IN THE HIGH COURT OF SOUTH AFRICA

GAUTENG PROVINCIAL DIVISION, PRETORIA

CASE NO: 60279/20

In the matter between:

DEAR SA Applicant

and

THE MINISTER OF COOPERATIVE GOVERNANCE AND TRADITIONAL AFFAIRS Respondent

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NOTICE OF MOTION

BE PLEASED TO TAKE NOTICE THAT the Applicant intends making application to this Honourable Court on an **urgent** basis and at 10h00 on **1 December 2020**, or as soon thereafter as is possible, for an Order in the following terms.

1. That the forms and service provided for in the Uniform Rules of the above Honourable Court be dispensed with and that this matter be dealt with as one of urgency in terms of Rule 6(12);

2. Ordering that the extension of the national state of disaster (COVID-19) published on 13 November 2020 in the Government Gazette Nr. 43905 in terms of section 27(1) of the Disaster Management Act be reviewed and set aside and be declared to be unlawful;

3. Directing that the costs of this Application be paid by the Respondent;

4. Further and/or alternative relief.

TAKE NOTICE THAT if you intend opposing the relief sought in terms of this Application, you are required

a) to notify Applicant's attorneys in writing by 10h00 on 18 November 2020;

b) to deliver an answering affidavit, if any, by 17h00 on 23 November 2020.

TAKE NOTICE FURTHER THAT if no notice of opposition is received the matter will be set down for hearing on the urgent roll for hearing at 10h00 on **1 December 2020**;

TAKE NOTICE FURTHER THAT the Affidavit of **Rob Hutchinson**, together with the annexures thereto, will be used in support of this Application.

TAKE NOTICE FURTHER THAT the Applicant has appointed the offices of its attorneys, set out here below, as the address at which it will accept service of all notices and processes in these proceedings.

KINDLY place the matter on the roll for hearing accordingly.

DATED AT **PRETORIA** ON THIS 16th DAY OF November 2020.

HURTER SPIES ATTORNEYS
Applicant's Attorneys
54 Union Avenue
Kloofsig
Pretoria
Ref: MAT 3181
Email: deloff@hurterspies.co.za
danielle@hurterspies.co.za

TO: THE REGISTRAR OF THE
ABOVE HONOURABLE COURT
PRETORIA

AND TO: STATE ATTORNEY
RESPONDENT'S ATTORNEY OF RECORD
316 Thabo Sehume Street
Pretoria

STATE ATTORNEY
RECEPTION
2020 -11- 16
PRIVATE BAG/PRIVAATSAK X91
PRETORIA 0001 (7)
STAATSPROKUREUR

IN THE HIGH COURT OF SOUTH AFRICA
GAUTENG PROVINCIAL DIVISION, PRETORIA

CASE NO:

In the matter between:

DEAR SA Applicant

and

THE MINISTER OF COOPERATIVE

GOVERNANCE AND TRADITIONAL AFFAIRS Respondent

FOUNDING AFFIDAVIT

I, the undersigned,

ROB HUTCHINSON

INTRODUCTION

1. I am a major male and a Director of the registered national not-for-profit company and civil rights organisation, Dear SA (Registration number 2017/264231/08).

2. I am duly authorised to depose to this affidavit on behalf of the Applicant.

3. The facts herein contained are all within my own personal knowledge, save as it may appear otherwise from the context, and are both true and correct.

4. To the extent that information does not fall within my personal knowledge, I will attempt to obtain confirmatory affidavits (if possible to do so). To the extent that I am unable to do so, I pray that the above Honourable Court admits such allegations as evidence in terms of section 3 of the Law of Evidence Amendment Act, No.45 of 1988. Where I rely on facts conveyed to me by third parties, I believe that those facts are true and correct.

5. Where I make submissions of a legal nature, I do so on the advice of our legal representatives.

PARTIES

6. The Applicant is Dear SA, a registered not for profit company and civil rights organisation with over 650 000 people on its database.

7. The Respondent is the Minister of Cooperative Governance and Traditional Affairs, with offices at 87 Hamilton Street, Arcadia, Pretoria, 0002, cited herein *via* the office of the State Attorney, 316 Thabo Sehume Street, Pretoria.

LOCUS STANDI

8. The Applicant is a non-profit company duly incorporated in terms of the relevant legislation in the Republic of South Africa with registration number 2017/264231/08 with its registered address and principal place of business at 104 8th Street Parkmore Sandton Gauteng 2196.

9. Dear SA is an active non-partisan, non-governmental organisation involved in the protection and development of civil rights within the context of the Constitution and it was created to promote democracy through public participation. In order not to burden these papers unduly,

I do not attach a copy of Dear SA's articles of association (which are available in the public domain in any event), but a copy will be made available to the court if it is required and requested.

10. The Applicant brings this application on behalf of its supporters and donors and in the public interest. It is a matter that concerns the safety, wellbeing and Constitutional rights of all South Africans. Dear SA is committed to the continuous monitoring of the status of civil rights in South Africa, and to taking appropriate action when such rights are violated.

11. The Applicant brings this application in order to assert its supporters and donors rights, as well as the public's right to just administrative action in terms of section 33 of the Constitution and section 6 of Promotion of Administrative Justice Act 3 of 2000 ('PAJA').

JURISDICTION

12. The above Honourable Court has jurisdiction to hear this application on the basis that:

    12.1. The Respondent is seated within the jurisdiction of the Honourable Court; and

    12.2. The cause of action, being the impugned extension, arose within the jurisdiction of the Honourable Court.

BACKGROUND FACTS

Declaration and Extensions of National Disaster

13. On **15 March 2020,** the Respondent declared a national disaster in terms of S27(1) of the Disaster Management Act (No. 57 of 2002) ("the Act"). The purpose of the declaration was to augment the existing measures undertaken by organs of state to deal with the Covid-19 pandemic.

14. The declaration states that regulations may be made in terms of the Act: "only to the extent that it is necessary for the purpose of - (a) assisting

and protecting the public; (b) providing relief to the public; (c) protecting property; (d) preventing or combatting disruption; or (e) dealing with the destructive and other effects of the disaster." The declaration is attached as **"RH1"**.

15. This state of disaster has been extended in terms of S27(5)(c) of the Act on six occasions, with the latest being on **13 November 2020**. A copy of the extension is attached as **"RH2"**.

Issuing of Regulations

16. On **18 March 2020**, the Respondent issued an initial set of regulations to prevent an escalation of the disaster or alleviate, contain and minimise the effects of the disaster.

17. Since then numerous regulations have been issued, some of which have constituted major derogations from the rights set out in the Bill of Rights.

18. The following examples demonstrate the enormous power that has been vested in the executive during the state of disaster without parliamentary oversight.

Derogations of Rights

Freedom of movement, residence and assembly

Rights

19. Everyone has the right to freedom of movement. They have the right to enter, leave and reside in South Africa.[1]

20. Everyone has the right, peacefully and unarmed, to assemble, to demonstrate, to picket and to present petitions.[2]

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[1] S21 of the Constitution of the Republic of South Africa, 1996
[2] S17 of the Constitution of the Republic of South Africa, 1996

Derogations

21. Municipalities were directed to close all public facilities that did not provide what was defined as "essential services". This included swimming pools, beaches, libraries, community halls, recreation centres, museums, galleries, markets, parks and events. [3]

22. Community gatherings, weddings and celebrations were prohibited. Funerals were allowed to continue, but the mourners were initially limited to close family and restricted to 50 people. [4]

23. No permits were issued for marches, protests and the handover of petitions.[5]

24. Every person was confined to their place of residence, unless strictly for the purpose of performing an essential service, obtaining an essential good or service, collecting a social grant, pension or seeking emergency, life-saving, or chronic medical attention.

25. Movement between provinces and between metropolitan and district areas was prohibited except for essential workers, transportation of cargo and mortal remains, and attendance of a funeral. [6]

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[3] S6.5.2(a) of Disaster Management Act (57/2002): Directions made in terms of Section 27(2) by the Minister of Cooperative Governance and Traditional Affairs

[4] S8 of Disaster Management Act (57/2002): Directions made in terms of Section 27(2) by the Minister of Cooperative Governance and Traditional Affairs 2 April 2020.

[5] S6.5.2(b) of Disaster Management Act (57/2002): Directions made in terms of Section 27(2) by the Minister of Cooperative Governance and Traditional Affairs 25 March 2020.

[6] Disaster Management Act (57/2002): Directions made in terms of Section 27(2) by the Minister of Cooperative Governance and Traditional Affairs 2 April 2020.

Economic Activity

Right

26. Every citizen has the right to choose their trade, occupation or profession freely.[7]

Limitations

27. All businesses and other entities were required to cease operations during the initial lockdown, save for any business or entity involved in the manufacturing, supply, or provision of an essential good or service. Retail shops and shopping malls were to be closed, except where essential goods are sold. Retail stores selling essential goods were prohibited from selling any other goods.[8]

Children, Family and Education

Rights

28. Every child under the age of 18 years has the right to family care or parental care, or to appropriate alternative care when removed from the family environment; to be protected from maltreatment, neglect, abuse or degradation; not to be detained except as a measure of last resort and kept separately from detained persons over the age of 18 years. A child's best interests are of paramount importance in every matter concerning the child.[9]

29. Everyone has the right to a basic education and access to further education.[10]

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[7] S12 of the Constitution of the Republic of South Africa, 1996
[8] S11B of Disaster Management Act (57/2002): Directions made in terms of Section 27(2) by the Minister of Cooperative Governance and Traditional Affairs 26 March 2020.
[9] S28 of the Constitution of the Republic of South Africa, 1996
[10] S29 of the Constitution of the Republic of South Africa, 1996

Limitations

30. Schools and partial care facilities were closed for months. [11]

31. Children were required to remain in the custody of the parent with whom they were with when the lockdown period started. They were prohibited from moving between parents. [12]

32. While many of these restrictions on fundamental rights have been lifted, the Respondent has imposed these restrictions without parliamentary oversight and may reimpose them. The Respondent is empowered to extend the state of disaster monthly *ad infinitum* without such oversight.

ASSUMPTIONS MADE DURING INITIAL DECLARATION OF STATE OF DISASTER

33. The purpose of declaring a national state of disaster was to flatten the curve of infections and protect the health care system from collapsing.

34. "Flattening the curve" refers to a public health strategy to slow down the spread of the SARS-CoV-2 virus which can lead to the COVID-19 disease. The reference to the "curve" is a reference to the epidemic curve, a visual representation of the number of infected people needing health care over time. During an epidemic, if the number of people requiring medical assistance exceeds the capability of the health care system to provide care, casualties can result not only in patients ill with the virus, but also other patients. Flattening the curve means slowing the spread of the epidemic so that the peak number of people requiring care at the same time is reduced, and the health care system does not exceed its capacity. Flattening the curve does not mean that fewer people will be

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[11] S6 of Disaster Management Act (57/2002): Directions made in terms of Section 27(2) by the Minister of Cooperative Governance and Traditional Affairs 18 March 2020.

[12] S6 of Directions of Minister of Social Development, in terms of regulation 10(5) of the Regulations published in Government Gazette No. 43107, Government Notice No. R318 of 18 March 2020,

infected or that fewer people will require medical assistance. It means simply that these people will present at hospitals over a longer period of time. In South Africa,, it was known that the virus could not be eradicated through the use of a lockdown, but it was thought that a lockdown would firstly buy time to prepare the health care system for a flood of cases and secondly spread those cases over time so that hospitals would not be saturated.

35. Lockdowns will not save the lives of those who contract Covid-19 and do not require hospitalisation. They also do not save the lives of those who contract the virus and would sadly and regrettably succumb to the disease even if they gained access to an ICU bed. They only assist those who contract the virus and would survive if they were hospitalised but are unable to receive such care because the health system has been overrun.

36. Prior to the state of disaster being declared, there was contradictory information in the public domain regarding the severity and infectiousness of the SARS-CoV-2 virus and how the virus affected different age groups and particular health demographics.

37. It was uncertain what the impact of measures to address the outbreak might be on lives and livelihoods.

38. Our healthcare system's ability to effectively deal with the outbreak was uncertain and time was needed to prepare for the wave of infections that was expected.

39. South Africa's means to efficiently track and trace the spread of the disease was thought to be limited.

40. The ability of government to communicate health and safety precautions effectively was uncertain. The magnitude of the infections of SARS-CoV-2 in South Africa was still unclear.

41. Models presented to government suggested that our healthcare system would not be able to cope and that hundreds of thousands of deaths from the COVID-19 disease could be expected.

42. On **19 March 2020**, Kyle Cowen writing for News24 under the headline "*EXCLUSIVE | The terrifying coronavirus projections that pushed govt into lockdown*" reported that SACEMA projected that if 100% of the population was susceptible and 40% of the population became infected, the number of deaths would be 351 000 and more than a 1 Million would need hospitalisation. If 100% of the population was susceptible and 20% of the population were to become infected it was projected that more than 500 000 would need to be hospitalised and 176 000 would die. [13]

43. On **6 May 2020**, SACEMA produced an updated report with models setting out the projected number of active, symptomatic cases that would arise and the number of ICU (intensive Care Unit) beds that would be need over the course of June 2020 to November 2020. The report is attached as **"RH3"**.

44. The report makes use of optimistic and pessimistic range estimate. The most pessimistic estimate was that 1.5 Million active symptomatic cases would be reached by mid-July with a peak need for over 100 000 hospital non-ICU beds and 40 000 ICU beds.

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[13] https://www.news24.com/news24/SouthAfrica/News/exclusive-the-terrifying-coronavirus-projections-that-pushed-government-into-lockdown-action-20200319

45. The most optimistic estimate was that 700 000 active symptomatic cases would be reached by mid-August with a peak need for nearly 60 000 hospital non-ICU beds and 20 000 ICU beds in September.

46. On **3 March 2020**, the WHO noted that, "Globally about 3.4% of reported #COVID19 cases have died."[14] This is a reference to the "case fatality rate" ("CFR")– the number of known cases who perish. The WHO arrived at this number by dividing the number of deaths by people who tested positive for SARS-CoV-2 into the total number of people who tested positive for the virus. In the same statement, the WHO noted that "seasonal flu generally kills far fewer than 1% of those infected." That is a reference to the "infection fatality rate" ("IFR") – the number of people presumed to be infected who perish. In the case of flu, the WHO arrives at the infection fatality rate by extrapolating from the number of people who present at hospital with flu symptoms, the total number of people infected with flu in a community. The number of people infected with a virus is, of course, a much larger number than the number of people testing positive for a virus and hence the comparison of CFR and IFR is unscientific.

47. Since **15 March 2020** and through the experience gained during the past seven months, the above listed uncertainties have been resolved and conclusively answered.

CURRENT COVID-19 SITUATION

48. We have, since the start of the pandemic, gained valuable and insightful expert knowledge regarding the severity and infectiousness of the SARS-CoV-2 that causes the COVID-19 disease.

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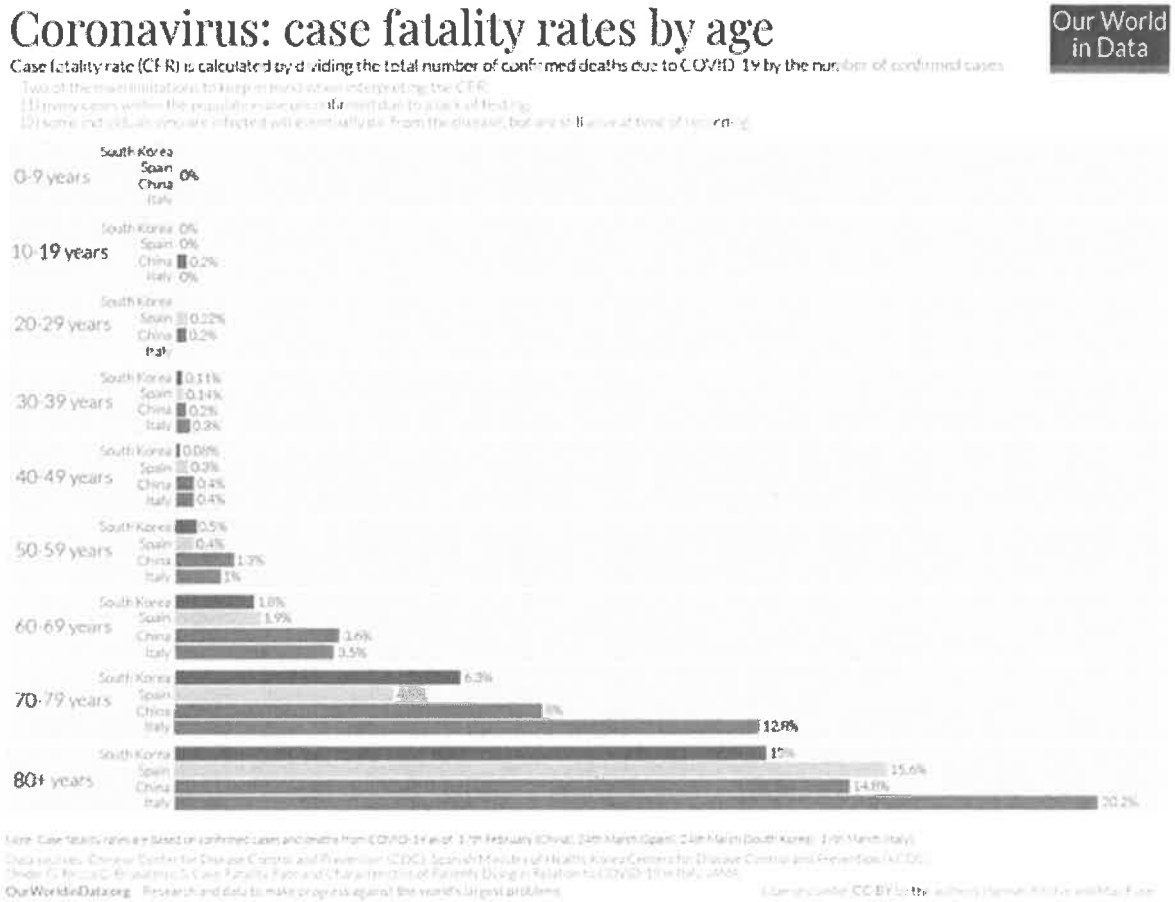
14 https://twitter.com/WHO/status/1234872254883909642?s=20.

Case Fatality Rate

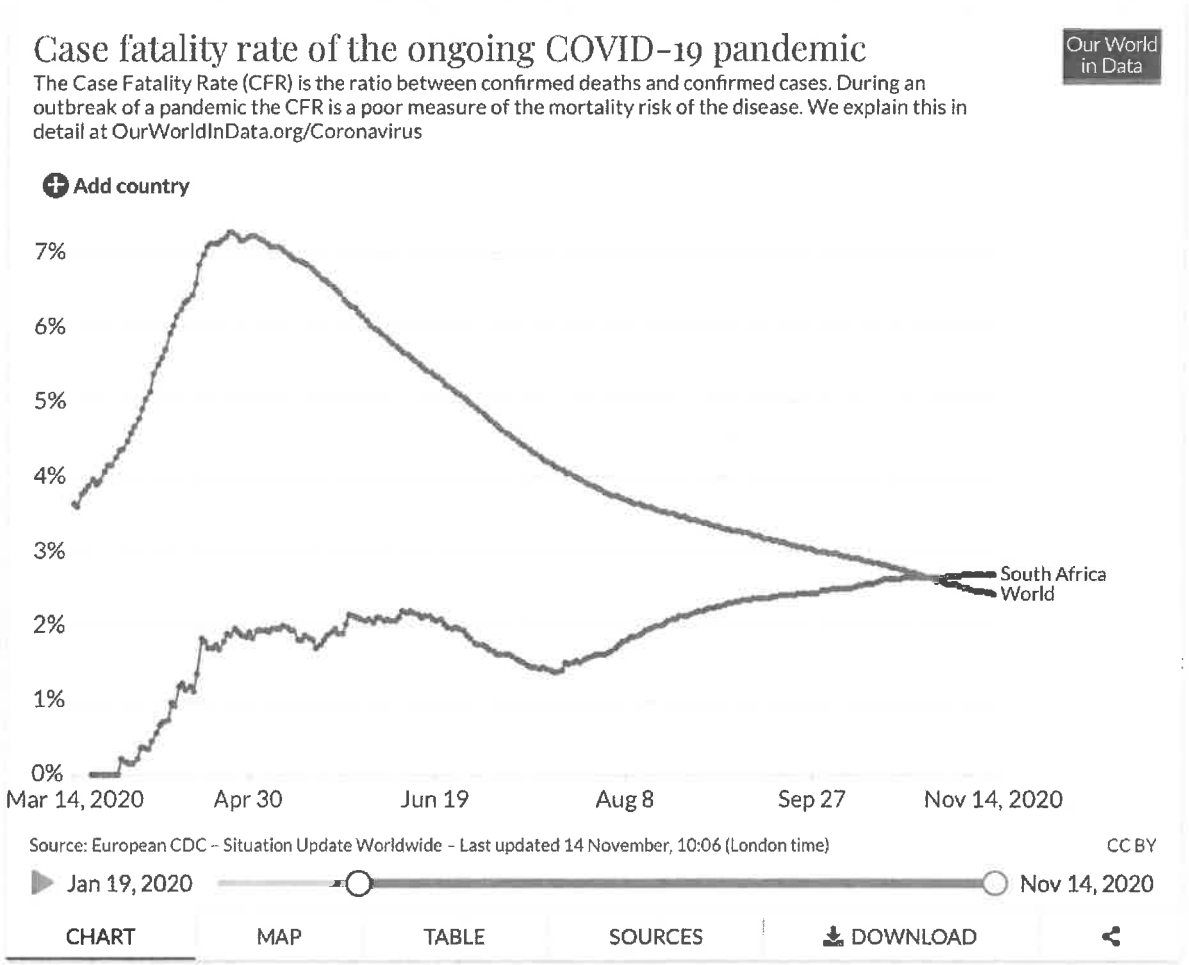
49. Our medical experts and epidemiologists have determined which groups are most at risk when contracting the virus and we have conclusively seen that the virus poses limited risks to minors. The CFR for children under 19 is 0%, and for adults under 50, it is less than 0.5%.[15]



50. Globally, as at **14 November 2020**, 53,52 million people have tested positive for SARS-CoV-2 of which 1.3 million people have died. This global case fatality rate has therefore reduced to 2.4%. The case fatality rate for South Africa is 2.7%.[16]

15 https://ourworldindata.org/mortality-risk-covid

16 https://ourworldindata.org/mortality-risk-covid



Infection Fatality Rate

51. It is now possible, through studies of the prevalence of antibodies in the community and other techniques, to determine how many people have been infected with SARS-CoV2 (as opposed to how many people have submitted to tests). The WHO noted on **5 October 2020** that 10% of the worlds' population (760 million people) are estimated to have been infected with SARS-CoV-2.[17] Given that as at **14 November 2020**, 1.3 million people have died of COVID-19, the infection fatality rate would be 0.17%. This accords with the WHO's research. The WHO recently published a paper by world famous epidemiologist John Ioannidis which

17 https://apnews.com/article/virus-outbreak-archive-united-nations-54a3a5869c9ae4ee623497691e796083

estimates the IFR of the virus is less than 0.2%. A copy of the report is attached as **"RH4"**.

