COVID-19 Actuarial Modelling of the Pandemic

Prepared by NMG Consulting

► Insight Report
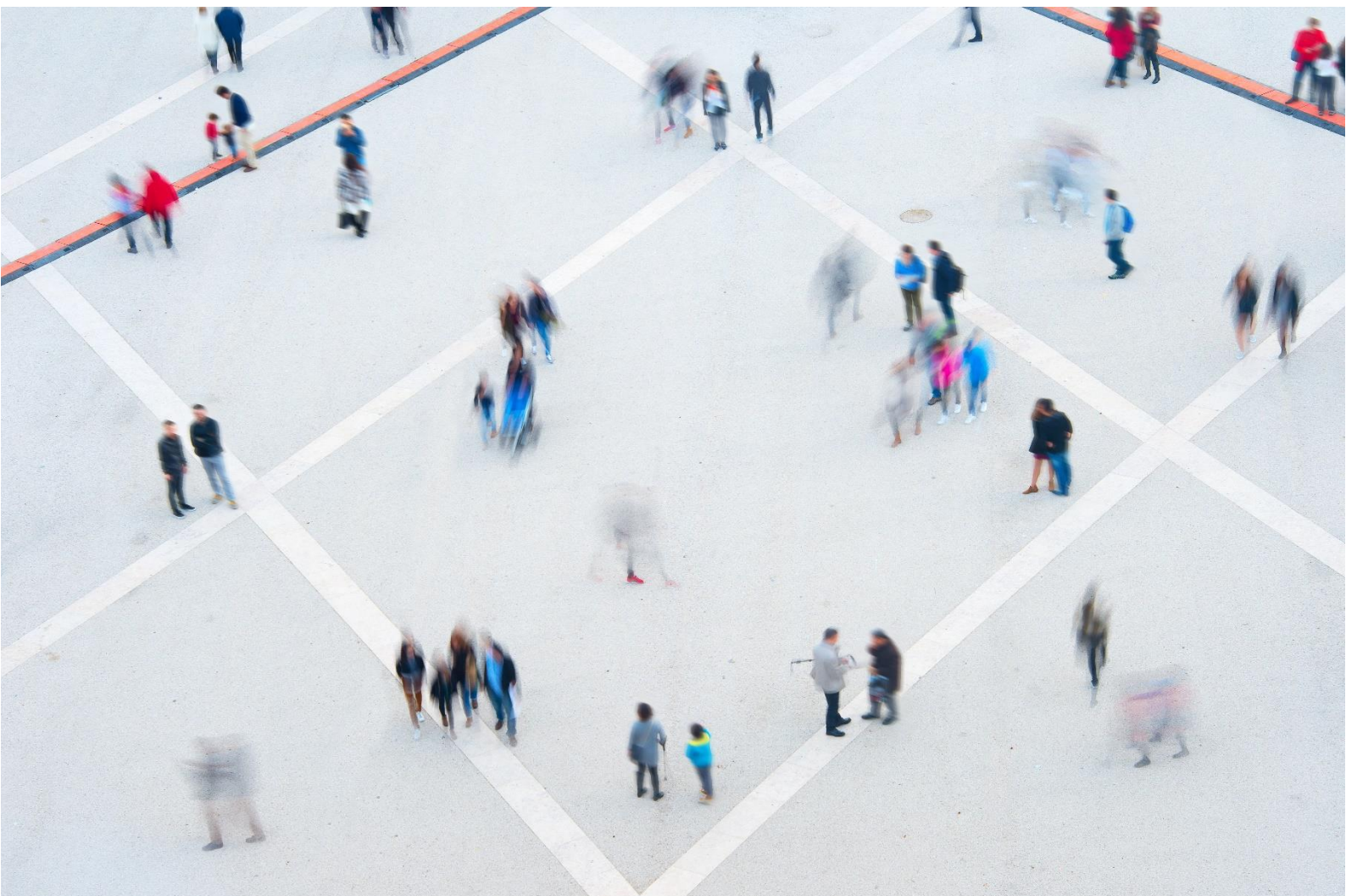

30 November 2021

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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.

