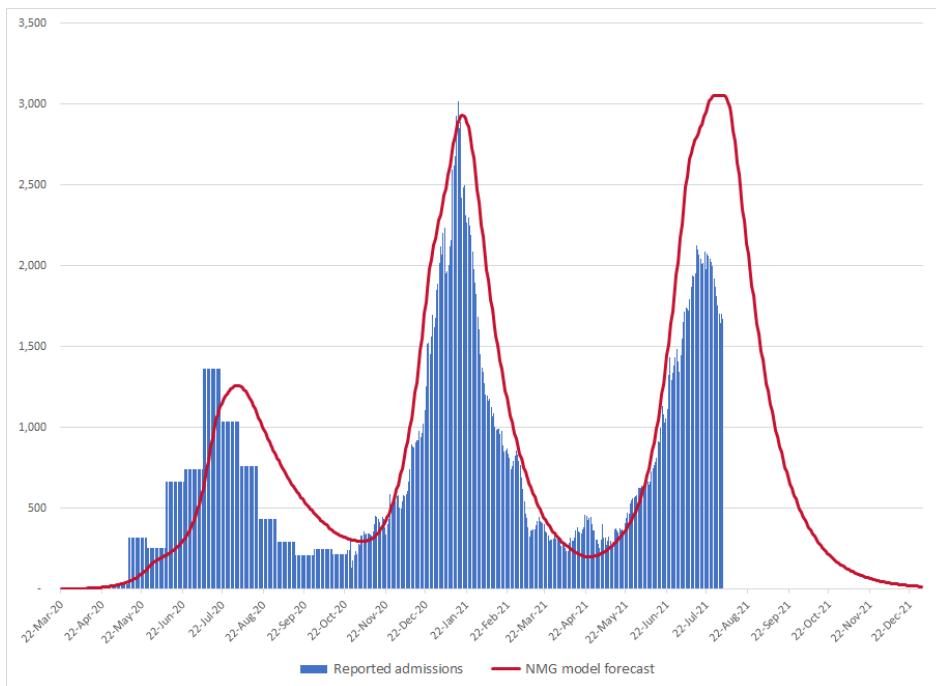

Figure 12　Forecast daily COVID-19 hospital admissions (7-day moving average) – South Africa

Thank you

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