The Cost of Measures to Address the Outbreak

52. The lockdown measures have had a devastating impact on the South African economy. During April, May and June, when the most severe lockdown restrictions were in place, gross domestic product contracted by over 16% giving an annualised decline of -51%. By comparison, in 2009, during the global financial crisis the annualised decline was -6.1%. Prior to the fourth quarter of 2020, the worst decline in recorded South African history was in 1982 when gross domestic product declined by -8.2%. Household spending has slumped by 49.8%.[18] In the second quarter of 2020 alone, South Africa shed 2.2 million jobs. An article from the Stats SA website is attached as **"RH5"**.

53. Economic factors have been shown to have a calculable negative consequence on health outcomes with poorer people living shorter lives. In addition, the lockdown restrictions have led directly to a negative health impact. 57% of people who needed hospital care in South Africa were apprehensive to attend hospital during lockdown. There have been drastic reductions in attendance at TB and HIV clinics as well as Cancer diagnoses. Research shows a decline in mental health and increases in calls to suicide lines during lockdown. Excess deaths in South Africa suggest that the impact of lockdown on mortality is already being experienced.

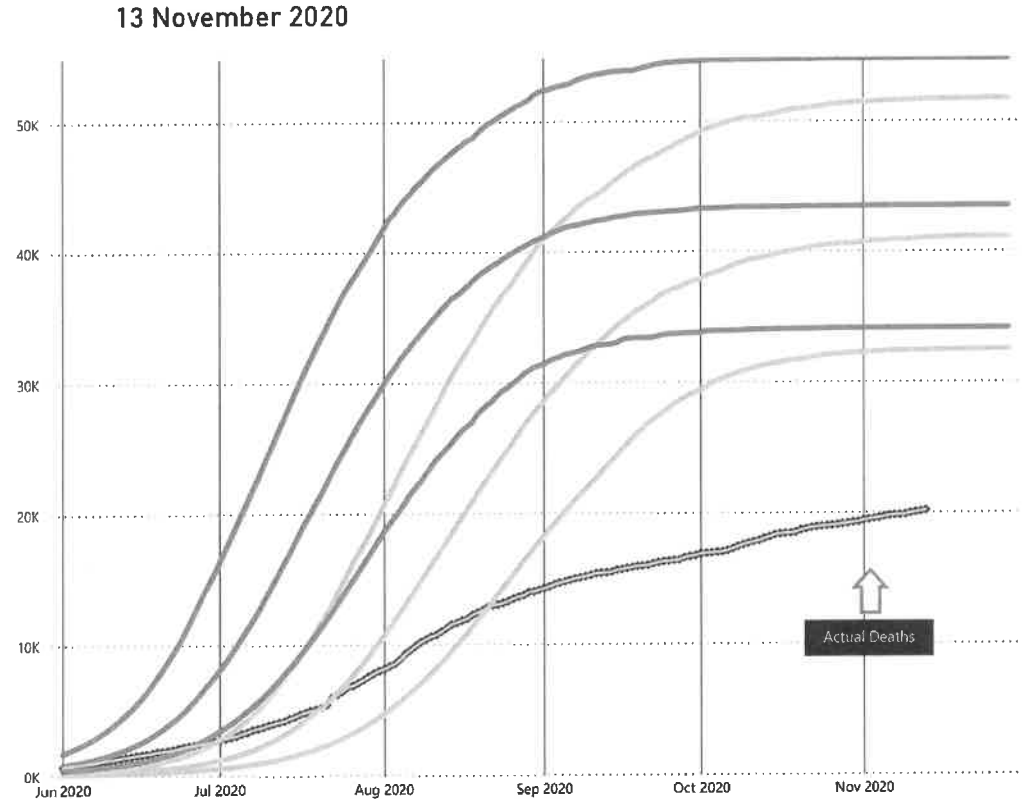
The Evolution of COVID-19 Models

54. SACEMA has stated that, although they provided their model to the National Institute for Communicable Diseases ("NICD, they were not aware that the results of that model were being used to inform policy

18 http://www.statssa.gov.za/?p=13601

decisions. They also stated that their models were not designed to inform policy decisions (like lockdown) but were merely for "situational awareness".

55. SACEMA abandoned its model soon after it was published and has advised that the model was not intended as a tool for decision-making. That model's replacement, the National Institutes for Communicable Diseases' "Epi Model" has not been updated since June and also appears to have been abandoned. When last updated, it forecast 40,000 deaths by the end of November. The Epi Model's performance against reality is being tracked[19] and it has proven to be wildly inaccurate. The Actuarial Society of South Africa's model has been slashed from its original projections and the lower estimate is now 27,000 deaths.



19 See page 3 of the document at https://app.powerbi.com/view?r=eyJrIjoiMGVjYjhkMjMtMzhjMy00OWRkLWJlNWItNjM0Nzl0Njhi NTlkliwidCI6IjlkZWYwNTBlLTExMDUtNDk1ZC1iNzUzLWRhOGRiZTc5MGVmNyJ9.

Impact on the Healthcare System

56. The Centre for Risk Analysis lists the available number of hospital beds in 2014 as follows.[20]

Total number of hospital beds in South Africa in 2014[5]

Province	Public hospital beds	Private hospitals beds	Total hospital beds
Eastern Cape	13 200	1 723	14 923
Free State	4 798	2 337	7 135
Gauteng	16 656	14 278	30 934
KwaZulu-Natal	22 048	4 514	26 562
Limpopo	7 745	600	8 345
Mpumalanga	4 745	1 252	5 997
North West	5 132	1 685	6 817
Northern Cape	1 523	293	1 816
Western Cape	12 241	4 385	16 626
South Africa	**85 362**	**31 067**	**119 155**

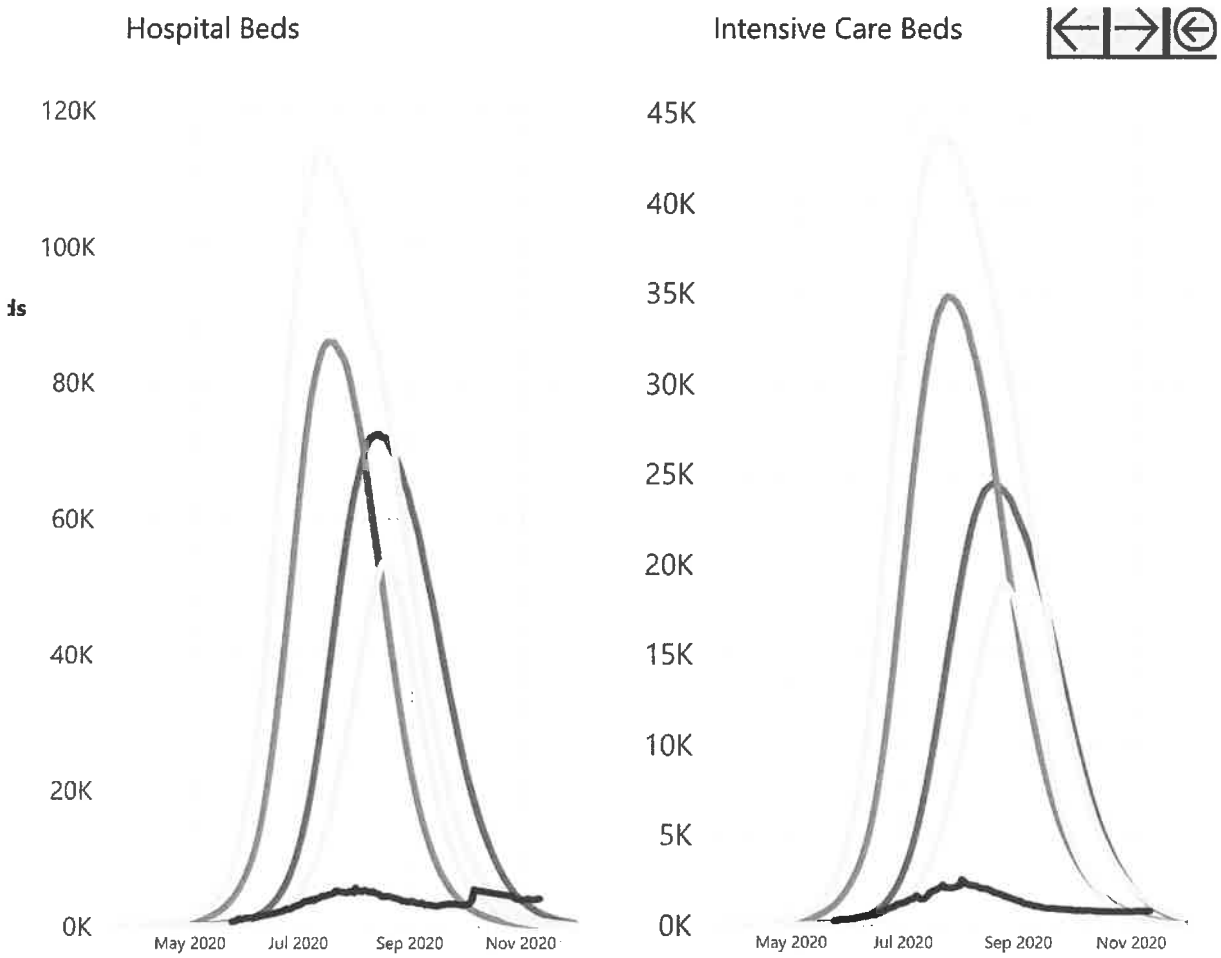
57. The number of hospital beds that were actually required during the last seven months was dramatically lower than initially anticipated. The NICD has produced a series of graphs that set out the actual use of hospitals over the past 15 weeks. These graphs are attached as **"RH6"**.

58. The pessimistic SACEMA projection was that 100 000 non-ICU beds would be needed in one day in reality less than this number of beds was needed over the course of the last seven months.

59. The current number of people admitted to hospital for Covid-19 across the country is under 5000. This is illustrated in the graphs below that show

[20] Public Health Sector in Need of an Antidote, 2016

actual usage with a black line against the models in red, blue and grey lines.



60. Seven months has granted our healthcare system the opportunity to prepare for peak infections. Treatment has improved enormously in that time with many new techniques reducing the mortality rate. Moreover, the peak of the so-called COVID-19 wave passed months ago. As in other countries, most field hospitals and temporary facilities providing additional beds for infected people proved to be unnecessary and have been closed, undoubtedly because the wave has passed. It is irrational to suggest, in the context of these facts, that the healthcare system is still being prepared for a peak.

61. Through community healthcare workers and stringent screening requirements, South Africa has developed the means to efficiently track

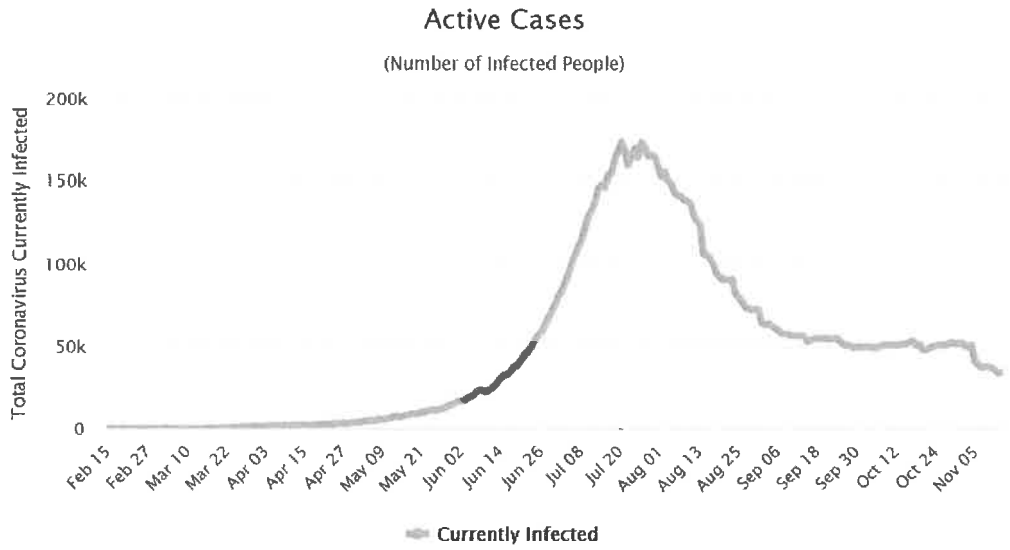
and trace the spread of the disease. Approximately 5 million COVID-19 tests have been conducted, making South Africa one of the world leaders in testing.

Ability of Government to Effectively Communicate

62. South Africans have been effectively educated on proper sanitising and the steps that should be taken when a person suspects that they may have contracted the virus. There is a relatively high level of compliance with recommendations and a low level of law enforcement required. Curfews have been shortened, the deployment of law enforcement reduced. The lowering of the lockdown stringency levels has not resulted in any material increase in mortality or infections.

63. The peak of the COVID-19 wave passed in August and we now have clear data for public health experts to track and predict future infections. At the time of writing this letter, South Africa has had an average of approximately 33 000 active cases of SARS-CoV-2 over the course of the past week, which is considerably lower than the peak of 173 590 active cases experienced on 20 July 2020. A graph from the data collection site worldometer is below.

Active Cases in South Africa



64. The number of recorded Covid-19 deaths has been far lower than expected and currently totals just over 20 000 deaths.

65. As is evident from the above synopsis, South Africa is no longer faced with the uncertainties that it was confronted with when the initial state of disaster was enacted and declared. Consequently, the circumstances that prompted the declaration have disappeared and therefore the underlying motivation for the national state of disaster has as well. There is also patently no requirement to augment existing measures and the State has reduced such measures over time with no material impact on infections or mortality.

66. The motivation for the state of disaster references the life of the nation being threatened by COVID-19, a natural disaster. Amongst the steps implemented were steps to restore and maintain peace and order, including the deployment of the National Defence Force and the imposition of curfews. In its implementation, the state of disaster is a state of emergency by a different name. In terms of Section 37 of the

Constitution, a state of emergency may only be maintained for 90 days before its extension must be approved by Parliament. No such parliamentary approval has been obtained for the latest extension.

GROUNDS OF REVIEW

67. The recent extension of the state of disaster is an administrative act reviewable in terms of section 6 of PAJA on one or more of the following grounds:-

67.1. The extension is not rationally connected to the purpose for which it was taken or the purpose of the empowering provision;

67.2. irrelevant considerations were taken into account or relevant considerations were not considered when extending the state of disaster;

67.3. The extension is unconstitutional and unlawful.

68. I am advised that PAJA defines administrative action *inter alia* as a decision taken by an organ of state such as the Minister when exercising a public power or performing a public function in terms of any legislation. The power to declare and extend the state of disaster originates in the Disaster Management Act.

69. Section 33 of the Constitution provides that:

"(1) Everyone has the right to administrative action that is lawful, reasonable and procedurally fair.

(2) Everyone whose rights have been adversely affected by administrative action has the right to be given written reasons.

(3) National legislation must be enacted to give effect to these rights, and must –

(a) provide for the review of administrative action by a court or, where appropriate, an independent and impartial tribunal;

(b) impose a duty on the state to give effect to the rights in subsections (1) and (2); and

(c) promote an efficient administration."

70. PAJA has been promulgated to give effect to section 33 of the Constitution. The Act provides that the Act was promulgated *"[t]o give effect to the right to administrative action that is lawful, reasonable and procedurally fair and to the right to written reasons for administrative action as contemplated in section 33 of the Constitution of the Republic of South Africa, 1996".*

71. Section 6 of PAJA provides for the circumstances in which litigants can bring a review application of a decision they consider to be administrative action.

72. Administrative action is defined in section 1 of the act as:

"Any decision taken or any failure to take a decision by
(a) an organ of state, when-
(i) exercising a power in terms of the Constitution or a provincial constitution; or
(ii) exercising a public power or performing a public function in terms of any legislation; or
(b) a natural or juristic person, other than an organ of the state, when exercising a public power or 35 performing a public function in terms of an empowering provision".

73. Section 6 of PAJA lists the grounds upon which an administrative decision can be brought under review. The section provides that:

"(1) Any person may institute proceedings in a court or a tribunal for the judicial review of an administrative action.

(2) A court or tribunal has the power to judicially review an administrative action if –

(a) the administrator who took it – (i) was not authorised to do so by the empowering provision; (ii) acted under a delegation of power which was not authorised by the empowering provision; or (iii) was biased or reasonably suspected of bias;

(b) a mandatory and material procedure or condition prescribed by an empowering provision was not complied with;

(c) the action was procedurally unfair;

(d) the action was materially influenced by an error of law;

(e) the action was taken – (i) for a reason, not authorised by the empowering provision; (ii) for an ulterior purpose or motive; (iii) because irrelevant considerations were taken into account or relevant considerations were not considered; (iv) because of the unauthorised or unwarranted dictates of another person or body; (v) in bad faith; or (vi) arbitrarily or capriciously;

(f) the action itself – (i) contravenes a law or is not authorised by the empowering provision; or (ii) is not rationally connected to – (aa) the purpose for which it was taken; (bb) the purpose of the empowering provision; (cc) the information before the administrator; or (dd) the reasons given for it by the administrator;

(g) the action concerned consists of a failure to take a decision;

(h) the exercise of the power or the performance of the function authorised by the empowering provision, in pursuance of which the administrative action was purportedly taken, is so unreasonable that no reasonable person could have so exercised the power or performed the function; or

(i) the action is otherwise unconstitutional or unlawful.

74. I am advised that in *Bato Star Fishing (Pty) Ltd v The Minister of Environmental Affairs and Tourism and Others* the Constitutional Court developed the test of reasonableness in administrative decision. The

court held that in considering whether the decision was reasonable or not depends on the circumstances of each case. In terms of the decision in Bato Star what is reasonable depends on whether a decision maker in the shoes of the decision maker would have arrived to the same decision taken by the decision maker.

75. The Constitutional Court further held that "factors relevant to determining whether a decision is reasonable or not will include the nature of the decision, the identity and expertise of the decision-maker, the range of factors relevant to the decision, the reasons given for the decision, the nature of the competing interests involved and the impact of the decision on the lives and well-being of those affected."

76. With the administrative decision of this nature, which does not go through common legislative processes through parliament, it becomes even more significant for a decision of this nature to be rational and constitutionally sound.

77. To the extent that it may be held not to qualify as "administrative action" as defined in PAJA, I am advised that the Minister is constrained by the principle of legality enshrined in section 1(c) of the Constitution and the common law. Legality entails that the Minister may exercise no power and perform no function beyond that which is conferred upon her by law. I am further advised that it is accepted by our Honourable courts that section 1(c) of the Constitution empowers them to review and set aside state action on grounds of irrationality and unconstitutionality.

IRRATIONALITY AND FAILURE TO TAKE INTO ACCOUNT RELEVANT CIRUMSTANCES

78. I am advised that in *Trinity Broadcasting, Ciskei Independent Communications Authority of SA* (2003) 4 All SA 589 (SCA) the court held that the rationality test should be applied to give effect to section 6(2) of PAJA. The test is objective, and the court should ask whether there is a rational objective basis justifying the connection made by the

administrative decision maker between the material that is made available and the conclusion he/she arrived at.

79. While it may have been rational to have declared a state of disaster in March, much has changed since then. It is no longer rational to have the declaration in place and it should not have been extended.

UNCONSTITUTIONAL

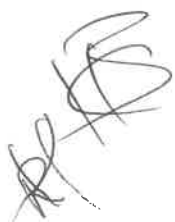
80. The state of disaster grants the executive the power to pass draconian legislation that has derogated from the rights of all those who live in South Africa. The state of disaster can be extended *ad infinitum* by the Minister without a requirement of Parliamentary oversight. This has occurred, and continues to occur, which undermines our constitutional democracy, premised on a genuine separation of powers.

A SECOND WAVE?

81. There remains the possibility that there will be a second wave of infections. The state has had sufficient time to prepare for this event and the first wave did not overwhelm the hospital system. If the situation changes, a new state of disaster could be declared based on new circumstances that may arise. It is improper to keep the current state of disaster perpetually in force on the basis that some new disaster may occur on some unknown date.

NO OTHER REMEDY

82. The Applicant wrote a letter of demand to the Respondent alerting her to the irrational and unconstitutional nature of the extension of the state of disaster and asking her to provide reasons for why the decision was made. A copy of the letter is attached as "**RH7**". No response has been received from the Respondent.



83. There are no further internal remedies that the Applicant can avail itself of to set aside the disputed regulation. Therefore, the Applicant has no other option but to approach this Honourable Court for the relief set out in its Notice of Motion.