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
- o A duration (in days) to the peak of the fourth wave
- o The speed of viral propagation (R0) of the variant causing the fourth wave
- o The impact on severity of illness of the variant (% impact)
- o The reduction in vaccine effectiveness of the variant (% impact)
    - o Efficacy against infection
    - o Efficacy against severe illness
- o The impact on natural immunity of the variant (% impact)
    - o Protection against infection
    - o 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. The model can be accessed at https://nmg-covid-19.sctechnology.co.za/

Fourth wave scenarios

Outputs from the web-based version of the NMG model are set out in an annexure to this report for four COVID-19 forecast scenarios for the fourth wave. All four scenarios assume that infections start to increase on 21 November 2021 and continue for a period of 80 days.

The first scenario (i) assumes that the speed of propagation of the virus causing the fourth wave exceeds the speeds measured in the first three waves. The speed of propagation is set at an R0 of 4.0. For this first scenario (i), the virus variant is assumed not to impact on the effectiveness of any of the vaccines or protection from natural immunity. The severity of disease is also assumed to be the same as with the earlier variants.

The other three scenarios (ii), (iii) and (iv) show the impact of a virus variant that has a similar speed of propagation as the earlier variants, namely an R0 of 3.0. This variant is assumed to behave as follows:

- o The scenario (ii) variant is assumed to reduce the effectiveness of the vaccines and natural immunity in preventing infections and reducing disease severity by 50%
- o The scenario (iii) variant is assumed to reduce the effectiveness of the vaccines and natural immunity in preventing infections by 50%
- o The scenario (iv) variant is assumed to reduce the effectiveness of the vaccines and natural immunity in preventing infections by 50% and have a disease severity of 50% of that of the earlier variants

Fourth wave scenario (i)

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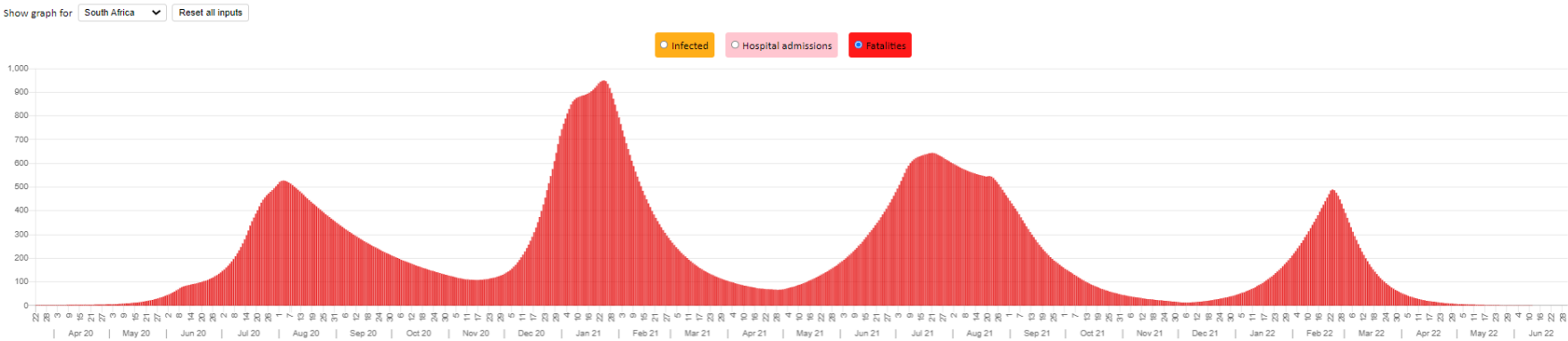
South Africa

	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	2,461,788	196,985	63,733
Fourth wave	3,710,903	61,718	20,770

Show graph for [Gauteng ▾] [Reset all inputs]

○ Infected   ○ Hospital admissions   ● Fatalities
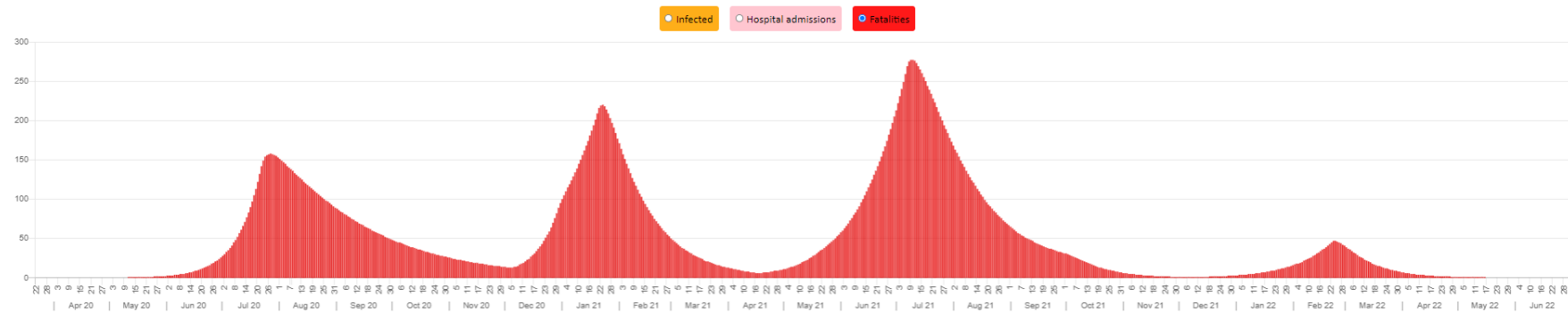
Gauteng

