

# COVID-19 Actuarial Modelling of the Pandemic

Prepared by NMG ConsultingInsight Report



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# 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 (NICD). The reporting on COVID-19 hospital admissions currently covers 99% of public and 100% of private hospital admissions.

The most recent version of the model includes data on the lives that have been vaccinated in each province. The population is divided into three groups; those who have been vaccinated, those with natural immunity from a past infection and those with no immunity. Vaccine efficacy against infection and severe illness are modelled separately.

### 1.2 Fourth wave scenarios

Various scenarios can be set for a fourth wave of the SARS-CoV-2 virus using the NMG model. The scenarios can be set for each of the major provinces using the following eight parameters:

- o A start date for the fourth wave
- A duration (in days) to the peak of the fourth wave
- The speed of viral propagation (R0) of the variant causing the fourth wave
- The impact on severity of illness of the variant (% impact)
- The reduction in vaccine effectiveness of the variant (% impact)
  - Efficacy against infection
  - Efficacy against severe illness
- The impact on natural immunity of the variant (% impact)
  - Protection against infection
  - Protection against severe illness

# 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 fourth wave in South Africa. Outputs from the model are set out in an annexure to this report for four COVID-19 forecast scenarios for the fourth wave. The first scenario is referred to as a base scenario and the other three scenarios as alternate scenarios in this report. The model can be accessed at <a href="https://nmg-covid-19.sctechnology.co.za/">https://nmg-covid-19.sctechnology.co.za/</a>

### 2.1 Base scenario for the fourth wave

All four scenarios assume that fourth wave infections start on a date and with a viral speed of propagation that has been derived from the hospital admission data reported to the NICD. The speed of propagation is faster than the speed measured for the earlier waves.

The base scenario (i) for the fourth wave assumes that the virus will propagate at this speed for 45 days before starting to decline. In the base scenario the disease severity caused by the virus is assumed to be at a level equivalent to that in the earlier waves.

The base scenario also assumes that the Omicron variant causing the fourth wave will impact on vaccine protection and natural immunity as follows:

- The Omicron variant is assumed to reduce the effectiveness of the vaccines and natural immunity in preventing infections by 70% and
- The Omicron variant assumed to reduce the effectiveness of the vaccines and natural immunity in preventing disease severity by 30%

### 2.2 Alternative scenarios for the fourth wave

The other three scenarios (ii), (iii) and (iv) for the fourth wave show the impact of a virus variant that has a similar speed of propagation to the base scenario but with the following adjustments to the base scenario parameters:

- In scenario (ii), the disease severity caused by the virus is assumed to be at a level of 50% of in the earlier waves;
- In scenario (iii), the virus is assumed to propagate for a period of 60 days before starting to decline;
- In scenario (iv), the Omicron variant is assumed to reduce the effectiveness of the vaccines and natural immunity in preventing infections and disease severity by 30% only.

## Fourth wave base scenario (i)

Outputs from the web-based version of the NMG model are set out below for the COVID-19 forecast base scenario (i) for the fourth wave:



	Infections at peak	Hospital admissions	Fatalities
First wave	1,455,671	122,320	41,955
Second wave	2,725,743	169,820	58,714
Third wave	3,031,812	203,473	64,761
Fourth wave	4,185,980	104,947	36,558

	Infections at peak	Hospital admissions	Fatalitie
First wave	387,072	24,493	8,031
Second wave	1,030,455	45,996	15,325
Third wave	841,433	24,551	7,798
Fourth wave	750,396	13,854	4,766

#### KwaZulu Natal

Gauteng



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	Infections at peak	Hospital admissions	Fatalities
First wave	490,204	31,406	10,329
Second wave	691,569	31,043	10,379
Third wave	1,145,321	56,454	17,957
Fourth wave	1,363,898	26,170	9,115

### Apr 20 | May 20 | Jun 20 | Jul 20 | Sep 20 | Oct 20 | Nev 20 | Dec 20 | Jan 21 | Feb 21 | Mar 21 | Apr 21 | Mar 21 | Jul 21 | Aug 21 | Sep 21 | Oct 21 | Nev 21 | Jan 22 | Feb 22 | Mar 22 | Apr 22 | Mar 22 | Jun 22

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#### Western Cape

	Infections at peak	Hospital admissions	Fatalities
First wave	159,871	18,354	4,563
Second wave	444,850	29,950	7,475
Third wave	511,575	39,503	9,453
Fourth wave	408,909	10,796	2,780

#### Show graph for Eastern Cape 🗸 Reset all inputs



#### Eastern Cape

	Infections at peak	Hospital admissions	Fatalities
First wave	349,985	20,778	10,278
Second wave	687,038	27,987	14,051
Third wave	344,498	15,380	7,395
Fourth wave	620,524	9,788	4,967

## Fourth wave scenario (ii)

Outputs from the web-based version of the NMG model are set out below for the COVID-19 forecast scenario (ii) for the fourth wave:



	Infections at peak	Hospital admissions	Fatalities
First wave	1,455,671	122,320	41,955
Second wave	2,725,743	169,820	58,714
Third wave	3,031,812	199,402	63,883
Fourth wave	4,185,980	51,424	17,914

## Fourth wave scenario (iii)

Outputs from the web-based version of the NMG model are set out below for the COVID-19 forecast scenario (iii) for the fourth wave:



	Infections at peak	Hospital admissions	Fatalities
First wave	1,455,671	122,320	41,955
Second wave	2,725,743	169,820	58,714
Third wave	6,631,556	203,473	64,761
Fourth wave	14,824,993	358,820	122,362

## Fourth wave scenario (iv)

Outputs from the web-based version of the NMG model are set out below for the COVID-19 forecast scenario (iv) for the fourth wave:



	Infections at peak	Hospital admissions	Fatalities
First wave	1,455,671	122,320	41,955
Second wave	2,725,743	169,820	58,714
Third wave	2,338,617	200,817	64,433
Fourth wave	1,397,601	35,598	12,650

# Thank you

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