URGENCY

84. I am advised that in order to approach the above Honourable Court on an urgent basis, the Applicant is required to set forth the circumstances which is averred render the matter urgent and the reasons why the Applicant claims that the Applicant could not be afforded substantial redress at a hearing in due course.

85. As to the grounds of urgency, this application is patently urgent because the state of disaster has just been extended and this extension will be in effect until 15 December 2020 (where after it is possible that the state of disaster may be re-extended). During this time, and under the existing regulations, there are various limitations on Constitutionally entrenched rights, which include, for example, limitations on:

85.1. the right to freedom and security of the person (a curfew remaining in place in terms of regulation 66 of the level 1 regulations as well as limitations on social gatherings in terms of regulation 69(4) of the level 1 regulations);

85.2. freedom of religion (gatherings at faith-based institutions being limited in terms of regulation 69(3) of the level 1 regulations);

85.3. freedom of assembly and the right to political rights (gatherings at political events being limited in terms of regulation 69(5) of the level 1 regulations); and

85.4. the right to freedom of trade, occupation and profession (regulation 78(1) of the level 1 regulations prohibiting certain businesses (as set out in Table 4 of the level 1 regulations) from operating).

86. As regards the reasons why the Applicant would not be afforded substantial redress in due course, I am advised that there is no remedy which can provide for redress relating to continued violations and limitations on Constitutional rights (including the economic and other harm which flow from such violations and limitations).

87. In the premise, the Applicant respectfully contends that the matter is sufficiently urgent to be adjudicated under these circumstances.

WHEREFORE I pray that the above Honourable Court grant the relief as set out in the **NOTICE OF MOTION** to which this affidavit and its annexures form an annexure.

ROB HUTCHINSON (DEPONENT)

SIGNED and **SWORN TO** before me, at **PRETORIA** on this 16th day of November **2020**, by the Deponent who has acknowledged that the Deponent knows and understands the contents of this Affidavit and has declared that the Deponent has no objection to taking the oath, and the Deponent regards the oath as binding on the Deponent's conscience and has uttered the following words: - *"I swear that the contents of this Affidavit are true, so help me God."*

COMMISSIONER OF OATHS

FULL NAMES:-

BUSINESS ADDRESS:-

OCCUPATION:-

KEVIN EBEN DE BRUIN
PRACTISING ATTORNEY
COMMISSIONER OF OATHS (EX OFFICIO)
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DEPARTMENT OF CO-OPERATIVE GOVERNANCE AND TRADITIONAL AFFAIRS

NO. 313 **15 MARCH 2020**

DISASTER MANAGEMENT ACT, 2002

DECLARATION OF A NATIONAL STATE OF DISASTER

Considering the magnitude and severity of the COVID-19 outbreak which has been declared a global pandemic by the World Health Organisation (WHO) and classified as a national disaster by the Head of the National Disaster Management Centre, and taking into account the need to augment the existing measures undertaken by organs of state to deal with the pandemic, I, Dr Nkosazana Dlamini Zuma, the Minister of Cooperative Governance and Traditional Affairs, as designated under Section 3 of the Disaster Management Act, 2002 (Act No. 57 of 2002) ("the Act"), in terms of -

1) Section 27(1) of the Act, hereby declare a national state of disaster having recognised that special circumstances exist to warrant the declaration of a national state of disaster; and

2) Section 27(2) of the Act may, when required, make regulations or issue directions or authorise the issue of directions concerning the matters listed therein, only to the extent that it is necessary for the purpose of —

   (a) assisting and protecting the public;

   (b) providing relief to the public;

   (c) protecting property;

   (d) preventing or combatting disruption; or

   (e) dealing with the destructive and other effects of the disaster.

NC Zuma

DR NKOSAZANA DLAMINI ZUMA, MP

MINISTER OF COOPERATIVE GOVERNANCE AND TRADITIONAL AFFAIRS

DATE: 15. 03. 2020.

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DEPARTMENT OF CO-OPERATIVE GOVERNANCE

NO. 1225 **14 NOVEMBER 2020**

DISASTER MANAGEMENT ACT, 2002

EXTENSION OF A NATIONAL STATE OF DISASTER (COVID-19)

I, the Minister of Cooperative Governance and Traditional Affairs, as designated under section 3 of the Disaster Management Act, 2002 (Act No. 57 of 2002) ("the Act"), in terms of section 27(5)(c) of the Act, hereby further extends the national state of disaster that I extended to 15 November 2020 by Government Notice 1090, published in Government Gazette 43808, to 15 December 2020, taking into account the need to continue augmenting the existing legislation and contingency arrangements undertaken by organs of state to address the impact of the disaster.

NC Zuma

DR NKOSAZANA DLAMINI ZUMA, MP

MINISTER OF COOPERATIVE GOVERNANCE AND TRADITIONAL AFFAIRS

DATE: 13. 11. 2020

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Estimating cases for COVID-19 in South Africa

Long-term national projections

Report Update: 6 May 2020

FOR PUBLIC RELEASE

Prepared by MASHA, HE²RO, and SACEMA

on behalf of the South African COVID-19 Modelling Consortium

Please address all queries and comments to: Harry Moultrie at HarryM@nicd.ac.za

The projections in this report are intended for planning purposes by the South African government.

USAID
FROM THE AMERICAN PEOPLE

Key Messages

COVID-19 is a new infectious disease. There is much still unknown about how the disease works, and how it will progress in the South African context. The South African COVID-19 Modelling Consortium was established to project the spread of the disease to support policy and planning in South Africa over the coming months.

Due to the rapidly changing nature of the outbreak globally and in South Africa, the projections are updated regularly as new data become available. As such, projections should be interpreted with caution. Changes in testing policy, contact tracing, and hospitalisation criteria will all impact the cases detected and treated as well as the required budget for the COVID-19 response in the next six months.

The model projects that by 1 June, under the optimistic scenario, detected cases are expected to rise to between 10,702 and 24,781 depending on availability of testing and the effectiveness of the post-lockdown. The cumulative number of deaths by 1 June is expected to be between 112 and 940.

The lockdown is anticipated to have flattened the curve and delayed the peak by 2 to 3 months, depending on the strength of the public's adherence to the lockdown and social distancing measures. In the coming weeks, we will be able to estimate more accurately what the effect has been.

South Africa is likely to see a peak demand for hospital and ICU beds between August and September. However, based on current resource levels, model projections indicate that the number of available hospital and ICU beds will likely be exhausted by July. The NDOH's COVID-19 budget will be between 10 and 15 billion rand and as such is affordable under the 20 billion rand budget allocation for the medical COVID-19 response.

Executive summary

The purpose of this report is to project estimated COVID-19 cases at national and provincial levels for the next six months. A mathematical model was used to simulate the transmission of local and imported COVID-19 cases based on data regarding laboratory confirmed infections until 30 April 2020 and using parameter estimates jointly agreed upon by the SA COVID-19 Modelling Consortium.

The model projects that by 1 June 2020, detected cases are expected to have risen to 15,817 (10,702, 24,781) in the optimistic scenario and 76,106 (44,955, 129,884) in the pessimistic scenario based on the availability of testing and effectiveness of the lockdown. The cumulative number of deaths by 1 June is expected to be between 112 and 940. The range of uncertainty grows with each month, with an estimated 3.4-3.7 million laboratory-confirmed cases by 1

November, with the number of deaths expected to be between 34,015 and 49,774. The required total budget for the national and provincial departments of health will be between 26 and 32 billion rand over the next 6 months, of which between 10 and 15 billion rand will accrue to the National Department of Health (NDOH). This budget covers personal protective equipment, the cost of additional ICU and hospital beds and staff, additional PHC staff, ventilators, drugs, isolation facilities, testing and surveillance and Port Health budgets. The NDOH portion of the budget is affordable under the 20 billion rand budget allocation for the medical COVID-19 response. **These projections are subject to considerable uncertainty and variability. Estimates will change and improve as the epidemic progresses and new data become available.** ICU and hospital bed numbers are to be interpreted with caution as severity of disease is yet to be contextualised to South Africa, and admission to ICU is likely to be subject to stricter criteria than globally. Nevertheless, model projections indicate that the number of available hospital and ICU beds will likely be exhausted by July, possibly increasing the death rate beyond what is projected here.

As updated testing and hospital data become available, the models can be calibrated to provide more robust predictions.

Due to the rapidly changing nature of the outbreak globally and in South Africa, the projections will need to be updated regularly and should be interpreted with caution. Changes in testing policy, contact tracing, and hospitalisation criteria will all impact the cases detected and treated in the next six months. The models have been developed using data that is subject to a high degree of uncertainty. Transmission has been modelled at national and provincial levels resulting in model predictions providing broad-stroke national/provincial guidance rather than informing strategy at a more granular level. All models are simplifications of reality that are designed to describe and predict system behaviour and are justified by the assumptions and data with which they are developed.

About the South African COVID-19 Modelling Consortium

The South African COVID-19 Modelling Consortium is group of researchers from academic, non-profit, and government institutions across South Africa. The group is coordinated by the National Institute for Communicable Diseases, on behalf of the National Department of Health. The mandate of the group is to provide, assess and validate model projections to be used for planning purposes by the Government of South Africa. For more information, please contact Dr Harry Moultrie (harrym@nicd.ac.za).

Context for interpreting projections

The results presented below must be interpreted carefully and considering the following points of additional context:

Not all COVID-19 infections will be detected. Infected individuals who are asymptomatic are not likely to seek out a diagnostic test. Additionally, with laboratory and testing constraints, it is not always possible to test all individuals who seek laboratory confirmation. A meeting of epidemiologists was convened at the NICD to estimate the number of cases active in the population that were not being detected. The number of confirmed COVID-19 cases, evolution of patient under investigation criteria for COVID-19 testing, the number of contacts identified and proportion traced, and publications/reports on under-detection rates in other countries were reviewed. It was concluded that all hospitalised severe and critically ill cases would be detected while only 1 in 4 mildly ill cases would be detected. This inflation factor is applied in the model projections. The true value is unknown and is likely to vary through time. For example, it is likely that with a scale-up in testing and laboratory facilities this inflation factor will go down. The estimate may be revised for future projections. Serosurveillance studies are being planned to provide more robust estimates.

Projections at the population level do not capture local clustering of cases. The methods used in this report make simplifying assumptions regarding how contacts between infectious and uninfected people occur and assume that mixing is random at the provincial level. The models therefore cannot capture the differences in risk experienced by some members of society – e.g. health care workers or those living in close, confined quarters such as prisons – nor can it capture the effects of specific events – e.g. religious gatherings and funerals – on local transmission.

Models project total need for hospital and ICU beds. As currently formulated, the model assumes that hospital resources, including availability of general ward and ICU beds, staff, and ventilators, will be able to meet demand. This approach is intended to demonstrate the system-wide need for these resources. In reality, the demand for these resources is expected to exceed capacity. The effect, in particular on mortality, of not being able to meet ICU and ventilator demand is not taken into account in the model, nor are the effects of any rationing of these resources.

Estimating mortality due to COVID-19. There is considerable uncertainty when projecting mortality due to COVID-19 using mathematical models. At this early stage of the epidemic, it is unclear what proportion of people who become infected will die as well as precisely how many people will become infected over the course of the epidemic. It is also unclear how risk factors such as HIV, TB, and non-communicable diseases will impact COVID-19 mortality in South Africa. In the model presented here, mortality has been projected using age-specific mortality from the Chinese epidemic adapted to the South African population.

It is particularly important to note that the projections over a six month period for South Africa cannot be compared to *current* mortality in other COVID-19 affected countries, as

mortality would have been observed for at most three months in those countries. All countries are currently in the early phase of their epidemics, with resurgence expected in the coming months. Current model projections track observed mortality in South Africa estimating 2 deaths per million population by 4 May 2020. This rate falls below countries such as Algeria (11 per million) and Egypt (4 per million) on the same date (https://www.worldometers.info/coronavirus/). The mortality and case projections are also determined on the assumption that social distancing will continue after the 5-week lockdown. New national and/or geographically targeted interventions will impact the expected deaths due to COVID-19.

Models do not account for population-wide behaviour changes in response to high levels of mortality. The projections provided in this document are based on an assumption that after the lifting of hard lockdown measures, level four restrictions are assumed to be in place for one month following which social distancing will continue at a moderate level, reducing transmission by 10-20%. No further responses to the epidemic are incorporated, either government-imposed measures such as lockdowns or natural behavioural changes induced by the severity the epidemic. In recent epidemics of severe disease, including the Ebola epidemic in West Africa, the population's response to high local mortality has played an important role in reducing the rate of epidemic growth and the ultimate number of infections and deaths. Similar dynamics have likely contributed to the decline of severe COVID-19 epidemics in countries such as Spain and Italy. The extent to which population-wide behavioural changes may influence the spread of the epidemic in South Africa, or how these changes may vary across the population, are unknown and not taken into account in the projections provided in this report.

Projections will improve with new data. At the time of this report, very limited data are available beyond the number of new cases confirmed through time at the national and provincial level. Additional data, in particular health system utilization data such as numbers of hospitalizations occurring in different geographic areas and duration of stay for patients requiring different types of care, will be required to further refine the model and tune it to the South African context. The uncertainty range in the projections has been generated by varying a subset of model parameters. These ranges will be modified as local data becomes available.

Understanding of the virus's epidemiology is continually evolving, both locally and globally. Important parameters about which there remains substantial uncertainty in the scientific literature include the proportion of infections that are truly asymptomatic, the relative infectiousness of these asymptomatic individuals, and the relative duration of infectiousness for these individuals, as well as the severity profile of cases in different contexts. The Appendix presents a sensitivity analysis that examines the effect of varying these factors on the timing and magnitude of the expected epidemic peak.

Budgets had to be calculated before anything was known about the cost and resources needed for these interventions in a routine setting. The estimated budget is based on best available data regarding the likely type, quantity and price of inputs as well as baseline availability of resources such as hospital beds, ventilator equipment, staff and testing capacity and their ability to be re-purposed for the COVID1-9 response. The prices of a number of central resources are currently subject to strong market forces as many countries around the world are competing for the same set of materials. Additionally, the increase in lead times on deliveries resulting from manufacturing countries' travel and trade bans means that even if the budget is made available, supply might not be complete or in time.

Note on the long term and short term projections for COVID-19

Three companion reports have been produced by the National COVID-19 Modelling Consortium to project cases and deaths for the COVID-19 epidemic in South Africa.

1. Short Term Projections: May 2020
2. Long Term National Projections
3. Long Term Provincial Projections

There are a number of key differences in the assumptions used to generate projections in the short and long term.

In the long run, it is expected that biological characteristics of the disease, its progression, severity and mortality, will be similar across the nine provinces. In order to generate long term projections, all provinces were assumed to have the same basic reproductive number (R_0), though this number was allowed to vary stochastically.

However, in the early stages of the epidemic, the disease may have seeded differently in the provinces and in communities with varying contact behaviour. Stochastic events such as clusters of cases or sharp increases in deaths may occur that are divergent from the average pattern. Hence the differences in patterns of growth of the epidemic tend to be larger at the beginning of the epidemic, but reduce as the epidemic progresses. Thus, to provide short term projections reflective of the trends observed in reported deaths, different R_0 values were estimated for each of the provinces.

These stochastic fluctuations are not expected to continue in the long run and therefore the basic reproductive number is assumed to be the same for all provinces in the long term projections. For this reason, there is a lack of congruence between the short term projections for 29 May 2020 and the long term projections for 1 June 2020 in the national and provincial reports.

The short-term projections will be updated on a weekly basis. We are planning to update the long-term projections towards the end of May, taking into account two aspects:

- additional data on the development of cases and deaths after the end of lock-down, which will give us a better estimate of the impact of Level 4 restrictions;
- better consideration of the spatial aspects of the epidemic at lower geographical scales.

Findings: Projected cases in the next six months

We model two scenarios, as detailed in Table 1, to capture uncertainty in the potential effectiveness of lockdown and social distancing measures. The scenarios are modelled as a reduction in the daily contact rate of individuals. Fixed values regarding the size of these reductions were determined by the SA COVID-19 Modelling Consortium. The level of adherence by the population to lockdown and social distancing regulations will influence the effectiveness of these measures.

Table 1. Modelled scenarios of intervention effectiveness

Scenarios	**Description**
Optimistic Effectiveness	Lockdown reduces transmissibility until 30 April ($0.4*R_0$; 60% reduction in transmission relative to baseline) Level four restrictions reduce transmissibility from 1 May to 31 May ($0.65*R_0$; 35% reduction in transmission relative to baseline) Social distancing (school closures, limited public gathering) reduces transmissibility - implemented after 31 May ($0.8*R_0$; 20% reduction in transmission relative to baseline)
Pessimistic Effectiveness	Lockdown reduces transmissibility until 30 April ($0.6*R_0$; 40% reduction in transmission relative to baseline) Level four restrictions reduce transmissibility from 1 May to 31 May ($0.75*R_0$; 25% reduction in transmission relative to baseline) Social distancing (school closures, limited public gathering) reduces transmissibility - implemented after 31 May ($0.9*R_0$; 10% reduction in transmission relative to baseline)

Table 2 summarises the ranges of the number of cases, required hospital and ICU beds, and deaths estimated by the mathematical model. It is important to realise that not all active cases will require healthcare. A substantial proportion of cases (75% in this analysis) are assumed to be asymptomatic or very mildly ill such that they would not require an outpatient care visit and would be very unlikely to seek COVID testing. Approximately 95% of active symptomatic cases are predicted to be mildly ill, with only a fraction of those seeking outpatient care or

COVID testing. **Large case numbers do not necessarily present a large burden on the health system.** As has been the experience of many countries around the world, the vast majority of COVID-19 cases will show no or mild symptoms. Thus, the total case numbers projected by the model and shown in this document are substantially higher than would be reported.

Estimates on hospitalisation and death are based on international data. These will be regularly updated with admissions and case fatality data as these become available and the epidemic progresses. The wide variability in these projections suggests that there is much unknown about the disease. As such these estimates should be treated with caution.

The number of cases detected depends on patients feeling sick enough to seek testing/hospitalisation and being able to receive a test. Different criteria may exist in the public and private sector resulting in different testing and positivity rates. The detection factor takes this into account by adjusting the number of overall cases for those that would be detected. The detection factor is arbitrary in that it may relate only to one point in time. As public awareness and test seeking or contact tracing increases, and as tests are scaled up around the country, this factor will decrease.

Figure 1. Projected National cases

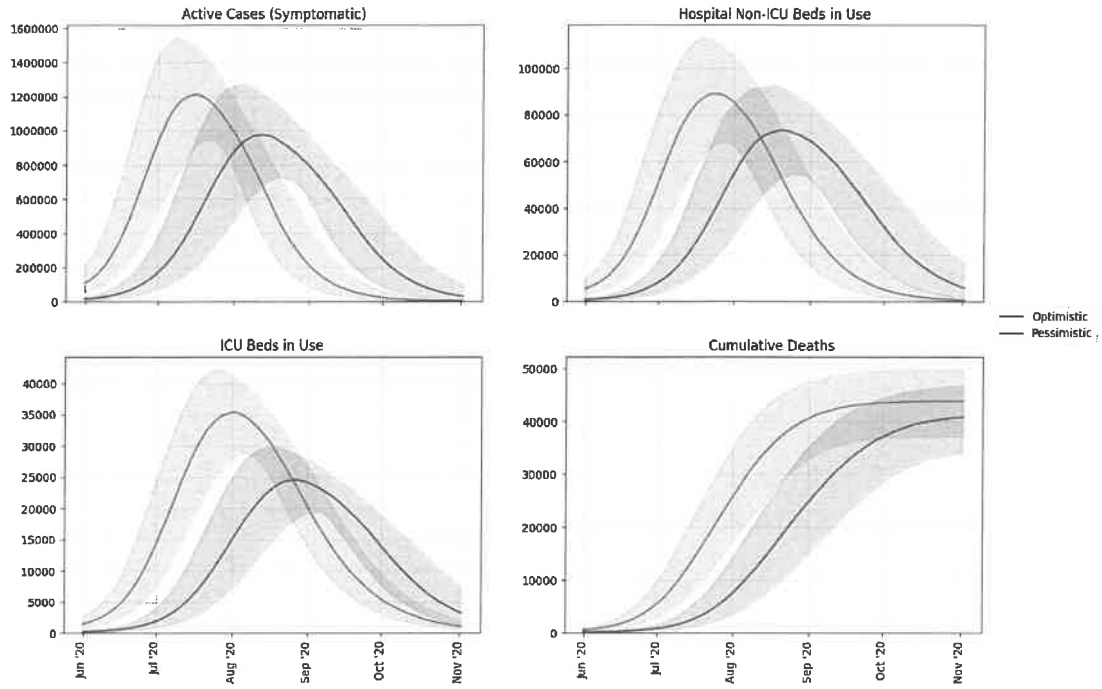


Table 2. Projected National cases

		Cumulative Incidence		Active Cases		
		Total	Symptomatic	All	Symptomatic	Cumulative Detected Cases
Optimistic	2020-06-01	382,366 (237,390 - 632,813)	71,541 (45,134 - 117,526)	82,298 (43,008 - 157,053)	14,763 (7,736 - 28,712)	15,817 (10,702 - 24,781)
	2020-07-01	3,661,393 (1,676,865 - 7,448,898)	598,489 (276,180 - 1,299,104)	966,647 (398,228 - 2,163,111)	169,318 (69,374 - 392,257)	112,997 (55,232 - 236,964)
	2020-08-01	21,686,098 (11,622,701 - 32,540,064)	4,270,362 (2,105,178 - 7,179,877)	4,696,334 (2,602,093 - 6,255,373)	874,156 (472,490 - 1,264,623)	910,318 (439,042 - 1,642,691)
	2020-09-01	41,487,628 (30,638,488 - 48,321,906)	9,524,163 (6,518,622 - 12,275,248)	4,063,347 (2,953,085 - 4,502,688)	791,638 (594,880 - 968,958)	2,416,136 (1,592,775 - 3,282,335)
	2020-10-01	47,781,735 (42,677,516 - 50,722,344)	11,744,679 (9,571,499 - 13,614,809)	1,171,259 (400,569 - 2,396,710)	244,925 (85,914 - 489,073)	3,245,104 (2,589,072 - 3,817,607)
	2020-11-01	48,658,190 (45,681,241 - 50,944,673)	12,153,147 (10,261,464 - 13,828,132)	141,168 (35,705 - 515,442)	32,146 (8,367 - 107,815)	3,450,932 (2,896,897 - 3,932,537)
Pessimistic	2020-06-01	2,306,459 (1,343,540 - 4,094,445)	394,780 (226,084 - 718,080)	598,761 (313,294 - 1,171,397)	107,255 (54,538 - 214,996)	76,106 (44,955 - 129,884)
	2020-07-01	20,139,796 (12,223,262 - 29,701,255)	3,761,577 (2,072,257 - 6,186,625)	5,058,676 (3,006,812 - 7,170,122)	942,500 (529,302 - 1,444,940)	743,689 (400,140 - 1,271,758)
	2020-08-01	44,867,939 (36,510,103 - 50,458,627)	10,327,075 (7,579,812 - 12,934,700)	5,011,909 (3,855,147 - 5,574,058)	991,907 (776,146 - 1,187,468)	2,586,688 (1,830,408 - 3,340,153)
	2020-09-01	50,929,041 (48,236,582 - 52,942,777)	12,651,032 (10,639,563 - 14,532,758)	960,210 (380,199 - 2,037,842)	212,102 (88,366 - 433,899)	3,532,779 (2,920,352 - 4,080,889)
	2020-10-01	51,444,712 (49,503,933 - 53,109,938)	12,926,888 (10,934,833 - 14,686,634)	87,694 (28,465 - 265,289)	23,404 (8,869 - 62,399)	3,670,117 (3,104,194 - 4,173,374)
	2020-11-01	51,474,905 (49,631,737 - 53,126,395)	12,941,100 (10,948,713 - 14,710,158)	7,199 (2,221 - 25,104)	2,579 (1,031 - 7,161)	3,685,249 (3,118,462 - 4,187,290)