	Infections at peak	Hospital admissions	Fatalities
First wave	490,204	31,406	10,329
Second wave	691,569	31,043	10,379
Third wave	767,742	53,664	17,513
Fourth wave	304,624	5,812	1,942

Show graph for [KwaZulu Natal ▾] [Reset all inputs]

○ Infected   ○ Hospital admissions   ● Fatalities
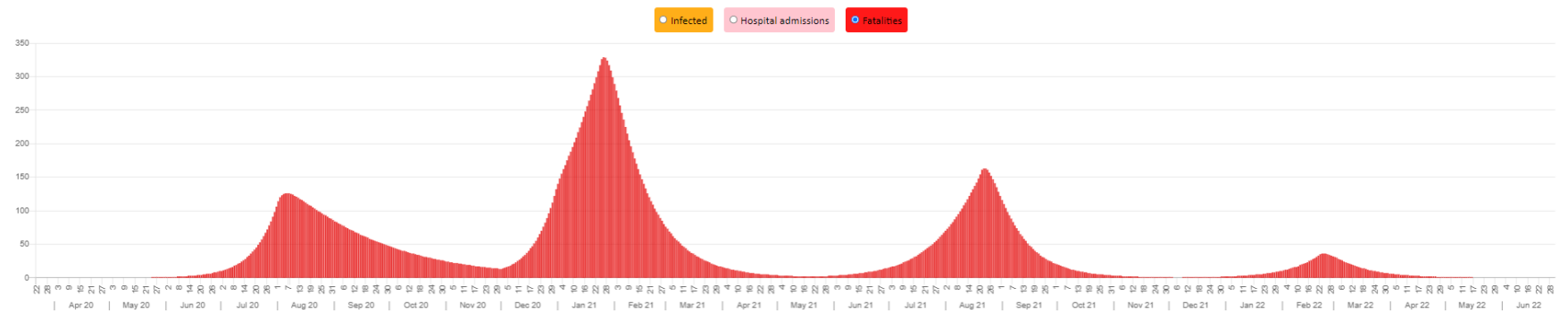
KwaZulu Natal

	Infections at peak	Hospital admissions	Fatalities
First wave	387,072	24,493	8,031
Second wave	1,030,455	45,996	15,325
Third wave	719,326	23,414	7,618
Fourth wave	263,385	4,382	1,462

Show graph for [Western Cape ▼] [Reset all inputs]

[● Infected] [○ Hospital admissions] [● Fatalities]
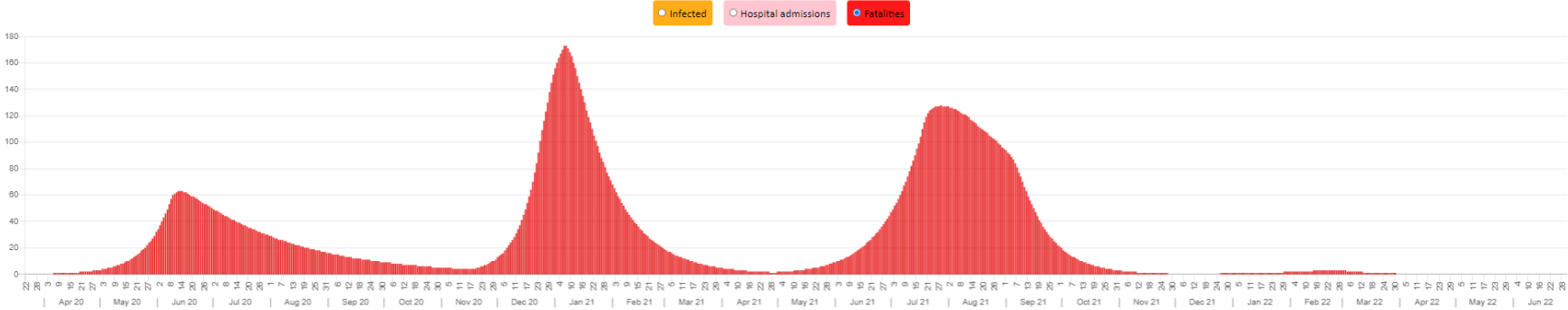
Western Cape

	Infections at peak	Hospital admissions	Fatalities
First wave	159,871	18,354	4,563
Second wave	444,850	29,950	7,475
Third wave	423,228	38,595	9,343
Fourth wave	27,134	656	166

Show graph for [Eastern Cape ▼] [Reset all inputs]

[● Infected] [○ Hospital admissions] [● Fatalities]
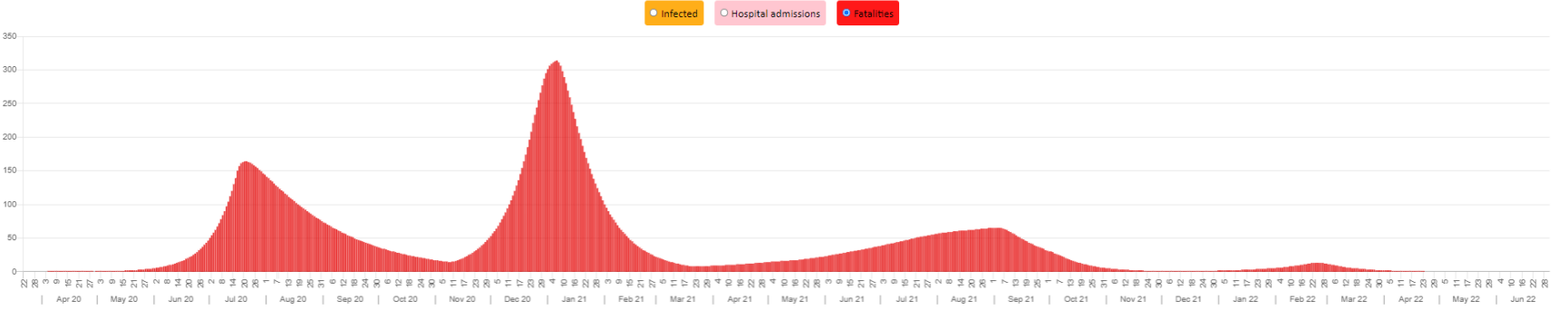
Eastern Cape

	Infections at peak	Hospital admissions	Fatalities
First wave	349,985	20,778	10,278
Second wave	687,038	27,987	14,051
Third wave	255,969	14,864	7,272
Fourth wave	87,667	1,198	602

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:
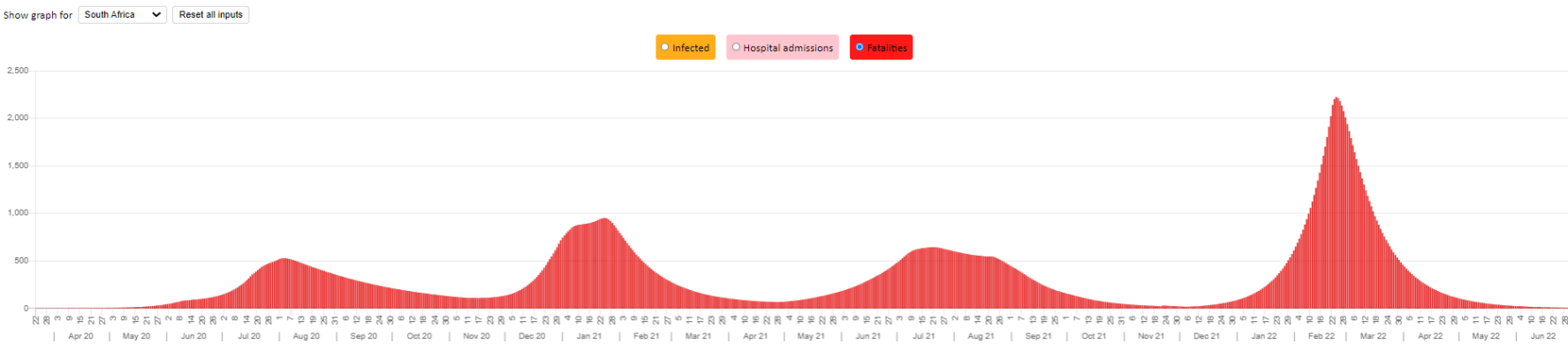
South Africa