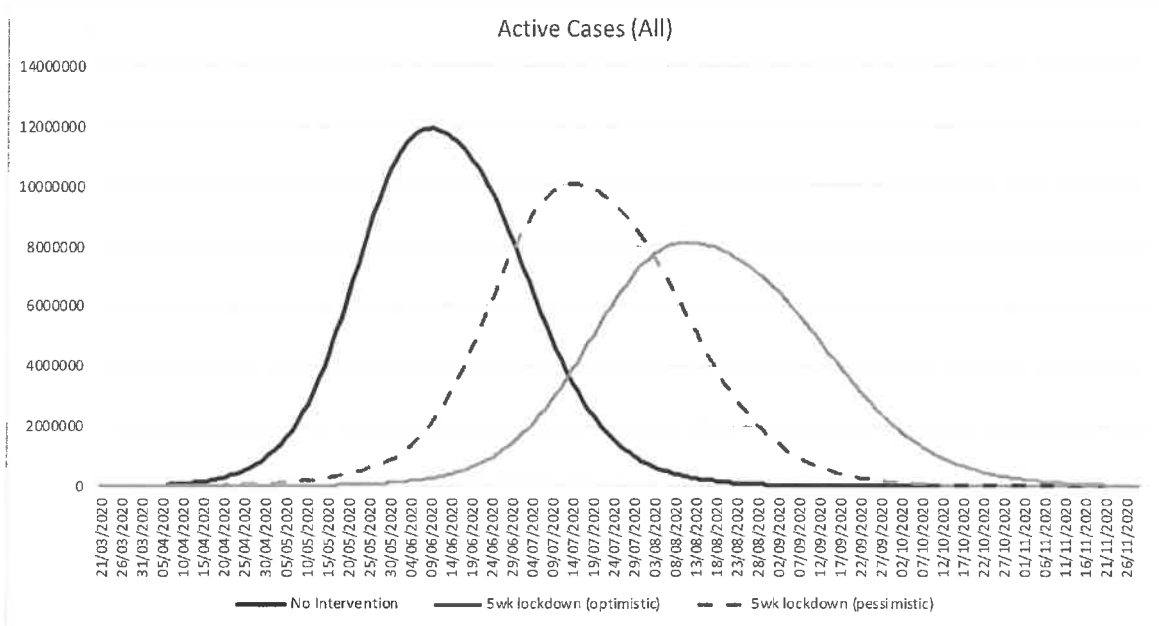
		Cumulative Admissions		Hospital Beds in Use		
		Non-ICU	ICU	Non-ICU	ICU	Cumulative Deaths
Optimistic	2020-06-01	2,256 (1,533 - 3,473)	729 (509 - 1,088)	797 (459 - 1,417)	206 (124 - 353)	151 (112 - 216)
	2020-07-01	15,559 (7,494 - 32,584)	4,563 (2,288 - 9,305)	8,079 (3,637 - 17,771)	1,904 (860 - 4,177)	822 (431 - 1,618)
	2020-08-01	120,685 (57,869 - 211,333)	38,392 (17,898 - 69,730)	54,543 (28,321 - 84,713)	14,973 (7,120 - 24,936)	7,430 (3,386 - 14,249)
	2020-09-01	295,663 (187,592 - 417,938)	106,621 (66,939 - 152,058)	68,893 (52,545 - 84,191)	24,113 (19,203 - 27,907)	24,750 (14,979 - 35,296)
	2020-10-01	382,637 (228,801 - 545,682)	146,208 (88,301 - 206,118)	31,924 (13,493 - 51,484)	13,829 (7,664 - 18,921)	37,090 (28,446 - 44,459)
	2020-11-01	398,642 (233,027 - 592,912)	154,810 (90,736 - 228,674)	6,034 (1,663 - 17,179)	3,372 (1,321 - 7,716)	40,784 (34,015 - 46,657)
Pessimistic	2020-06-01	10,491 (6,252 - 18,515)	3,134 (1,906 - 5,373)	5,295 (2,904 - 9,990)	1,427 (815 - 2,586)	571 (363 - 940)
	2020-07-01	100,141 (53,767 - 170,262)	30,273 (16,056 - 53,112)	51,450 (28,253 - 82,260)	14,483 (7,651 - 24,735)	5,486 (2,849 - 9,869)
	2020-08-01	317,464 (218,114 - 430,965)	113,133 (77,200 - 155,052)	85,462 (66,685 - 105,619)	35,380 (27,830 - 41,328)	25,647 (17,037 - 34,982)
	2020-09-01	414,516 (268,720 - 575,892)	158,892 (104,060 - 218,569)	31,851 (15,444 - 53,186)	20,121 (13,658 - 26,613)	40,565 (32,773 - 47,489)
	2020-10-01	425,360 (272,006 - 605,924)	165,134 (106,082 - 234,462)	5,024 (1,915 - 12,257)	5,410 (3,073 - 9,545)	43,543 (36,811 - 49,614)
	2020-11-01	426,207 (272,216 - 609,022)	165,634 (106,210 - 236,259)	606 (215 - 1,818)	1,078 (577 - 2,125)	43,831 (37,094 - 49,774)

**Projections on hospital bed use assume unconstrained resources (testing, hospital beds, ICU beds)

The projected impact of lockdown

The scale-up in testing and data collected over the next few weeks will allow models to estimate the impact of lockdown. In the absence of such data, using the suggested optimistic and pessimistic effectiveness of lockdown, the model projected the epidemic curve for the scenarios of no intervention and the 35-day lockdown followed by Level 4 restrictions for one month and social distancing thereafter. The figure below is subject to wide uncertainty when estimating eight months into the future. The optimistic and pessimistic impacts of lockdown demonstrate considerable shifts in and flattening of the epidemic curve. The projected epidemic curves in Figure 2 show all active infections (asymptomatic and symptomatic), whether detected or not.

Figure 2. Projected epidemic curves (total active infections) under the 5-week lockdown scenario compared to a hypothetical scenario with no lockdown



Required budget

We projected the required budget for the first 6 months of the COVID-19 response (Apr-Sept 2020) under the pessimistic and optimistic scenarios, covering the incremental cost of personal protective equipment (PPE), additional ICU and hospital beds and staff, additional PHC staff, ventilators, oxygen, drugs at all levels of care, isolation facilities, testing and surveillance and Port Health budgets. Excluded are the costs of setting up and running field hospitals, oxygen delivery equipment, additional testing platforms beyond the currently planned ones (Xpert and Alinity), and additional NHLS staff. Stipends for additional community health workers to carry out screening activities are excluded as these are funded by a donor's budget; their PPE and other equipment is however covered. Based on this, the required total budget for the national and provincial departments of health will be between 26 and 32 billion rand over the next 6 months, of which between 10 and 15 billion rand will accrue to the National Department of Health (NDOH), in keeping with the additional 20 billion rand allocation for the medical aspect of the COVID-19 response announced by the President on 21 April 2020. (Note that while the details of the distribution of the budget items between the NDOH and provinces are still subject to discussion, this distribution assumes that the cost of testing, thermometers, drugs, and PHC staff will be borne by provinces).

Provincial variability

The epidemics in the provinces that had early seeding and growth of the epidemic (KwaZulu-Natal, Gauteng and Western Cape) are all expected to peak quickly. The peaks of other provinces are projected to occur later due in part to their population distribution and delayed seeding. Once public sector testing has increased substantially, the models will be re-calibrated to better inform exact timing of each provincial peak and at which dates the hospital resources are expected to be exceeded. Figure 3 below shows this variation in timing of the epidemic peak between the provinces under the optimistic and pessimistic lockdown scenarios.

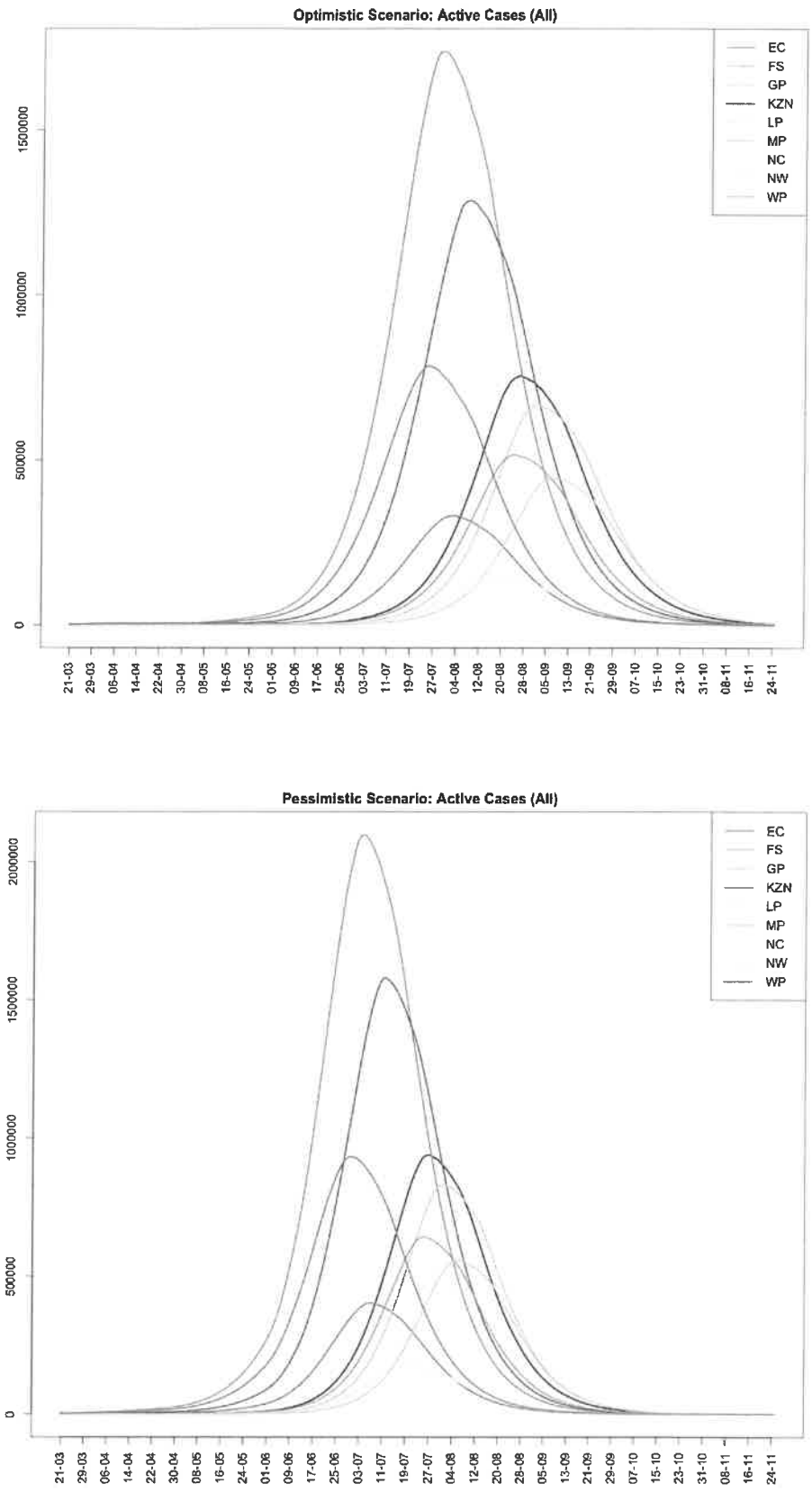


Figure 3. Projected provincial epidemic curves under optimistic and pessimistic scenarios

Key Parameter values:

Table 4 below shows the values of key parameters used to inform the model. Parameter values have been selected for use by an expert panel of clinicians on the SA Covid-19 Modelling Consortium.

Table 4. Key model parameters

	Parameter	**Value (range)**	**Sources**
Infection severity**	Proportion of cases that are asymptomatic	75% (0.7, 0.8)	[1], [2], [3]
	Mild to moderate cases among the symptomatic	(95.64%, 96.78%)	[5]
	Severe cases among the symptomatic	(2.46%-3.64%)	
	Critical cases among the symptomatic	(1.16%-1.45%)	
	Proportion of cases that are fatal	(0.30%, 0.412%)	[4], [5]
Timeframes & treatment durations	Time from infection to onset of infectiousness	4 days (2.0-6.0)	[4], [6], [7], [8], [9], [10] with input from analysis of NICD data.
	Time from onset of infectiousness to onset of symptoms	2 days (1.0-3.0)	
	Duration of infectiousness from onset of symptoms	5 days (4.0, 6.0)	
	Time from onset of mild symptoms to testing	4 days (3.0-5.0)	
	Time from onset of symptoms to hospitalisation	5 days (4.0–6.0)	
	Time from onset of symptoms to ICU admission	9 days (7.0–11.0)	
	Duration of hospital stay	12 days (8.0–14·0)	
	Duration from ICU admission to discharge	18 days (14·0–18·0)	
	Duration from ICU admission to death	5 days (4.0-7.0)	

Data sources

The model has been informed by published and pre-print academic literature, global COVID-19 case information (specifically from the European CDC, World Health Organization and China CDC), South African population statistics from Stats SA's 2019 mid-year report, expert input from members of the SA COVID-19 Modelling Consortium, and national case details from the South African National Institute for Communicable Diseases and https://sacoronavirus.co.za/category/press-releases-and-notices/.

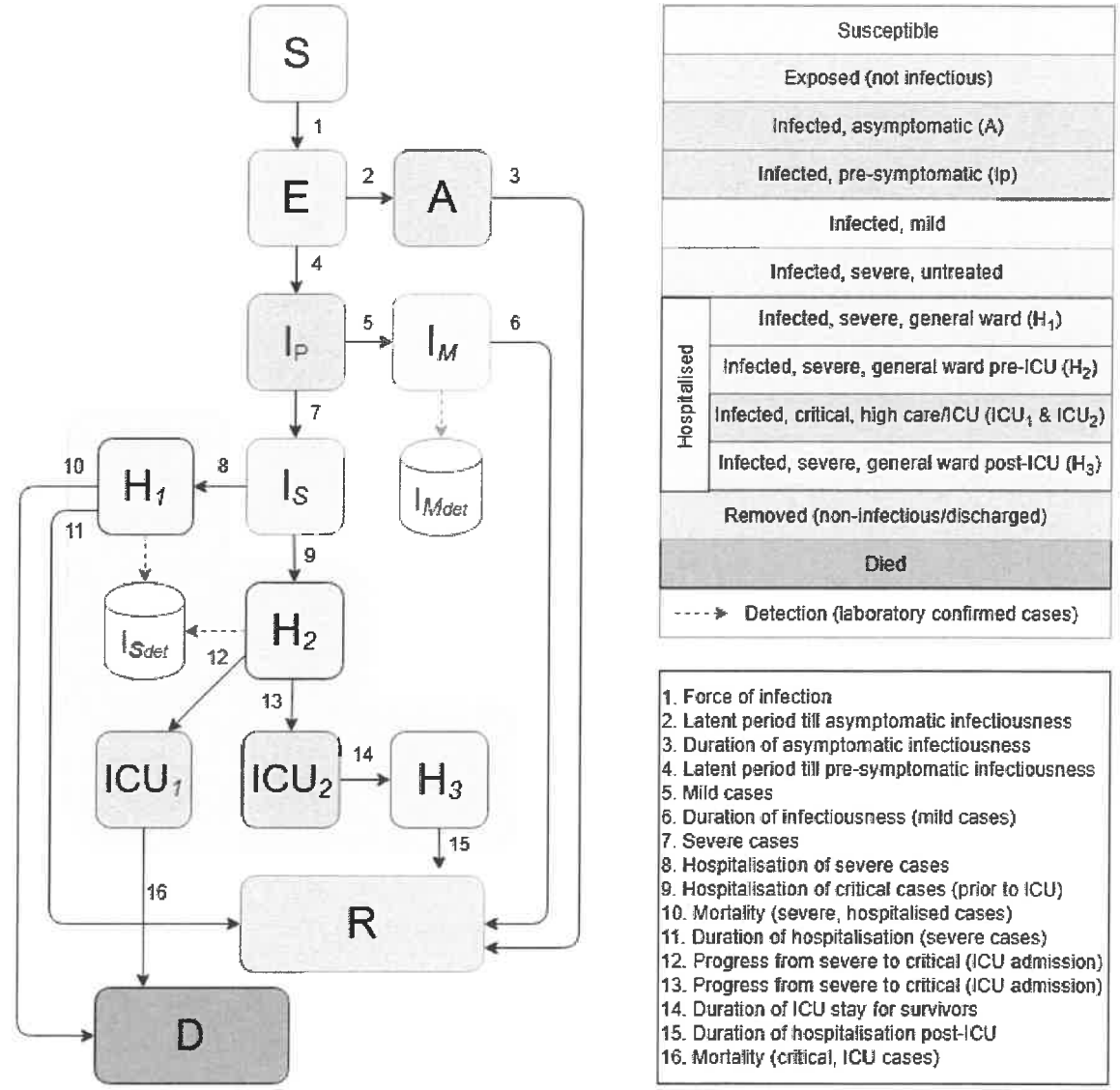
About the National COVID-19 Epi Model

The National COVID-19 Epi Model (NCEM) is a stochastic compartmental transmission model to estimate the total and reported incidence of COVID-19 in the nine provinces of South Africa. The outputs of the model may be used to inform resource requirements and predict where gaps could arise based on the available resources within the South African health system. The model follows a generalised Susceptible-Exposed-Infectious-Recovered (SEIR) structure accounting for disease severity (asymptomatic, mild, severe and critical cases) and the treatment pathway (outpatients, non-ICU and ICU beds) as shown in Figure 4. Contributors to the NCEM include Sheetal Silal, Rachel Hounsell, Jared Norman, Juliet Pulliam, Roxanne Beauclair, Jeremy Bingham, Jonathan Dushoff, Reshma Kassanjee, Michael Li, Cari van Schalkwyk, Alex Welte, Lise Jamieson, Brooke Nichols and Gesine Meyer-Rath. For more information please contact Dr Sheetal Silal (sheetal.silal@uct.ac.za).

About the National COVID-19 Cost Model

The National COVID-19 Cost Model (NCCM) was developed using inputs from a range of health economists in South Africa contributing data from existing sources that were adapted to represent the type, number, and prices of ingredients required in the country's COVID-19 response. The model produces the COVID-19 response budget for the National and provincial departments of health, incremental to existing resources such as hospital beds and staff contingents. Contributors to the NCCM include Gesine Meyer-Rath, Kerensa Govender, and Jacqui Miot from the Health Economics and Epidemiology Research Office (HE2RO) at Wits, Nikhil Khanna and colleagues at the Clinton Health Access Initiative (CHAI) South Africa, Ijeoma Edoka and colleagues at PRICELESS at Wits, Donnela Besada and Emmanuelle Daviaud at the Medical Research Council (MRC), Steve Cohen at Genesis, and David Crewe-Brown from SCTA. For more information please contact Dr Gesine Meyer-Rath (gesine@bu.edu).

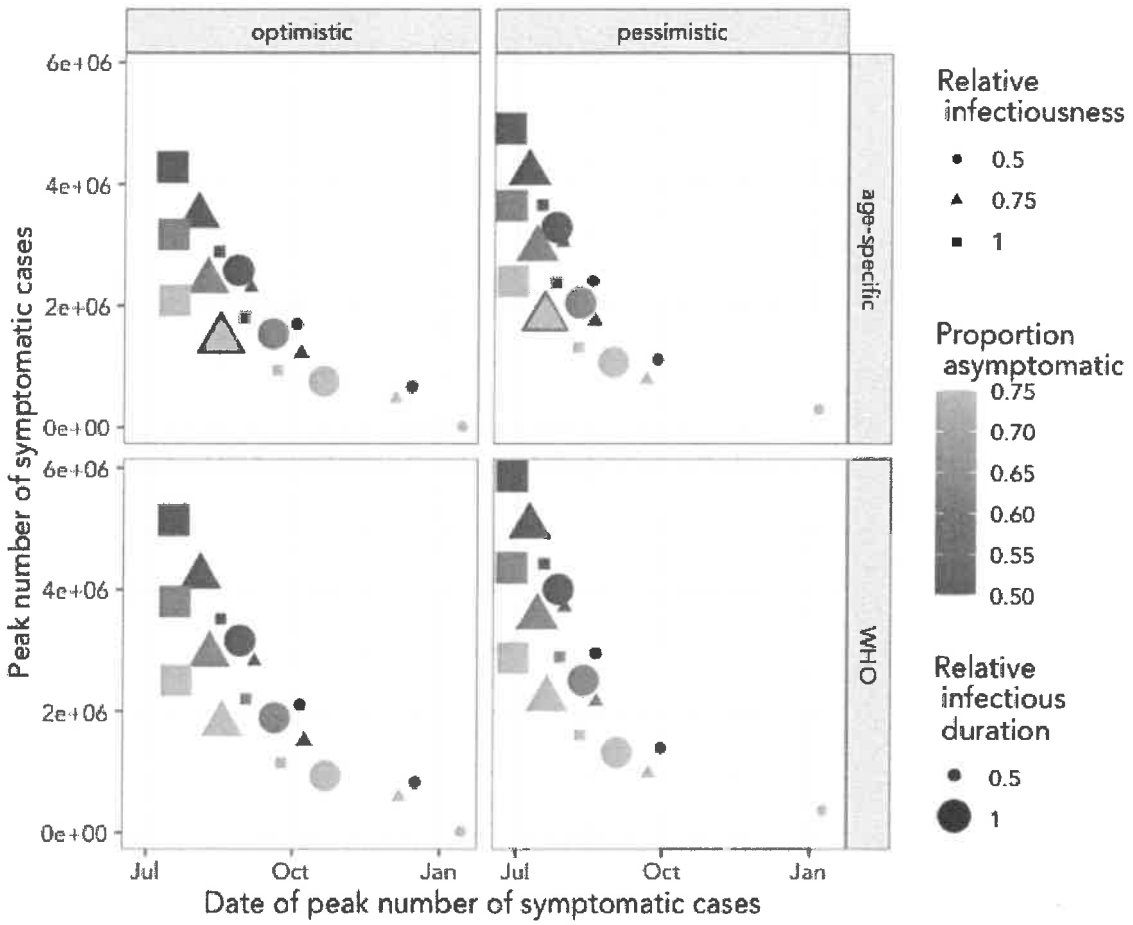
Figure 4. Generalised SEIR Model Structure (Disease and Treatment Pathway)



Appendix

Sensitivity analysis examines the effect of varying certain parameters on the timing and magnitude of the expected epidemic peak. The points representing the parameters used in the main analyses are outlined in red. The following parameters were explored:

- Proportion of infectious that are asymptomatic throughout the course of infection (values considered in sensitivity analysis: 0.5, 0.625, 0.75; value used in main analysis: 0.75).
- Relative infectiousness of asymptomatic infections to symptomatic ones (values considered in sensitivity analysis: 0.5, 0.75, 1; value used in main analysis: 0.75).
- Infectious duration of asymptomatic infections relative to mild infections (values considered in sensitivity analysis: 0.5, 1; value used in main analysis: 1).
- Distribution of mild, severe, and critical cases (levels considered were the values as presented in the WHO-China mission report and values derived from adjusting the China age-specific severity values to the South African population; the adjusted, age-specific values were used in the main analysis).
- Scenario regarding effectiveness of interventions (optimistic and pessimistic, as described above; both are presented in main analysis).



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Infection fatality rate of COVID-19 inferred from seroprevalence data

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Abstract

Objective To estimate the infection fatality rate of coronavirus disease 2019 (COVID-19) from seroprevalence data.

Methods I searched PubMed and preprint servers for COVID-19 seroprevalence studies with a sample size ≥ 500 as of 9 September, 2020. I also retrieved additional results of national studies from preliminary press releases and reports. I assessed the studies for design features and seroprevalence estimates. I estimated the infection fatality rate for each study by dividing the number of COVID-19 deaths by the number of people estimated to be infected in each region. I corrected for the number of antibody types tested (immunoglobin, IgG, IgM, IgA).

Results I included 61 studies (74 estimates) and eight preliminary national estimates. Seroprevalence estimates ranged from 0.02% to 53.40%. Infection fatality rates ranged from 0.00% to 1.63%, corrected values from 0.00% to 1.54%. Across 51 locations, the median COVID-19 infection fatality rate was 0.27% (corrected 0.23%): the rate was 0.09% in locations with COVID-19 population mortality rates less than the global average (< 118 deaths/million), 0.20% in locations with 118–500 COVID-19 deaths/million people and 0.57% in locations with > 500 COVID-19 deaths/million people. In people < 70 years, infection fatality rates ranged from 0.00% to 0.31% with crude and corrected medians of 0.05%.

Conclusion The infection fatality rate of COVID-19 can vary substantially across different locations and this may reflect differences in population age structure and case-mix of infected and deceased patients and other factors. The inferred infection fatality rates tended to be much lower than estimates made earlier in the pandemic.

Introduction

The infection fatality rate, the probability of dying for a person who is infected, is one of the most important features of the coronavirus disease 2019 (COVID-19) pandemic. The expected total mortality burden of COVID-19 is directly related to the infection fatality rate. Moreover,

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justification for various non-pharmacological public health interventions depends on the infection fatality rate. Some stringent interventions that potentially also result in more noticeable collateral harms[1] may be considered appropriate, if the infection fatality rate is high. Conversely, the same measures may fall short of acceptable risk–benefit thresholds, if the infection fatality rate is low.

Early data from China suggested a 3.4% case fatality rate[2] and that asymptomatic infections were uncommon,[3] thus the case fatality rate and infection fatality rate would be about the same. Mathematical models have suggested that 40–81% of the world population could be infected,[4,5] and have lowered the infection fatality rate to 1.0% or 0.9%.[5,6] Since March 2020, many studies have estimated the spread of the virus causing COVID-19 – severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) – in various locations by evaluating seroprevalence. I used the prevalence data from these studies to infer estimates of the COVID-19 infection fatality rate.

Methods

Seroprevalence studies

The input data for calculations of infection fatality rate were studies on the seroprevalence of COVID-19 done in the general population, or in samples that might approximately represent the general population (e.g. with proper reweighting), that had been published in peer-reviewed journals or as preprints (irrespective of language) as of 9 September 2020. I considered only studies with at least 500 assessed samples because smaller data sets would result in large uncertainty for any calculations based on these data. I included studies that made seroprevalence assessments at different time intervals if at least one time interval assessment had a sample size of at least 500 participants. If there were different eligible time intervals, I selected the one with the highest seroprevalence, since seroprevalence may decrease over time as antibody titres decrease. I excluded studies with data collected for more than a month that could not be broken into at least one eligible time interval less than one month duration because it would not be possible to estimate a point seroprevalence reliably. Studies were eligible regardless of the exact age range of participants included, but I excluded studies with only children.

I also examined results from national studies from preliminary press releases and reports whenever a country had no other data presented in published papers of preprints. This inclusion allowed these countries to be represented, but information was less complete than information in published papers or preprints and thus requires caution.

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I included studies on blood donors, although they may underestimate seroprevalence and overestimate infection fatality rate because of the healthy volunteer effect. I excluded studies on health-care workers, since this group is at a potentially high exposure risk, which may result in seroprevalence estimates much higher than the general population and thus an improbably low infection fatality rate. Similarly, I also excluded studies on communities (e.g. shelters or religious or other shared-living communities). Studies were eligible regardless of whether they aimed to evaluate seroprevalence in large or small regions, provided that the population of reference in the region was at least 5000 people.

I searched PubMed® (LitCOVID), and medRxiv, bioRxiv and Research Square using the terms "seroprevalence" OR "antibodies" with continuous updates. I made the first search in early May and did monthly updates, with the last update on 9 September, 2020. I contacted field experts to retrieve any important studies that may have been missed.

From each study, I extracted information on location, recruitment and sampling strategy, dates of sample collection, sample size, types of antibody measured (immunoglobulin G (IgG), IgM and IgA), the estimated crude seroprevalence (positive samples divided by all samples tested), adjusted seroprevalence and the factors that the authors considered for adjustment.

Inferred infection fatality rate

If a study did not cover an entire country, I collected information on the population of the relevant location from the paper or recent census data so as to approximate as much as possible the relevant catchment area (e.g. region(s) or county(ies)). Some studies targeted specific age groups (e.g. excluding elderly people and/or excluding children) and some estimated numbers of people infected in the population based on specific age groups. For consistency, I used the entire population (all ages) and, separately, the population 0–70 years to estimate numbers of infected people. I assumed that the seroprevalence would be similar in different age groups, but I also recorded any significant differences in seroprevalence across age strata so as to examine the validity of this assumption.

I calculated the number of infected people by multiplying the relevant population size and the adjusted estimate of seroprevalence. If a study did not give an adjusted seroprevalence estimate, I used the unadjusted seroprevalence instead. When seroprevalence estimates with different adjustments were available, I selected the analysis with largest adjustment. The factors adjusted for included COVID-19 test performance, sampling design, and other factors such as age,

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sex, clustering effects or socioeconomic factors. I did not adjust for specificity in test performance when positive antibody results were already validated by a different method.

For the number of COVID-19 deaths, I chose the number of deaths accumulated until the date 1 week after the midpoint of the study period (or the date closest to this that had available data) – unless the authors of the study had strong arguments to choose some other time point or approach. The 1-week lag accounts for different delays in developing antibodies versus dying from infection. The number of deaths is an approximation because it is not known when exactly each patient who died was infected. The 1-week cut-off after the study midpoint may underestimate deaths in places where patients are in hospital for a long time before death, and may overestimate deaths in places where patients die soon because of poor or even inappropriate care. Whether or not the health system became overloaded may also affect the number of deaths. Moreover, because of imperfect diagnostic documentation, COVID-19 deaths may have been both overcounted and undercounted in different locations and at different time points.

I calculated the inferred infection fatality rate by dividing the number of deaths by the number of infected people for the entire population, and separately for people < 70 years. I took the proportion of COVID-19 deaths that occurred in people < 70 years old from situational reports for the respective locations that I retrieved at the time I identified the seroprevalence studies. I also calculated a corrected infection fatality rate to try and account for the fact that only one or two types of antibodies (among IgG, IgM, IgA) might have been used. I corrected seroprevalence upwards (and inferred infection fatality rate downwards) by one tenth of its value if a study did not measure IgM and similarly if IgA was not measured. This correction is reasonable based on some early evidence,[7] although there is uncertainty about the exact correction factor.

Data synthesis

The estimates of the infection fatality rate across all locations showed great heterogeneity with I^2 exceeding 99.9%; thus, a meta-analysis would be inappropriate to report across all locations. Quantitative synthesis with meta-analysis across all locations would also be misleading since locations with high COVID-19 seroprevalence would tend to carry more weight than locations with low seroprevalence. Furthermore, locations with more studies (typically those that have attracted more attention because of high death tolls and thus high infection fatality rates) would be represented multiple times in the calculations. In addition, poorly conducted studies with fewer adjustments would get more weight because of spuriously narrower confidence intervals than

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more rigorous studies with more careful adjustments which allow for more uncertainty. Finally, with a highly skewed distribution of the infection fatality rate and with large between-study heterogeneity, typical random effects models would produce an incorrectly high summary infection fatality rate that approximates the mean of the study-specific estimates (also strongly influenced by high-mortality locations where more studies have been done); for such a skewed distribution, the median is more appropriate.

Therefore, in a first step, I grouped estimates of the infection fatality rate from studies in the same country (or for the United States of America, the same state) together and calculated a single infection fatality rate for that location, weighting the study-specific infection fatality rates by the sample size of each study. This approach avoided inappropriately giving more weight to studies with higher seroprevalence estimates and those with seemingly narrower confidence intervals because of poor or no adjustments, while still giving more weight to larger studies. Then, I used the single summary estimate for each location to calculate the median of the distribution of location-specific infection fatality rate estimates. Finally, I explored whether the location-specific infection fatality rates were associated with the COVID-19 mortality rate in the population (COVID-19 deaths per million people) in each location as of 12 September 2020; this analysis allowed me to assess whether estimates of the infection fatality rate tended to be higher in locations with a higher burden of death from COVID-19.

Results

Seroprevalence studies

I retrieved 61 studies with 74 eligible estimates published either in the peer-reviewed literature or as preprints as of 9 September 2020.[8–68] Furthermore, I also considered another eight preliminary national estimates.[69–76] This search yielded a total of 82 eligible estimates (Fig. 1).

The studies varied substantially in sampling and recruitment designs (Table 1; available at: http://www.who.int/bulletin/volumes/##/##/##-######). Of the 61 studies, 24 studies[8,10,16,17,20,22,25,33,34,36,37,42,46–49,52–54,61,63,65,68] explicitly aimed for random sampling from the general population. In principle, random sampling is a stronger design. However, even then, people who cannot be reached (e.g. by email or telephone or even by visiting them at a house location) will not be recruited, and these vulnerable populations are likely to be missed. Moreover, several such studies[8,10,16,37,42] focused on geographical locations with high numbers of deaths,

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higher than other locations in the same city or country, and this emphasis would tend to select eventually for a higher infection fatality rate on average.

Eleven studies assessed blood donors,[12,15,18,24,28,31,41,44,45,55,60] which might underestimate COVID-19 seroprevalence in the general population. For example, 200 blood donors in Oise, France showed 3.00% seroprevalence, while the seroprevalence was 25.87% (171/661) in pupils, siblings, parents, teachers and staff at a high school with a cluster of cases in the same area; the true population seroprevalence may be between these two values.[13]

For other studies, healthy volunteer bias[19] may underestimate seroprevalence, attracting people with symptoms[26] may overestimate seroprevalence, and studies of employees,[14,21,25,32,66] grocery store clients[23] or patient cohorts[11,14,27–30,36,38,40,50,51,56,59,62,64,67] risk sampling bias in an unpredictable direction.

All the studies tested for IgG antibodies but only about half also assessed IgM and few assessed IgA. Only seven studies assessed all three types of antibodies and/or used pan-Ig antibodies. The ratio of people sampled versus the total population of the region was more than 1:1000 in 20 studies (Table 2; available at: http://www.who.int/bulletin/volumes/##/##/##-######).

Seroprevalence estimates

Seroprevalence for the infection ranged from 0.02% to 53.40% (58.40% in the slum sub-population in Mumbai; Table 3). Studies varied considerably depending on whether or not they tried to adjust their estimates for test performance, sampling (to get closer to a more representative sample), clustering (e.g. when including household members) and other factors. The adjusted seroprevalence occasionally differed substantially from the unadjusted value. In studies that used samples from multiple locations, between-location heterogeneity was seen (e.g. 0.00–25.00% across 133 Brazilian cities).[25]

Inferred infection fatality rate

Inferred infection fatality rate estimates varied from 0.00% to 1.63% (Table 4). Corrected values also varied considerably (0.00–1.54%).

For 15 locations, more than one estimate of the infection fatality rate was available and thus I could compare the infection fatality rate from different studies evaluating the same location. The estimates of infection fatality rate tended to be more homogeneous within each location, while

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they differed markedly across locations (Fig. 2). Within the same location, infection fatality rate estimates tend to have only small differences, even though it is possible that different areas within the same location may also have real differences in infection fatality rate. France is one exception where differences are large, but both estimates come from population studies of outbreaks from schools and thus may not provide good estimates of population seroprevalence and may lead to an underestimated infection fatality rate.

I used summary estimates weighted for sample size to generate a single estimate for each location. Data were available for 51 different locations (including the inferred infection fatality rates from the eight preliminary additional national estimates in Table 5).

The median infection fatality rate across all 51 locations was 0.27% (corrected 0.23%). Most data came from locations with high death tolls from COVID-19 and 32 of the locations had a population mortality rate (COVID-19 deaths per million population) higher than the global average (118 deaths from COVID-19 per million as of 12 September 2020;[79] Fig. 3). Uncorrected estimates of the infection fatality rate of COVID-19 ranged from 0.01% to 0.67% (median 0.10%) across the 19 locations with a population mortality rate for COVID-19 lower than the global average, from 0.07% to 0.73% (median 0.20%) across 17 locations with population mortality rate higher than the global average but lower than 500 COVID-19 deaths per million, and from 0.20% to 1.63% (median 0.71%) across 15 locations with more than 500 COVID-19 deaths per million. The corrected estimates of the median infection fatality rate were 0.09%, 0.20% and 0.57%, respectively, for the three location groups.

For people < 70 years old, the infection fatality rate of COVId-19 across 40 locations with available data ranged from 0.00% to 0.31% (median 0.05%); the corrected values were similar.

Discussion

The infection fatality rate is not a fixed physical constant and it can vary substantially across locations, depending on the population structure, the case-mix of infected and deceased individuals and other, local factors. The studies analysed here represent 82 different estimates of the infection fatality rate of COVID-19, but they are not fully representative of all countries and locations around the world. Most of the studies are from locations with overall COVID-19 mortality rates that are higher than the global average. The inferred median infection fatality rate in locations with a COVID-19 mortality rate lower than the global average is low (0.09%). If one

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could sample equally from all locations globally, the median infection fatality rate might be even substantially lower than the 0.23% observed in my analysis.

COVID-19 has a very steep age gradient for risk of death.[80] Moreover, many, and in some cases most, deaths in European countries that have had large numbers of cases and deaths[81] and in the USA[82] occurred in nursing homes. Locations with many nursing home deaths may have high estimates of the infection fatality rate, but the infection fatality rate would still be low among non-elderly, non-debilitated people.

Within China, the much higher infection fatality rate estimates in Wuhan compared with other areas of the country may reflect widespread nosocomial infections,[83] as well as unfamiliarity with how to manage the infection as the first location that had to deal with COVID-19. The very many deaths in nursing homes, nosocomial infections and overwhelmed hospitals may also explain the high number of fatalities in specific locations in Italy[84] and New York and neighbouring states.[23,27,35,56] Poor decisions (e.g. sending COVID-19 patients to nursing homes), poor management (e.g. unnecessary mechanical ventilation) and hydroxychloroquine may also have contributed to worse outcomes. High levels of congestion (e.g. in busy public transport systems) may also have exposed many people to high infectious loads and, thus, perhaps more severe disease. A more aggressive viral clade has also been speculated.[85] The infection fatality rate may be very high among disadvantaged populations and settings with a combination of factors predisposing to higher fatalities.[37]

Very low infection fatality rates seem common in Asian countries.[8,11,29,48,49,51,59,61,67] A younger population in these countries (excluding Japan), previous immunity from exposure to other coronaviruses, genetic differences, hygiene etiquette, lower infectious load and other unknown factors may explain these low rates. The infection fatality rate is low also in low-income countries in both Asia and Africa,[44,49,66,67] perhaps reflecting the young age-structure. However, comorbidities, poverty, frailty (e.g. malnutrition) and congested urban living circumstances may have an adverse effect on risk and thus increase infection fatality rate.

Antibody titres may decline with time[10,28,32,86,87] and this would give falsely low prevalence estimates. I considered the maximum seroprevalence estimate when multiple repeated measurements at different time points were available, but even then some of this decline cannot be fully accounted for. With four exceptions,[10,28,32,51] the maximum seroprevalence value was at the latest time point.

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Positive controls for the antibody assays used were typically symptomatic patients with positive polymerase chain reaction tests. Symptomatic patients may be more likely to develop antibodies.[87–91] Since seroprevalence studies specifically try to reveal undiagnosed asymptomatic and mildly symptomatic infections, a lower sensitivity for these mild infections could lead to substantial underestimates of the number of infected people and overestimate of the inferred infection fatality rate.

A main issue with seroprevalence studies is whether they offer a representative picture of the population in the assessed region. A generic problem is that vulnerable people at high risk of infection and/or death may be more difficult to recruit in survey-type studies. COVID-19 infection is particularly widespread and/or lethal in nursing homes, in homeless people, in prisons and in disadvantaged minorities.[92] Most of these populations are very difficult, or even impossible, to reach and sample and they are probably under-represented to various degrees (or even entirely missed) in surveys. This sampling obstacle would result in underestimating the seroprevalence and overestimating infection fatality rate.

In principle, adjusted seroprevalence values may be closer to the true estimate, but the adjustments show that each study alone may have unavoidable uncertainty and fluctuation, depending on the type of analysis chosen. Furthermore, my corrected infection fatality rate estimates try to account for undercounting of infected people when not all three antibodies (IgG, IgM and IgA) were assessed. However, the magnitude of the correction is uncertain and may vary in different circumstances. An unknown proportion of people may have responded to the virus using immune mechanisms (mucosal, innate, cellular) without generating any serum antibodies.[93–97]

A limitation of this analysis is that several studies included have not yet been fully peer-reviewed and some are still ongoing. Moreover, despite efforts made by seroprevalence studies to generate estimates applicable to the general population, representativeness is difficult to ensure, even for the most rigorous studies and despite adjustments made. Estimating a single infection fatality rate value for a whole country or state can be misleading, when there is often huge variation in the population mixing patterns and pockets of high or low mortality. Furthermore, many studies have evaluated people within restricted age ranges, and the age groups that are not included may differ in seroprevalence. Statistically significant, modest differences in seroprevalence across some age groups have been observed in several studies.[10,13,15,23,27,36,38]

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Lower values have been seen in young children and higher values in adolescents and young adults, but these patterns are inconsistent and not strong enough to suggest major differences extrapolating across age groups.

Acknowledging these limitations, based on the currently available data, one may project that over half a billion people have been infected as of 12 September, 2020, far more than the approximately 29 million documented laboratory-confirmed cases. Most locations probably have an infection fatality rate less than 0.20% and with appropriate, precise non-pharmacological measures that selectively try to protect high-risk vulnerable populations and settings, the infection fatality rate may be brought even lower.