	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	3,486,077	197,223	63,813
Fourth wave	9,413,750	278,580	93,143

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:
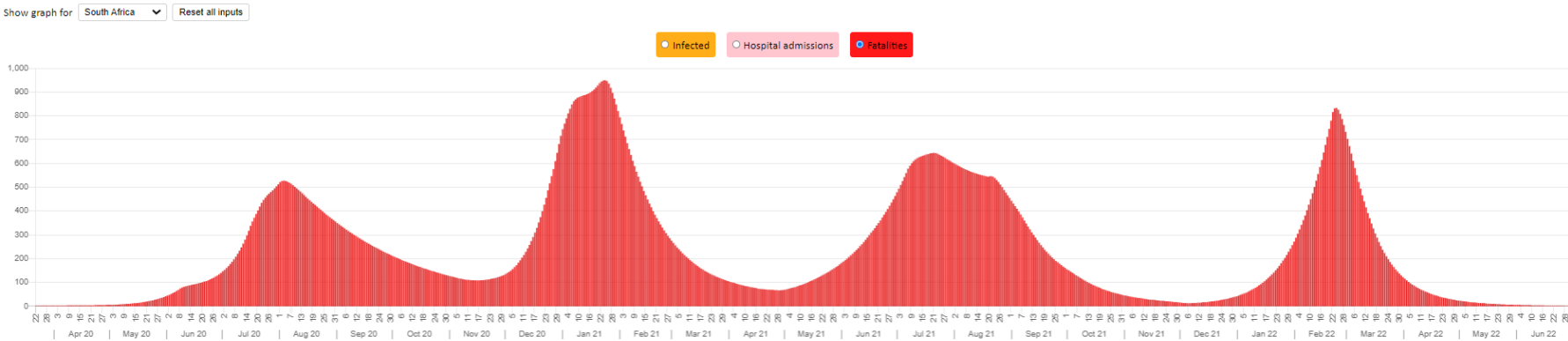

South Africa

	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	3,486,077	196,968	63,733
Fourth wave	9,413,750	100,583	33,869

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:
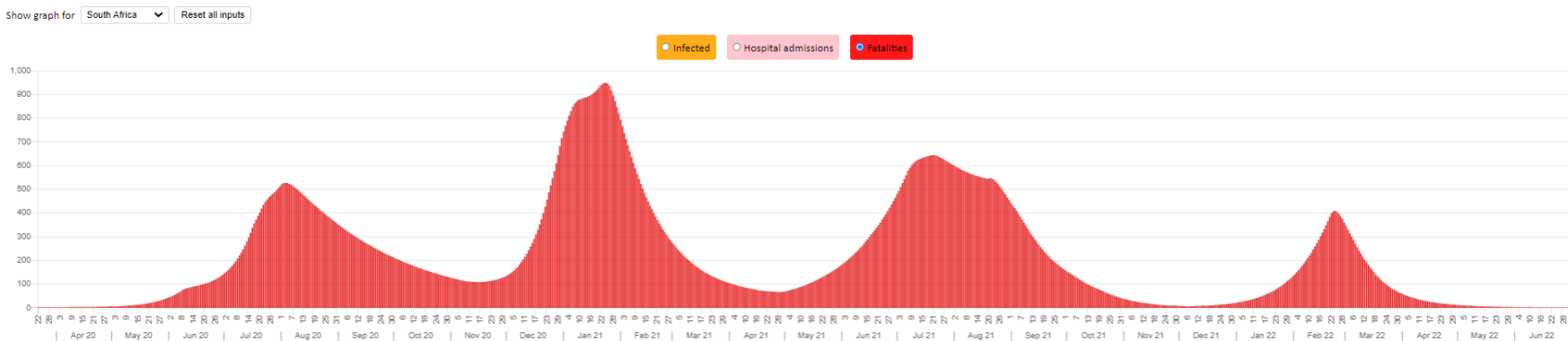

South Africa

	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	3,486,077	196,076	63,358
Fourth wave	9,413,750	49,286	16,596

Thank you

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