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I am a co-author (not principal investigator) of one of the seroprevalence studies.

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Table 1. **Eligible seroprevalence studies on COVID-19 published or deposited as preprints as of 9 September 2020: dates, sampling and recruitment**

Author	Country (location)	Dates	Sampling and recruitment
Figar et al.[47]	Argentina (Barrio Padre Mugica)	10–26 June	Probabilistic sampling of a slum neighbourhood, sampling from people 14 years or older across households
Herzog et al.[38]	Belgium	30 March–5 April and 20–26 April	Residual sera from 10 private diagnostic laboratories in Belgium, with fixed numbers per age group, region and periodical sampling, and stratified by sex
Hallal et al.[25]	Brazil	15–22 May	Sampling from 133 cities (the main city in each region), selecting 25 census tracts with probability proportionate to size in each sentinel city, and 10 households at random in each tract. Aiming for 250 participants per city
Gomes et al.[34]	Brazil (Espirito Santo)	13–15 May	Cross-section of major municipalities with houses as the sampling units
Da Silva et al.[68]	Brazil (Maranhao)	27 July–8 August	Three-stage cluster sampling stratified by four state regions in the state of Maranhao; the estimates took clustering, stratification and non-response into account
Amorim Filho et al.[41]	Brazil (Rio de Janeiro)	14–27 April (eligible: 24–27 April)	Blood donors without flulike symptoms within 30 days of donation; had close contact with suspected or confirmed COVID-19 cases in the 30 days before donation; or had travelled abroad in the past 30 days
Silveira et al.[17]	Brazil (Rio Grande do Sul)	9–11 May (third round, after 11–13 April, and 25–27 April)	Multistage probability sampling in each of nine cities to select 500 households, from which one member was randomly chosen for testing
Tess et al.[42]	Brazil (Sao Paulo)	4–12 May	Randomly selected adults and their cohabitants sampled from six districts of Sao Paulo City with high numbers of cases
Skowronski et al.[50]	Canada (British Columbia)	15–27 May (after baseline in 5–13 March)	Specimens from patients attending one of about 80 diagnostic service centres of the only outpatient laboratory network in the Lower Mainland
Torres et al.[43]	Chile (Vitacura)	4–19 May	Classroom stratified sample of children and all staff in a community placed on quarantine after school outbreak
Chang et al.[55]	China	January–April weekly: 3–23 February (Wuhan); 24 February–15 March (Shenzhen); 10 February–1 March (Shijiazhuang)	38 144 healthy blood donors in Wuhan, Shenzhen and Shijiazhuang who met the criteria for blood donation during the COVID-19 pandemic in China
Wu et al.[14]	China (Wuhan)	3–15 April	People applying for a permission to resume work (n = 1 021) and hospitalized patients (n = 381)
Ling et al.[32]	China (Wuhan)	26 March–28 April	Age 16–64 years, going back to work, with no fever, headache or other symptoms of COVID-19
Xu et al.[60]	China (Guangzhou)	23 March–2 April	Healthy blood donors in Guangzhou

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Xu et al.[40]	China (several regions)	30 March–10 April	Voluntary participation by public call for haemodialysis patients (n = 979 in Zingzhou, Ubei and n = 563 in Guangzhou/Foshun, Guangdong) and outpatients in Chingqing (n = 993), and community residents in Chengdu, Sichuan (n = 9 442), and required testing for factory workers in Guangzhou, Guandong (n = 442)
Jerkovic et al.[26]	Croatia	23–28 April	DIV Group factory workers in Split and Sibenik-Knin invited for voluntary testing
Erikstrup et al.[12]	Denmark	6 April–3 May	All Danish blood donors aged 17–69 years giving blood. Blood donors are healthy and must comply with strict eligibility criteria; they must self-defer for two weeks if they develop fever with upper respiratory symptoms
Petersen et al.[52]	Denmark (Faroe Islands)	27 April–1 May	1500 randomly selected residents invited to participate, samples collected from 1 075
Fontanet et al.[39]	France (Crepy-en-Valois)	28–30 April	Pupils, their parents and relatives, and staff of primary schools exposed to SARS-CoV-2 in February and March 2020 in a city north of Paris
Fontanet et al.[13]	France (Oise)	30 March–4 April	Pupils, their parents and siblings, as well as teachers and non-teaching staff of a high-school
Streeck et al.[16]	Germany (Gangelt)	30 March–6 April	600 adults with different surnames in Gangelt were randomly selected; all household members were asked to participate in the study
Kraehling et al.[21]	Germany (Frankfurt)	6–14 April	Employees of Infraserv Höchst, a large industrial site operator in Frankfurt am Main. No exclusion criteria
Bogogiannidou et al.[62]	Greece	March and April (April data used)	Leftover blood samples collected from a nationwide laboratory network, including both private and public hospital laboratories (27 laboratories in total)
Merkely et al.[57]	Hungary	1–16 May	Representative sample (n = 17 787) of the Hungarian population ≥ 14 years living in private households (8 283 810)
Gudbjatsson et al.[58]	Iceland	Several cohorts between April and June[a]	30 576 people in Iceland, including those documented to be infected, those quarantined and people not known to have been exposed.
Malani et al.[61]	India (Mumbai)	29 June–19 July	Geographically-spaced community sampling of households, one individual per household was tested in slum and non-slum communities in three wards, one each from the three main zones of Mumbai
Khan et al.[67]	India (Srinagar)	1–15 July	Adults (> 18 years) who visited selected hospitals across the Srinagar District
Shakiba et al.[8]	Islamic Republic of Iran (Guilan)	April (until 21 April)	Population-based cluster random sampling design through telephone call invitation, household-based
Fiore et al.[31]	Italy (Apulia)	1–31 May	Blood donors 18–65 years old free of recent symptoms possibly related to COVID-19, no close contact with confirmed cases, symptom-free in the preceding 14 days, no contact with suspected cases
Doi et al.[11]	Japan (Kobe)	31 March–7 April	Randomly selected patients who visited outpatient clinics and received blood testing for any reason. Patients who visited the emergency department or the designated fever consultation service were excluded
Takita et al.[29]	Japan (Tokyo)	21 April–20 May	Two community clinics in the main railway stations in Tokyo (Navitas Clinic Shinjuku and Tachikawa)

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Nawa et al.[48]	Japan (Utsunomiya City)	14 June–5 July	Invitations enclosed with a questionnaire were sent to 2 290 people in 1 000 households randomly selected from Utsunomiya City's basic resident registry; 742 completed the study
Uyoga et al.[44]	Kenya	30 April–16 June (~90% of samples in last 30 days)	Residual blood donor serum samples from donors 16–65 years in four sites (Mombasa, Nairobi, Eldoret and Kisumu)
Snoeck et al.[20]	Luxembourg	16 April–5 May	Representative sample (no details how ensured), 1 807 of 2000 contacted provided data, were < 79 years and had serology results
Slot et al.[15]	Netherlands	1–15 April	Blood donors. Donors must be completely healthy, but they may have been ill in the past, provided that they recovered at least 2 weeks before
Westerhuis et al.[64]	Netherlands (Rotterdam)	Early March and early April	Left-over plasma samples from patients of nine age categories in Erasmus Medical Center in Rotterdam: 879 samples in early March and 729 in early April)
Nisar et al.[49]	Pakistan (Karachi)	25 June–11 July (after baseline on 15–25 April)	Cross-sectional household surveys in a low- (district Malir) and high-transmission (district East) area of Karachi with households selected using simple random sampling (Malir) and systematic random sampling (East)
Javed et al.[66]	Pakistan (urban Karachi, Lahore, Multan, Peshawar and Quetta)	06-Jul	Adult, working population aged 18–65 years, recruited from dense, urban workplaces including factories, businesses, restaurants, media houses, schools, banks, hospitals (health-care providers), and from families of positive cases in cities in Pakistan
Abu Raddad et al.[51]	Qatar	12 May–12 July (highest seroprevalence on 12–31 May)	Convenience sample of residual blood specimens collected for routine clinical screening or clinical management from 32 970 outpatient and inpatient departments for a variety of health conditions (n = 937 in 12–31 May)
Noh et al.[59]	Republic of Korea	25–29 May	Outpatients who visited two hospitals in south-west Seoul which serve six administrative areas
Pollan et al.[36]	Spain	27 April–11 May	35 883 households selected from municipal rolls using two-stage random sampling stratified by province and municipality size, with all residents invited to participate (75.1% of all contacted individuals participated)
Crovetto et al.[30]	Spain (Barcelona)	14 April–5 May	Consecutive pregnant women for first trimester screening or delivery in two hospitals
Stringhini et al.[10]	Switzerland (Geneva)	6 April–9 May (5 consecutive weeks)	Randomly selected previous participants of the Bus Santé study with an email (or telephone contact, if email unavailable); participants were invited to bring all members of their household aged 5 years and older
Emmenegger et al.[28]	Switzerland (Zurich)	Prepandemic until June (patients) and May (blood donors)	Patients at the University Hospital of Zurich and blood donors in Zurich and Lucerne
Ward et al.[65]	United Kingdom (England)	20 June–13 July	Random population sample of 100 000 adults over 18 years
Thompson et al.[18]	United Kingdom (Scotland)	21–23 March	Blood donors. Donors should not have felt unwell in the past 14 days; some other deferrals also applied regarding travel and COVID-19 symptoms

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Havers et al.[35]	USA (10 states)	23 March–1 April (Washington, Puget Sound and New York, New York City), 1–8 April (Louisiana), 5–10 April (Florida, south), 13–25 April (Pennsylvania, Philadelphia, metropolitan area), 20–26 April (Missouri), 23–27 April (California, San Francisco Bay Area), 20 April–3 May (Utah), 26 April–3 May (Connecticut), 30 April–12 May (Minnesota, Minneapolis)	Convenience samples using residual sera obtained for routine clinical testing (screening or management) by two commercial laboratory companies
Ng et al.[24]	USA (California, Bay Area)	March	1000 blood donors in diverse Bay Area locations (excluding those with self-reported symptoms or abnormal vital signs)
Sood[22]	USA (California, Los Angeles)	10–14 April	Proprietary database representative of the county. A random sample of these residents was invited, with quotas for enrolment for subgroups based on age, sex, race and ethnicity distribution
Chamie et al.[33]	USA (California, San Francisco)	25–28 April	United States census tract 022 901 population-dense area (58% Latin American) in San Francisco Mission district, expanded to neighbouring blocks on 28 April
Bendavid et al.[19]	USA (California, Santa Clara)	2–3 April	Facebook advertisement with additional targeting by zip code
Biggs et al.[53]	USA (Georgia, DeKalb and Fulton)	28 April–3 May	Two-stage cluster sampling design used to randomly select 30 census blocks in DeKalb county and 30 census blocks in Fulton county, with a target of seven participating households per census block
McLaughlin et al.[46]	USA (Idaho, Blaine county)	4–19 May	Volunteers who registered via a secure web link, using prestratification weighting to the population distribution by age and sex within each zip code
Bryan et al.[9]	USA (Idaho, Boise)	Late April	People from the Boise, Idaho metropolitan area, part of the Crush the Curve initiative
Menachemi et al.[54]	USA (Indiana)	25–29 April	Stratified random sampling among all persons aged ≥ 12 years using Indiana's 10 public health preparedness districts as sampling strata
Feehan et al.[63]	USA (Louisiana, Baton Rouge)	15–31 July	Representative sample in a method developed by Public Democracy

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Feehan et al.[37]	USA (Louisiana, Orleans and Jefferson Parish)	9–15 May	Pool of potential participants reflecting the demographics of the parishes was based on 50 characteristics, then a randomized subset of 150 000 people was selected, and 25 000 were approached with digital apps, and 2 640 were recruited
Rosenberg et al.[23]	USA (New York)	19–28 April	Convenience sample of people ≥ 18 years living in New York State, recruited consecutively on entering 99 grocery stores and through an in-store flyer
Meyers et al.[56]	USA (New York)	2–30 March (Columbia University Medical Center, New York City); 13–28 March (CareMount central laboratory)	Discarded clinical samples in Columbia Medical Center, New York City (n = 814 in 24 February–30 March, 742 of those in the period 2–30 March) and samples from CareMount central laboratory (960 samples on 13 and 14 March, 505 samples on 20/21 March, and 376 samples on 27/28 March) from its network of clinics in five counties north of New York City
Reifer et al.[27]	USA (New York, Brooklyn)	Early May	Patients seen in an urgent care facility in Brooklyn
Nesbitt et al.[45]	USA (Rhode Island)	27 April–11 May	Consecutive blood donors

COVID-19: coronavirus disease-19; SARS-CoV-2: severe acute respiratory syndrome coronavirus 2.

[a] Sample collection time for some sub-cohorts may have exceeded 1 month, but more than half of the cases were already documented by polymerase chain reaction testing before any antibody testing and the last death occurred on 20 April.

Note: Some studies included additional data sets that did not fulfil the eligibility criteria (e.g. had sample size < 500 or were health-care workers) and they are not presented here.

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Table 2. **Sample size, types of antibodies assessed and population size in the studies included to assess COVID-19 infection fatality rate, 2020**

Country (location)	Sample size[a], no.	Antibody	Population,[b] no.	% of population <70 years[c]
Argentina (Barrio Padre Mugica)[47]	873	IgG	49 983	99
Belgium[38]	3 391 (20–26 April)	IgG	11 589 623	86
Brazil (133 cities)[25]	24 995	IgG and IgM	74 656 499	94 (Brazil)
Brazil (Espirito Santo)[34]	4 608	IgG and IgM	4 018 650	94 (Brazil)
Brazil (Maranhao)[68]	3 156	IgG and IgM	7 114 598	92
Brazil (Rio de Janeiro), blood donors[41]	669 (24–27 April)	IgG and IgM	17 264 943	94 (Brazil)
Brazil (Rio Grande do Sul)[17]	4 500	IgG	11 377 239	91
Brazil (Sao Paulo)[42]	517	IgG and IgM	298 240 (6 districts)	94 (Brazil)
Canada (British Columbia)[50]	885	IgG, IgM and IgA	5 071 000	94
Chile (Vitacura)[43]	1 244	IgG and IgM	85 000	92 (Chile)
China, blood donors[55]				
Wuhan	930 (3–23 February)	IgG and IgM	11 210 000	93 (China)
Shenzhen	3 507 (24 February–15 March)	IgG and IgM	13 030 000	93 (China)
Shijiazhuang	6 455 (10 February–1 March)	IgG and IgM	11 030 000	93 (China)
China (Wuhan)[14]	1 401	IgG and IgM	11 080 000	93 (China)
China (Wuhan)[32]	1 196 (4–8 April)	IgG and IgM	11 080 000	93 (China)
China (Guangzhou), blood donors[60]	2 199	IgG, IgM and IgA	115 210 000 (Guangdong)	93 (China)
China (several regions)[40]				
Hubei (not Wuhan)	979	IgG and IgM	48 058 000	93 (China)
Chongqing	993	IgG and IgM	31 243 200	93 (China)
Sichuan	9 442	IgG and IgM	83 750 000	93 (China)
Guangdong	1 005	IgG and IgM	115 210 000	93 (China)
Croatia[26]	1 494	IgG and IgM	4 076 000	86
Denmark blood donors[12]	20 640	IgG and IgM	5 771 876	86
Denmark (Faroe Islands)[52]	1 075	IgG and IgM	52 428	88
France (Crepy-en-Valois)[39]	1 340	IgG	5 978 000 (Hauts-de-France)	89
France (Oise)[13]	661	IgG	5 978 000 (Hauts-de-France)	89
Germany (Gangelt)[16]	919	IgG and IgA	12 597	86
Germany (Frankfurt)[21]	1 000	IgG	2 681 000[d]	84 (Germany)
Greece[62]	6 586 (4 511 in April)	IgG	10 412 967	84
Hungary[57]	10 504	IgG (also had PCR)	9 657 451	88
Iceland[58]	30 576	Pan-Ig	366 854	90
India (Mumbai)[61]	6 904 (4 202 in slums, 2 702 not in slums)	IgG	1 414 917 (705 523 in slums, 709 394 in non-slums) in the 3 ward areas	98
India (Srinagar)[67]	2 906	IgG	1 500 000	97
Islamic Republic of Iran (Guilan)[8]	551	IgG and IgM	2 354 848	95
Italy (Apulia), blood donors[31]	909	IgG and /IgM	4 029 000	84
Japan (Kobe)[11]	1 000	IgG	1 518 870	79 (Japan)
Japan (Tokyo)[29]	1 071	IgG	13 902 077	79 (Japan)
Japan (Utsunomiya City)[48]	742	IgG	518 610	79 (Japan)
Kenya, blood donors[44]	3 098	IgG	47 564 296	99
Luxembourg[20]	1 807	IgG and IgA[e]	615 729	90
Netherlands blood donors[15]	7 361	IgG, IgM and IgA	17 097 123	86
Netherlands (Rotterdam)[64]	729 (early April)	IgG	17 097 123 (Netherlands)	86
Pakistan (Karachi)[49]	1 004	IgG and IgM	16 700 000	98 (Pakistan)
Pakistan (urban)[66]	24 210	IgG and IgM	79 000 000 (urban)	98

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Qatar[51]	937	IgG	2 800 000	99
Republic of Korea[59]	1 500	IgG	2 667 341	90 (southern Republic of Korea)
Spain[36]	61 075	IgG	46 940 000	85
Spain (Barcelona)[30]	874	IgG, IgM and IgA	7 566 000 (Catalonia)	86
Switzerland (Geneva)[10]	577 (20–27 April)	IgG	500 000	88
Switzerland (Zurich)[28]	1 644 patients (1–15 April)	IgG	1 520 968 (Zurich canton)	88
Switzerland (Zurich)[28]	1 640 blood donors (May)	IgG	1 930 525 (Zurich and Lucerne)	88
United Kingdom (England)[65]	109 076	IgG	56 287 000	86
United Kingdom (Scotland), blood donors[18]	500	IgG	5 400 000	88
USA (10 states)[35]				
Washington, Puget Sound	3 264	Pan-Ig	4 273 548	90 (Washington)
Utah	1 132	Pan-Ig	3 282 120	92
New York, New York City	2 482	Pan-Ig	9 260 870	89
Missouri	1 882	Pan-Ig	6 110 800	88
Florida, south	1 742	Pan-Ig	6 345 345	86 (Florida)
Connecticut	1 431	Pan-Ig	3 562 989	88
Louisiana	1 184	Pan-Ig	4 644 049	92 =
California, San Francisco Bay	1 224	Pan-Ig	2 173 082	90
Pennsylvania, Philadelphia	824	Pan-Ig	4 910 139	90
Minnesota, Minneapolis	860	Pan-Ig	3 857 479	90
USA (California, Bay Area)[24]	1 000	IgG	7 753 000	90
USA (California, Los Angeles)[22]	863	IgG and IgM	7 892 000	92
USA (California, San Francisco)[33]	3 953	IgG (also PCR testing)	5174 (in census tract 022 901)	95
USA (California, Santa Clara)[19]	3 300	IgG and IgM	1 928 000	90
USA (Idaho, Boise)[9]	4 856	IgG	481 587 (Ada county)	92
USA (Georgia, DeKalb and Fulton counties)[53]	696	Total Ig	1 806 672	88 (Georgia)
USA (Idaho, Blaine county)[46]	917	IgG	23 089	92
USA (Indiana)[54]	3 629	IgG (also RT–PCR done)	6 730 000	89
USA (Louisiana, Baton Rouge)[63]	138	IgG	699 200 (East Baton Rouge, West Baton Rouge, Ascension, Livingston)	92 (Louisiana)
USA (Louisiana, Orleans and Jefferson Parish)[37]	2 640	IgG	825 057	92 (Louisiana)
USA (New York)[23]	15 101	IgG	19 450 000	90
USA, New York[56]				
Columbia University Medical Center, New York City	742 (2–30 March)	IgG and IgM	9 260 870	89
CareMount central laboratory, five New York state counties	1 841	IgG and IgM	10 189 130 (New York state excluding New York City)	89
USA (New York, Brooklyn)[27]	11 092	IgG	2 559 903	91
USA (Rhode Island), blood donors[45]	1 996	IgG and IgM	1 059 000	88

COVID-19: coronavirus disease-19; Ig: immunoglobin; RT–PCR: real-time polymerase chain reaction.

[a] Dates in brackets are the specific dates used when seroprevalence was evaluated at multiple consecutive time points or setting.

[b] Some studies focused on age-restricted populations of the specific location under study, for example: people 17–70 years in the Denmark blood donor study (n = 3 800 000); people 18–79-years in the Luxembourg study (n = 483 000);

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people < 70 years in the Netherlands blood donor study (n = 13 745 768); people ≥ 18 years in the New York state study (n = 15 280 000); people > 19 years in the Utah population of the 10-state United States study (n = 2 173 082); people ≥ 18 years in Blaine county, Idaho (n = 17 611); people 15–64 years in the Kenya blood donor study (n = 27 150 165); people > 14 years living in private premises in Hungary; people > 18 years (n = 551 185) in Baton Rouge, Louisiana; people 18–65 years working in urban locations in Pakistan (n = 22 100 000); and people > 18 years in Srinagar District, India (n = 1 020 000). In this table and subsequent analyses, the entire population in the location is considered for consistency across studies.

[c] Information in parenthesis specify the population.

[d] Participants were recruited from a large number of districts, but most districts had very few participants; here I included the population of the nine districts with > 1:10 000 sampling ratio (846/1000 participants came from these nine districts).

[e] Considered positive if both IgG and IgA were positive; in the other studies, detection of any antibody was considered positive.

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Table 3. **Prevalence of COVID-19 and estimated number of people infected, 2020**

Country (location)	Seroprevalence (%)		Estimated no. of people infected
	Crude	Adjusted (adjustments)	
Argentina (Barrio Padre Mugica)[47]	ND	53.4 (age, sex, household, non-response)	26 691
Belgium[38]	5.7	6.0 (sampling, age, sex, province)	695 377
Brazil (133 cities)[25]	1.39	1.62 overall, varying from 0 to 25.0 across 133 cities (test, design)	1 209 435[a]
Brazil (Espirito Santo)[34]	2.1	ND	84 391
Brazil (Maranhao)[68]	37	40.4 (clustering, stratification, non-response)	2 877 454
Brazil (Rio de Janeiro), blood donors[41]	6	4.7 (age, sex, test)	811 452
Brazil (Rio Grande do Sul)[17]	0.222	0.222 (sampling)[b]	25 283
Brazil (Sao Paulo)[42]	5.2	4.7 (sampling design)	14 017
Canada (British Columbia)[50]	0.45	0.55 (age)	27 890
Chile (Vitacura)[43]	11.2	ND	9 500
China, blood donors[55]			
Wuhan	3.87	ND	433 827
Shenzhen	0.06	ND	7 818
Shijiazhuang	0.02	ND	2 206
China (Wuhan)[14]	10	ND	1 108 000
China (Wuhan)[32]	8.36 (3.53 for entire period)	ND (2.80 (age, sex, test) for entire period)	926 288
China (Guangzhou), blood donors[60]	0.09	ND	104 783
China (several regions)[40]			
Hubei (not Wuhan)	3.6	ND	1 718 110
Chongqing	3.8	ND	11 956 109
Sichuan	0.6	ND	487 847
Guangdong	2.2	ND	2 522 010
Croatia[26]	1.27[c]	ND	51 765
Denmark, blood donors[12]	2	1.9 (test)	109 665
Denmark (Faroe Islands)[52]	0.6	0.7 (test)	365
France (Crepy-en-Valois)[39]	10.4	ND	620 105
France (Oise)[13]	25.9	ND	1 548 000
Germany (Gangelt)[16]	15	20.0 (test, cluster, symptoms)	2 519
Germany (Frankfurt)[21]	0.6	ND	16 086
Greece[62]	0.42 (April)	0.49 (age, sex, region)[d]	51 023
Hungary[57]	0.67	0.68 (design, age, sex, district)	65 671
Iceland[58]	2.3 (quarantined), 0.3 (unknown exposure)	0.9 (including those positive by PCR)	3 177
India (Mumbai)[61]	54.1 in slum areas, 16.1 in non-slum areas	58.4 in slum areas, 17.3 in non-slum areas (test, age, sex)	534 750
India (Srinagar)[67]	3.8	3.6 (age, sex)	54 000
Islamic Republic of Iran (Guilan)[8]	22	33.0 (test, sampling)	770 000
Italy (Apulia), blood donors[31]	0.99	ND	39 887
Japan (Kobe)[11]	3.3	2.7 (age, sex)	40 999
Japan (Tokyo)[29]	3.83	ND	532 450
Japan (Utsunomiya City)[48]	0.4	1.23 (age, sex, distance to clinic, district, cohabitants)	6 378
Kenya, blood donors[44]	5.6	5.2 (age, sex, region, test)	2 783 453
Luxembourg[20]	1.9	2.1 (age, sex, district)	12 684
Netherlands, blood donors[15]	2.7	ND	461 622
Netherlands (Rotterdam)[64]	3	ND	512 910

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Pakistan (Karachi)[49]	16.3 (20.0 in East, 12.7 in Malir)	11.9 (age, sex; 15.1 in East, 8.7 in Malir)	1 987 300
Pakistan (urban)[66]	17.5	ND	13 825 000
Qatar[51]	30.4 (24.0 for entire period)	ND	851 200
Republic of Korea[59]	0.07	ND	1 867
Spain[36]	ND	5.0[e] (sampling, age, sex, income)	2 347 000
Spain (Barcelona)[30]	14.3	ND	1 081 938
Switzerland (Geneva)[10]	10.6	10.9 (test, age, sex)	54 500
Switzerland (Zurich)[28]	Unclear	1.3 in patients during 1–15 April and 1.6 in blood donors in May (multivariate Gaussian conditioning)	19 773 (Zurich); 30 888 (Zurich and Lucerne)
United Kingdom (England)[65]	5.6	6.0 (test, sampling)	3 360 000
United Kingdom (Scotland) blood donors[18]	1.2	ND	64 800
USA (six states)[35]		(age, sex, test)	
Washington, Puget Sound	1.3	1.1	48 291
Utah	2.4	2.2	71 550
New York, New York City	5.7	6.9	641 778
Missouri	2.9	2.7	161 936
Florida, south	2.2	1.9	117 389
Connecticut	4.9	4.9	176 012
Louisiana	ND	5.8	267 033
California, San Francisco Bay	ND	1	64 626
Pennsylvania, Philadelphia	ND	3.2	156 633
Minnesota, Minneapolis	ND	2.4	90 651
USA (California, Bay Area)[24]	0.4 (blood donors)	0.1 (test and confirmation)	7 753
USA (California, Los Angeles)[22]	4.06	4.65 (test, sex, race and ethnicity, income)	367 000
USA (California, San Francisco)[33]	4.3 in the census track	6.1 (age, sex, race and ethnicity, test)	316
USA (California, Santa Clara)[19]	1.5	2.6 (test, sampling, cluster)	51 000
USA (Idaho, Boise)[9]	1.79	ND	8620
USA (Georgia, DeKalb and Fulton counties)[53]	2.7	2.5 (age, sex, race and ethnicity)	45 167
USA (Idaho, Blaine county)[46]	22.4	23.4 (test, age, sex, household)	5 403
USA (Indiana)[54]	2.3 (IgG or PCR)	2.8 (age, race, Hispanic ethnicity)	187 802
USA (Louisiana, Baton Rouge)[63]	6	6.6 (census, race, parish) including PCR positives	46 147
USA (Louisiana, Orleans and Jefferson Parish)[37]	6.9 (IgG or PCR)	6.9 for IgG (census weighting, demographics)	56 578
USA (New York)[23]	12.5	14.0 (test, sex, age race and ethnicity, region)	2 723 000
USA, New York[56]			
Columbia University Medical Center, New York City	5	ND	463 044
CareMount central laboratory, five New York state counties	1.8	ND	183 404
USA (New York, Brooklyn)[27]	47	ND	1 203 154
USA (Rhode Island), blood donors[45]	3.9	ND	41 384

COVID-19: coronavirus disease 2019; ND: no data available; PCR: polymerase chain reaction; test: test performance.

[a] The authors calculated 760 000 to be infected in the 90 cities that had 200–250 samples tested, but many of the other 43 cities with < 200 samples may be equally or ever better represented since they tended to be smaller than the 90 cities (mean population 356 213 versus 659 326).

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[b] An estimate is also provided adjusting for test performance, but the assumed specificity of 99.0% seems inappropriately low, since as part of the validation process the authors found that several of the test-positive individuals had household members who were also infected, thus the estimated specificity was deemed by the authors to be at least 99.95%.

[c] 1.20% in workers in Split without mobility restrictions, 3.37% in workers in Knin without mobility restrictions, 1.57% for all workers without mobility restrictions; Split and Knin tended to have somewhat higher death rates than nationwide Croatia, but residence of workers is not given, so the entire population of the country is used in the calculations.

[d] An estimate is also provided adjusting for test performance resulting in adjusted seroprevalence of 0.23%, but this seems inappropriately low, since the authors report that all positive results were further validated by ELISA.

[e] 5.0% with point of care test, 4.6% with immunoassay, 3.7% with both tests positive, 6.2% with at least one test positive.

Notes: Of the studies where seroprevalence was evaluated at multiple consecutive time points, the seroprevalence estimate was the highest in the most recent time interval with few exceptions, for example: in the Switzerland (Geneva) study,[10] the highest value was seen 2 weeks before the last time interval; in the Switzerland (Zurich) study,[28] the highest value was seen in the period 1–15 April for patients at the university hospital and in May for blood donors; and in the China (Wuhan) study,[32] the highest value was seen about 3 weeks before the last time interval.

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Table 4. **Deaths from COVID-19 and inferred infection fatality rates, overall and in people younger than 70 years, by location, 2020**

Location	Deaths from COVID-19, no. (date)	Inferred infection fatality rate (corrected), %	% of deaths from COVID-19 in people < 70 years[a]	Infection fatality rate in people < 70 years (corrected), %
Argentina (Barrio Padre Mugica)[47]	44 (1 July)	0.16 (0.13)	~70	0.11 (0.09)
Belgium[38]	7594 (30 April)	1.09 (0.87)	10	0.13 (0.10)
Brazil (133 cities)[25]	–[b]	Median 0.30 (0.27)	31 (< 60 years)	0.10 (0.9)
Brazil (Espirito Santo)[34]	363 (21 May)	0.43 (0.39)	31 (Brazil, < 60 years)	0.14 (0.13)
Brazil (Maranhao)[68]	4272 (8 August)	0.15 (0.14)	23	0.04 (0.03)
Brazil (Rio de Janeiro), blood donors[41]	1019 (3 May)	0.12 (0.11)	31 (Brazil, < 60 years)	0.04 (0.04)
Brazil (Rio Grande do Sul)[17]	124 (14 May)	0.49 (0.39)	31 (Brazil, < 60 years)	0.19 (0.15)
Brazil (Sao Paulo)[c,42]	Unknown (15 May)	Unknown, but likely > 0.4	31 (Brazil, < 60 years)	Unknown, but likely > 0.1
Canada (British Columbia)[50]	164 (28 May)	0.59 (0.59)	13	0.08 (0.08)
Chile (Vitacura) [c,43]	Unknown (18 May)	Unknown, but likely < 0.2	36 (Chile)	Unknown, but likely < 0.1
China, blood donors[55]				
Wuhan	1935 (20 February)	0.45 (0.41)	50	0.24 (0.22)
Shenzhen	1 (5 March)	0.01 (0.01)	About 50 (if similar to Wuhan)	0.01 (0.01)
Shijiazhuang	1 (27 February)	0.05 (0.04)	About 50 (if similar to Wuhan)	0.03 (0.02)
China (Wuhan)[14]	3869 (2 May)	0.35 (0.31)	50	0.19 (0.15)
China (Wuhan)[32]	3869 (13 April)	0.42 (0.38)	50	0.23 (0.21)
China (Guangzhou), blood donors[60]	8 (5 April)	0.00 (0.00)	About 50 (if similar to Wuhan)	0.00 (0.00)
China (several regions)[40]				
Hubei (not Wuhan)	643 (12 April)	0.04 (0.03)	About 50 (if similar to Wuhan)	0.02 (0.02)
Chongqing	6 (12 April)	0.00 (0.00)	About 50 (if similar to Wuhan)	0.00 (0.00)
Guangdong	8 (12 April)	0.00 (0.00)	About 50 (if similar to Wuhan)	0.00 (0.00)
Sichuan	3 (12 April)	0.00 (0.00)	About 50 (if similar to Wuhan)	0.00 (0.00)
Croatia[26]	79 (3 May)	0.15 (0.14)	13	0.02 (0.02)
Denmark, blood donors[12]	370 (21 April)	0.34 (0.27)	12	0.05 (0.04)
Faroe Islands[52]	0 (5 May)	0.00 (0.00)	0	0.00 (0.00)
France (Crepy-en-Valois)[39]	2325 (5 May)[d]	0.37 (0.30)	7 (France, < 65 years)	0.04 (0.03)
France (Oise)[13]	932 (7 April)[d]	0.06 (0.05)	7 (France, < 65 years)	0.01 (0.01)
Germany (Gangelt)[16]	7 (15 April)	0.28 (0.25)	0	0.00 (0.00)
Germany (Frankfurt)[21]	42[e] (17 April)	0.26 (0.21)	14 (Germany)	0.04 (0.03)
Greece[62]	121 (22 April)	0.24 (0.19)	30	0.09 (0.07)
Hungary[57]	442 (15 May)	0.67 (0.54)	No data	No data
Iceland[58]	10 (1 June)	0.30 (0.30)	30	0.10 (0.10)
India (Mumbai)[61]	495 (13–20 July)	0.09 (0.07)	50 (< 60 years, India)	0.04 (0.03)
India (Srinagar)[67]	35 (15 July)[f]	0.06 (0.05)	50 (< 60 years, India)	0.03 (0.03)
Islamic Republic of Iran (Guilan)[8]	617 (23 April)	0.08 (0.07)	No data	No data
Italy (Apulia), blood donors[31]	530 (22 May)	1.33 (1.20)	15 (Italy)	0.24 (0.22)
Japan (Kobe)[11]	10 (mid-April)	0.02 (0.02)	21 (Japan)	0.01 (0.01)
Japan (Tokyo)[29]	189 (11 May)	0.04 (0.03)	21 (Japan)	0.01 (0.01)
Japan (Utsunomiya City)[48]	0 (14 June)	0.00 (0.00)	0	0.00 (0.00)

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Kenya, blood donors[44]	64 (31 May)	0.00 (0.00)	58 (< 60 years)	0.00 (0.00)
Luxembourg[20]	92 (2 May)	0.73 (0.58)	9	0.07 (0.06)
Netherlands, blood donors[15]	3134 (15 April)	0.68 (0.68)	11	0.09 (0.09)
Netherlands (Rotterdam)[64]	3134 (15 April)	0.65 (0.52)	11	0.08 (0.06)
Pakistan (Karachi)[49]	~1500 (9 July)[g]	0.08 (0.07)	~70	0.06 (0.05)
Pakistan (urban)[66]	5266 (13 July)[h]	0.04 (0.04)	~70	0.03 (0.03)
Qatar[51]	93 (19 June)	0.01 (0.01)	74	0.01 (0.01)
Republic of Korea[59]	2 (3 June)[i]	0.10 (0.09)	0	0.00 (0.00)
Spain[36]	26 920 (11 May)	1.15 (0.92)	13	0.18 (0.14)
Spain (Barcelona)[30]	5137 (2 May)	0.48 (0.48)	13 (Spain)	0.07 (0.07)
Switzerland (Geneva)[10]	243 (30 April)	0.45 (0.36)	8	0.04 (0.03)
Switzerland (Zurich)[28]	107 (15 April, Zurich), 147 (22 May, Zurich and Lucerne)	0.51 (0.41)	8 (Switzerland)	0.05 (0.04)
England[65]	38 854 (9 July)	1.16 (0.93)	20	0.27 (0.22)
Scotland, blood donors[18]	47 (1 April)	0.07 (0.06)	9 (< 65 years)	0.01 (0.01)
USA (10 states)[35]				
Washington, Puget Sound	207 (4 April)	0.43 (0.43)	10 (state, < 60 years)	0.05 (0.05)
Utah	58 (4 May)	0.08 (0.08)	28 (< 65 years)	0.03 (0.03)
New York	4146 (4 April)	0.65 (0.65)	34 (state)	0.25 (0.25)
Missouri	329 (30 April)	0.20 (0.20)	23	0.05 (0.05)
Florida, south	295 (15 April)	0.25 (0.25)	28 (state)	0.08 (0.08)
Connecticut	2718 (6 May)	1.54 (1.54)	18	0.31 (0.31)
Louisiana	806 (11 April)	0.30 (0.30)	32	0.10 (0.10)
California, San Francisco Bay	321 (1 May)	0.50 (0.50)	25	0.14 (0.14)
Pennsylvania, Philadelphia	697 (26 April)	0.45 (0.45)	21 (state)	0.10 (0.10)
Minnesota, Minneapolis	436 (13 May)	0.48 (0.48)	20 (state)	0.10 (0.10)
USA (California, Bay Area)[24]	12 (22 March)	0.15 (0.12)	25	0.04 (0.03)
USA (California, Los Angeles)[22]	724 (19 April)	0.20 (0.18)	24 (< 65 years)	0.06 (0.05)
USA (California, San Francisco)[33]	0 (4 May)	0.00 (0.00)	0	0.00 (0.00)
USA (California; Santa Clara)[19]	94 (22 April)	0.18 (0.17)	35	0.07 (0.06)
USA (Idaho, Boise)[9]	14 (24 April)	0.16 (0.13)	14 (Idaho)	0.02 (0.02)
USA (Georgia)[53]	198 (7 May)	0.44 (0.44)	30	0.15 (0.15)
USA (Idaho, Blaine county)[46]	5 (19 May)	0.10 (0.08)	14 (Idaho)	0.02 (0.01)
USA (Indiana)[54]	1099 (30 April)	0.58 (0.46)	24	0.16 (0.13)
USA (Louisiana, Baton Rouge)[63]	420 (30 July)	0.91 (0.73)	32 (Louisiana)	0.32 (0.25)
USA (Louisiana, Orleans and Jefferson Parish)[37]	925 (16 May)	1.63 (1.31)	32	0.57 (0.46)
USA (New York)[23]	18 610 (30 April)[j]	0.68 (0.54)[j]	34	0.26 (0.23)[d]
USA (New York Columbia University Medical Center, New York City and CareMount central laboratory, five New York state counties)[56]	965 (28 March, New York state)	0.15 (0.14)	34	0.06 (0.05)
USA (New York, Brooklyn)[27]	4894 (19 May)[j]	0.41 (0.33)[j]	34 (New York state)	0.15 (0.14)[d]
USA (Rhode Island), blood donors[45]	430 (11 May)	1.04 (0.83)	17	0.20 (0.16)

COVID-19: coronavirus disease 2019.

[a] Whenever the number or proportion of COVID-19 deaths at age < 70 years was not provided in the paper, I retrieved the proportion of these deaths from situation reports of the relevant location. If I could not find this information for the specific location, I used a larger geographic area. For Brazil, the closest information that I found was from a news report.[77] For Croatia, I retrieved data on age for 45/103 deaths through Wikipedia.[78]

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[b] Data are provided by the authors for deaths per 100 000 population in each city along with inferred infection fatality rate in each city, with wide differences across cities; the infection fatality rate shown here is the median across the 36 cities with 200–250 samples and at least one positive sample (the interquartile range for the uncorrected infection fatality rate is 0.20–0.60% and across all cities is 0–2.4%, but with very wide uncertainty in each city). A higher infection fatality rate is alluded to in the preprint, but the preprint also shows a scatter diagram for survey-based seroprevalence versus reported deaths per population with a regression slope that agrees with an infection fatality rate of 0.3%.

[c] Information on deaths was not available for the specific locations. In the Sao Paulo study, the authors selected six districts of Sao Paulo most affected by COVID-19, they do not name the districts and the number of deaths as of mid-May is not available, but using data for death rates across all Sao Paulo would give an infection fatality rate of > 0.4% overall. In the Vitacura study, similarly one can infer from the wider Santiago metropolitan area that the infection fatality rate in the Vitacura area would probably be < 0.2% overall.

[d] For France, government situation reports provide the number of deaths per region only for in-hospital deaths; therefore, I multiplied the number of in-hospital deaths by a factor equal to: total number of deaths/in-hospital deaths for all of France.

[e] Estimated from no. of deaths in Hesse province on 17 April × proportion of deaths in the nine districts with key enrolment (enrolment ratio > 1:10 000) in the study among all deaths in Hesse province.

[f] I calculated the approximate number of deaths assuming the same case fatality ratio in the Srinagar district as in the Jammu and Kashmir state where it is located.

[g] For Karachi, it is assumed that about 30% of COVID-19 deaths in Pakistan are in Karachi (since about 30% of the cases are there).

[h] The number of deaths across all Pakistan; I assumed that this number is a good approximation of deaths in urban areas (most deaths occur in urban areas and there is some potential underreporting).

[i] I calculated the approximate number of deaths from the number of cases in the study areas in south-western Seoul, assuming a similar case fatality as in Seoul overall.

[j] Confirmed COVID-19 deaths; inclusion of probable COVID-19 deaths would increase the infection fatality rate estimates by about a quarter.

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Table 5. **Infection fatality rates for coronavirus disease-19 inferred from preliminary nationwide seroprevalence data, 2020**

Country	Sample size (antibody)	Date	Reported seroprevalence (%)	Population, no.	Deaths, no. (date)	Inferred infection fatality rate (corrected), %
Afghanistan[75]	9 500 (IgG?)	August?	31.5	39 021 453	1300 (8 May)	0.01 (0.01)
Czechia[71]	26 549 (IgG)	23 April–1 May	0.4	10 710 000	252 (4 May)	0.59 (0.47)
Finland[69]	674 (IgG)	20–26 April[a]	2.52	5 541 000	211 (30 April)	0.15 (0.12)
Georgia[76]	1 068 (IgG?)	18–27 May	1	3 988 264	12 (30 May)	0.03 (0.03)[b]
Israel[72]	1 709 (IgG?)	May	2–3	9 198 000	299 (10 June)	0.13 (0.10)[c]
Russian Federation[74]	650 000 (IgG?)	June?	14	145 941 776	5859 (7 June)	0.03 (0.03)
Slovenia[73]	1368 (IgG?)	April	3.1	2 079 000	92 (1 May)	0.14 (0.11)
Sweden[70]	1 200 (IgG)	18–24 May	6.3	10 101 000	4501 (28 May)	0.71 (0.57)

COVID-19: coronavirus disease 2019; Ig: immunoglobin.

[a] The seroprevalence was slightly lower in subsequent weeks.

[b] The survey was done in Tbilisi, the capital city with a population 1.1 million. I could not retrieve the count of deaths in Tbilisi, but if more deaths happened in Tbilisi, then the infection fatality rate may be higher, but still < 0.1%.

[c] Assuming a seroprevalence of 2.5%.

Notes: These are countries for which no eligible studies were retrieved in the literature search. The results of these studies have been announced to the press and/or in preliminary reports, but are not yet peer reviewed and published. The question marks indicate that the antibody type or date were not clear.

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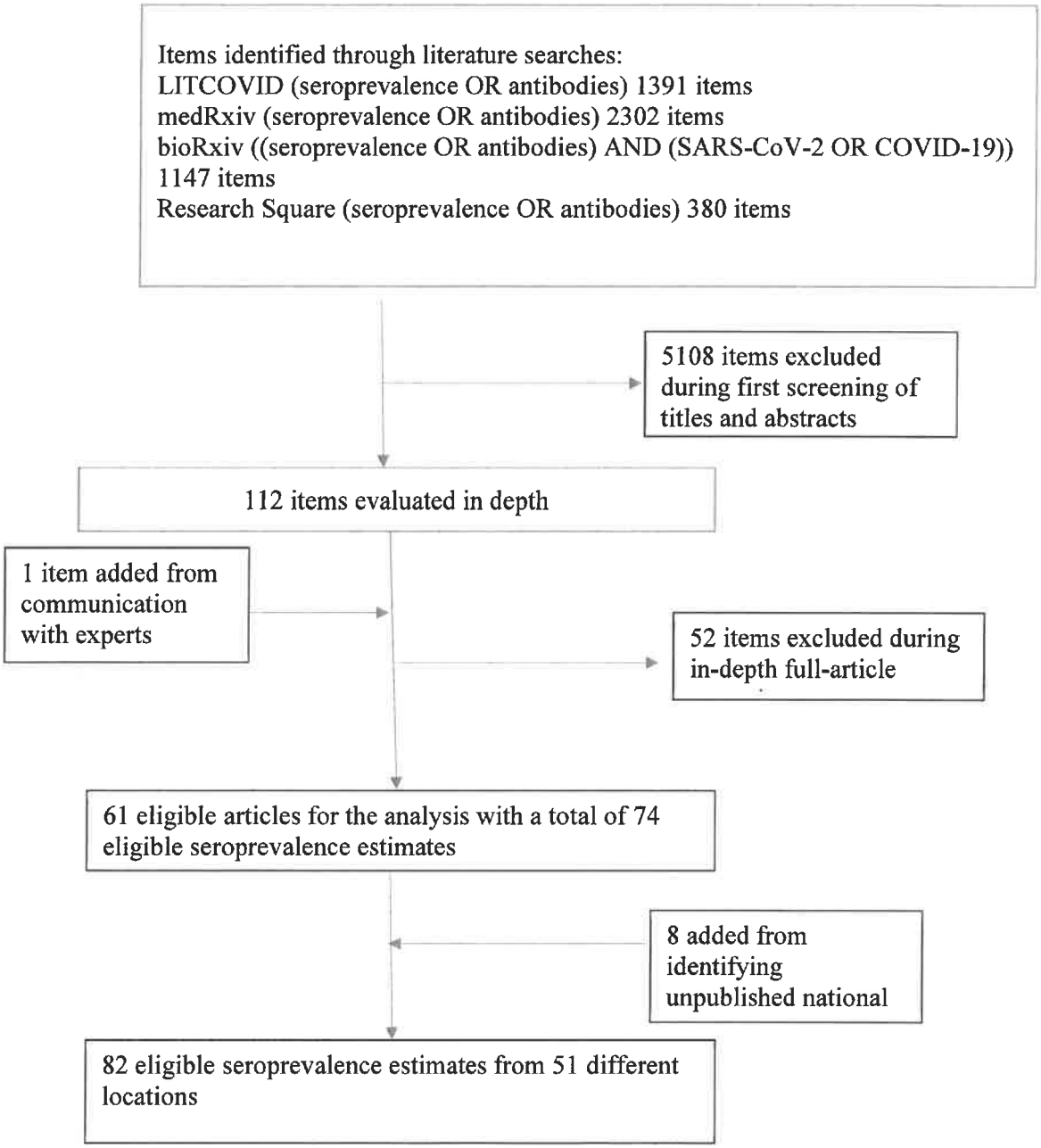
Fig. 1. **Flowchart for selection of seroprevalence studies on severe acute respiratory syndrome coronavirus 2, 2020**



COVID-19: coronavirus disease 2019; SARS-CoV-2: severe acute respiratory syndrome coronavirus 2.

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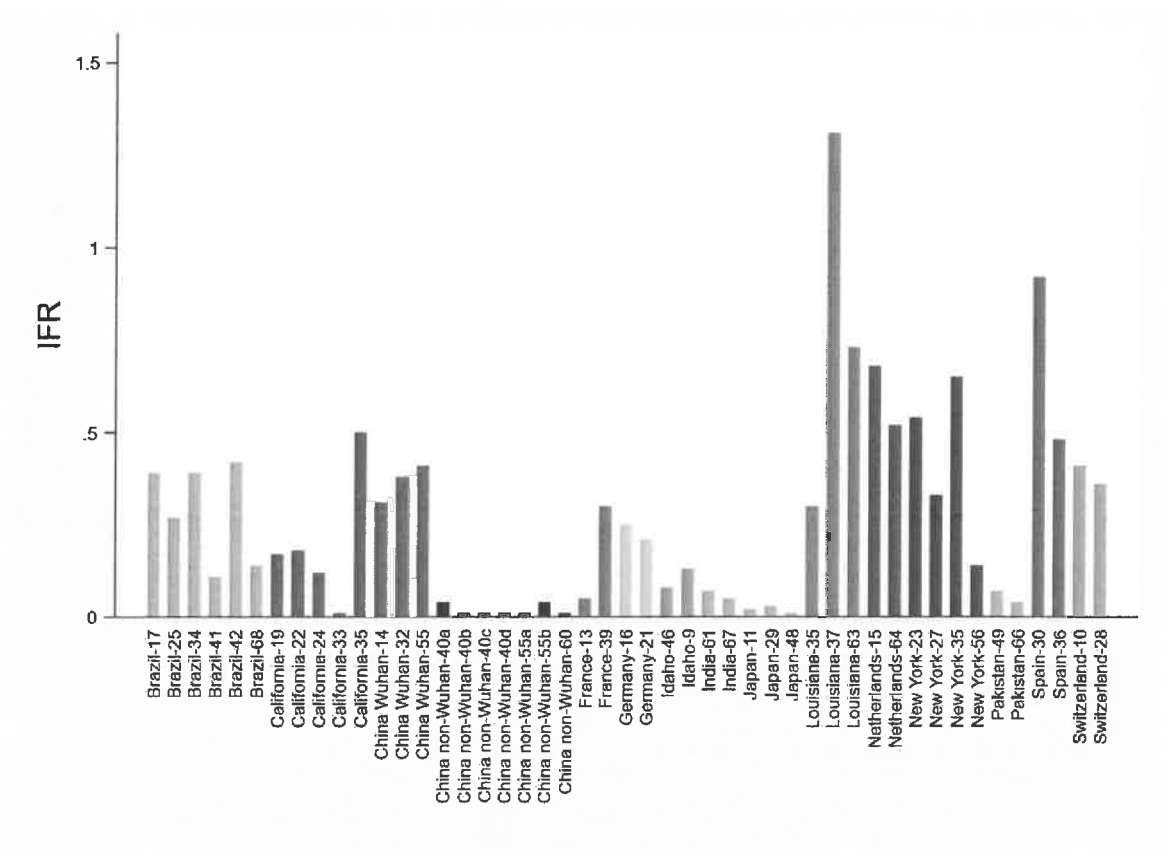
Fig. 2. **Estimates of infection fatality rates for COVID-19 in locations that had two or more estimates, 2020**



COVID-19: coronavirus disease 2019.

Notes: Locations are defined at the level of countries, except for the USA where they are defined at the level of states and China is separated into Wuhan and non-Wuhan areas. Corrected infection fatality rate estimates are shown (correcting for what types of antibodies were assayed).

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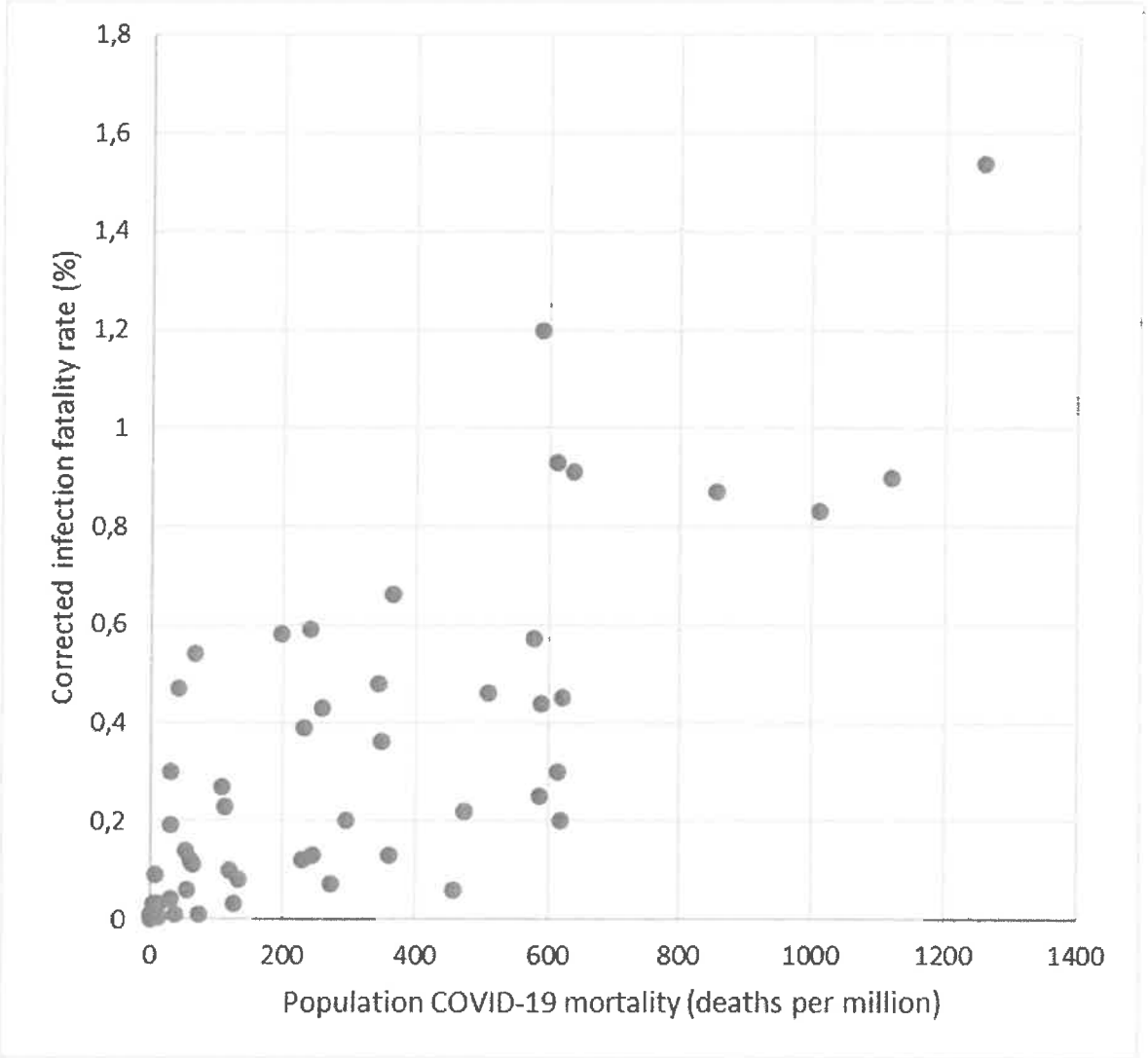
Fig. 3. **Corrected estimates of COVID-19 infection fatality rate in each location plotted against COVID-19 mortality rate as of September 12, 2020 in that location**



COVID-19: coronavirus disease 2019

Notes: Locations are defined at the level of countries, except for the United Kingdom of Great Britain and Northern Ireland where they are defined by jurisdiction, USA are defined at the level of states and China is separated into Wuhan and non-Wuhan areas. Included locations are: Afghanistan; Argentina, Belgium Brazil; Canada; Chile; China (non-Wuhan and Wuhan); Croatia; Czechia; Denmark; Faroe Islands; Finland; France; Georgia; Germany; Greece; Hungary; Iceland; India; Islamic Republic of Iran (Islamic Republic of); Israel; Italy; Japan; Kenya; Luxembourg; Netherlands; Pakistan; Qatar; Russian Federation; Slovenia; Republic of Korea; Spain; Sweden; Switzerland; United Kingdom (England, Scotland); and USA (California, Connecticut, Florida, Georgia, Idaho, Indiana, Louisiana, Minnesota, Missouri, New York, Pennsylvania, Rhode Island, Utah, Washington). When several infection fatality rate estimates were available from multiple studies for a location, the sample size-weighted mean is used. One outlier location with very high deaths per million population (1702 for New York) is not shown.

Steep slump in GDP as COVID-19 takes its toll on the economy

The punch in the gut was severe. Perhaps the second quarter of 2020 will become known as the pandemic quarter. South Africa's economy suffered a significant contraction during April, May and June, when the country operated under widespread lockdown restrictions in response to COVID-19.

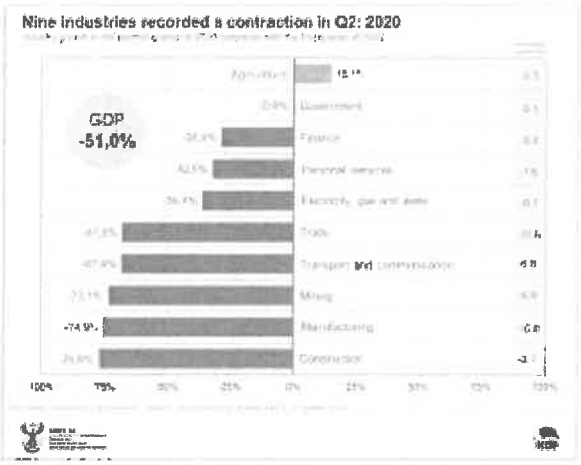
Gross domestic product (GDP) fell by just over 16% between the first and second quarters of 2020, giving an annualised growth rate of -51%.[1]

This contraction dwarfs the annualised slowdown of 6,1% recorded in the first quarter of 2009 during the global financial crisis. Historical data from 1960, sourced from the South African Reserve Bank, show that the second quarter of 2020 experienced the biggest fall in GDP since that year, far steeper than the annualised 8,2% decline in the fourth quarter of 1982.[2]

In constant 2010 prices, the country generated almost R654 billion (not annualised) in the second quarter of 2020. This was the lowest level of production since the first quarter of 2009 when the economy generated R649 billion.

Agriculture keeps its head above water as economy dives

Nearly all industries experienced a massive drop in output in the second quarter of 2020. Construction was the biggest loser. Already in bad shape before the pandemic, the industry experienced its eighth consecutive quarter of economic decline, slumping further by 76,6% (note that this and following growth rates are all annualised).



Manufacturing output shrank by 74,9%. Plagued by work stoppages and lower demand for steel, factories specialising in metals and machinery were severely affected. The ban on alcohol sales had a heavy impact on the food and beverage division of manufacturing.

Air travel came to an almost complete halt, contributing to the fall in economic activity in the transport and communication industry. There was also less activity by rail and road freight operators due to restrictions on the production and movement of various goods.

The retail ban on alcohol sales and closure of tourist accommodation facilities were notable drags on trade activity. Wholesalers and motor vehicle traders also reported significant declines.

Finance and personal services, the two industries that have shown a great deal of resilience over the last decade, did not escape the maelstrom. The finance industry, which includes banking, insurance services, real estate and business services, fell by 28,9%.

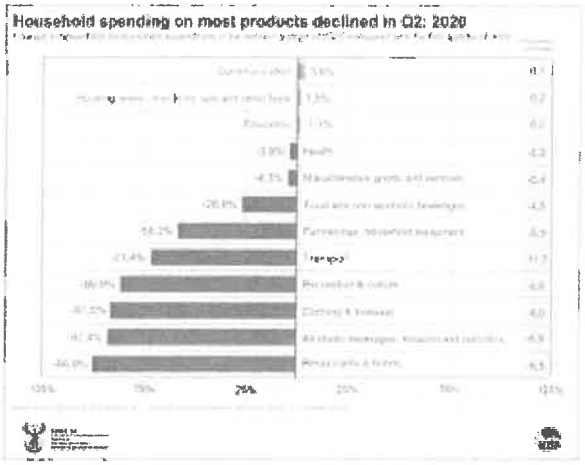
Personal services recorded its first quarter of negative growth since 2009. Businesses, such as gyms and hairdressers, closed their doors and hospitals halted elective operations. The cancelation of sporting and recreation events also dragged the industry lower.

Agriculture was the only industry that seemed relatively unaffected. An increase in maize exports, as well as rising international demand for citrus fruits and pecan nuts, helped the industry expand by 15,1%. Locally, the baking craze that gripped the country during the lockdown increased the demand for home cooking products.

Household spending plummets, but consumers spend more on communication

Stats SA also measures the expenditure side of GDP, reflecting the demand side of the economy. Expenditure on GDP in the second quarter tumbled by 52,3% (seasonally adjusted and annualised), dragged lower mainly by falling exports and household spending.

Household spending slumped by 49,8% in line with the closure of hotels, restaurants, transport services, recreational facilities and many stores. Spending on restaurants and hotels ground to an almost complete halt, plunging by 99,9%.



The alcohol and cigarette bans had an impact too. Consumer spending on these items fell by 92,4%.

Communication, housing and education expenditure was up in the second quarter. Cut off from family and friends – and having to suddenly work and study from home – many consumers increased their spending on communication services (most notably on data).

For more information, download the GDP release, media presentation and the associated Excel files here.

[1] An annualised growth rate shows what growth would be over a full year if the quarter-on-quarter growth rate were to occur four times in succession. Unless otherwise indicated, all growth rates in this article are quarter-on-quarter, seasonally adjusted and annualised, and in real (volume) terms.

[2] South African Reserve Bank, Historical macroeconomic timeseries information, Gross domestic product at market prices (KBP6006D) (access the data here). An annualised quarter-on-quarter growth rate was applied to the data for this article.

RH6

Saturday, 14 November 2020

NICD COVID-19 Surveillance in Selected Hospitals

National

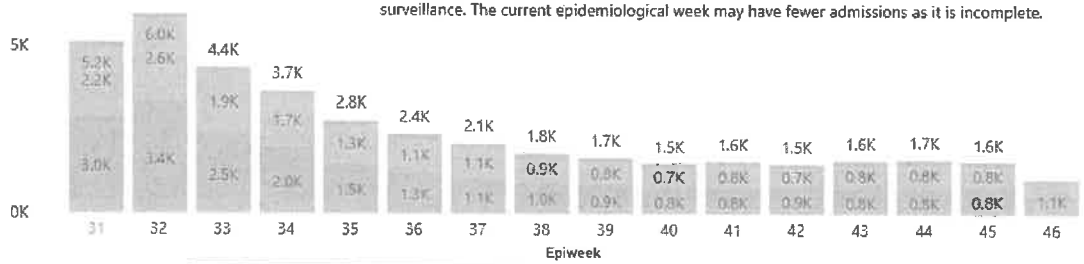
health
Department: Health
REPUBLIC OF SOUTH AFRICA

This report presents data collected using clinical information from admitted patients at selected hospitals to identify trends in admissions of COVID-19 patients. Not all hospitals currently participate and new facilities continue to enroll. The data below refer to admitted patients with laboratory-confirmed COVID-19.

Hospital admissions of COVID-19 cases, by health sector, by epidemiological week

Private Public Total: 98.89K

The number of reported admissions may change day-to-day as new facilities enroll in this sentinel surveillance. The current epidemiological week may have fewer admissions as it is incomplete.



Ward of currently admitted patients

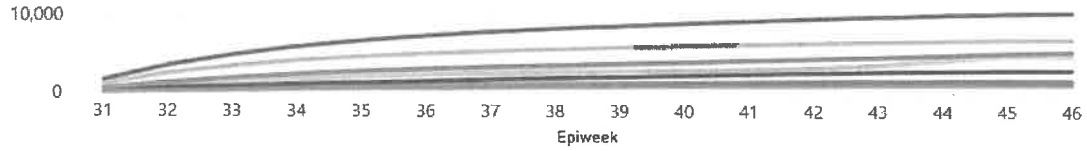
Currently in Hospital: 4.89K

ICU High Care General

Province

- Eastern Cape
- Free State
- Gauteng
- KwaZulu-Natal
- Limpopo
- Mpumalanga
- North West
- Northern Cape
- Western Cape

Cumulative reported admissions by province, by epidemiological week



Eastern Cape Free State Gauteng KwaZulu-Natal Limpopo Mpumalanga North West Northern Cape Western Cape

Interventions for currently admitted patients

Currently in Hospital: 4.89K

Currently Ventilated Currently Oxygenated

Sector

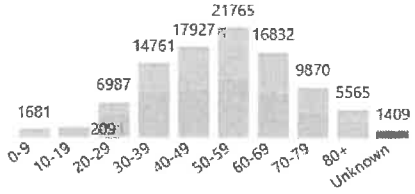
- Private
- Public

Hospital Coverage

100% Private Hospitals (of 244)
104% Public Hospitals (of 341)

Admissions to date by age group and sex

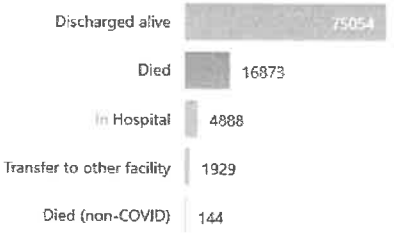
Total: 98.89K



Female Male

Admissions to date by discharge type

Total: 98.89K

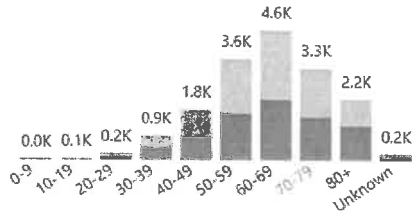


Total healthcare workers admitted	Current healthcare workers admitted
4431	134
% of total admitted	**% of current admitted**
4%	3%

Healthcare worker is defined as a Doctor, Nurse, Allied Health, Lab worker, Paramedic or Porter

Deaths to date by age group and sex

Total: 17K



Female Male

Source: NICD DATCOV19 Platform

Contact: DATCOV19@nicd.ac.za or Dr Waasila Jassat 082 927 4138

RH6

Saturday, 14 November 2020

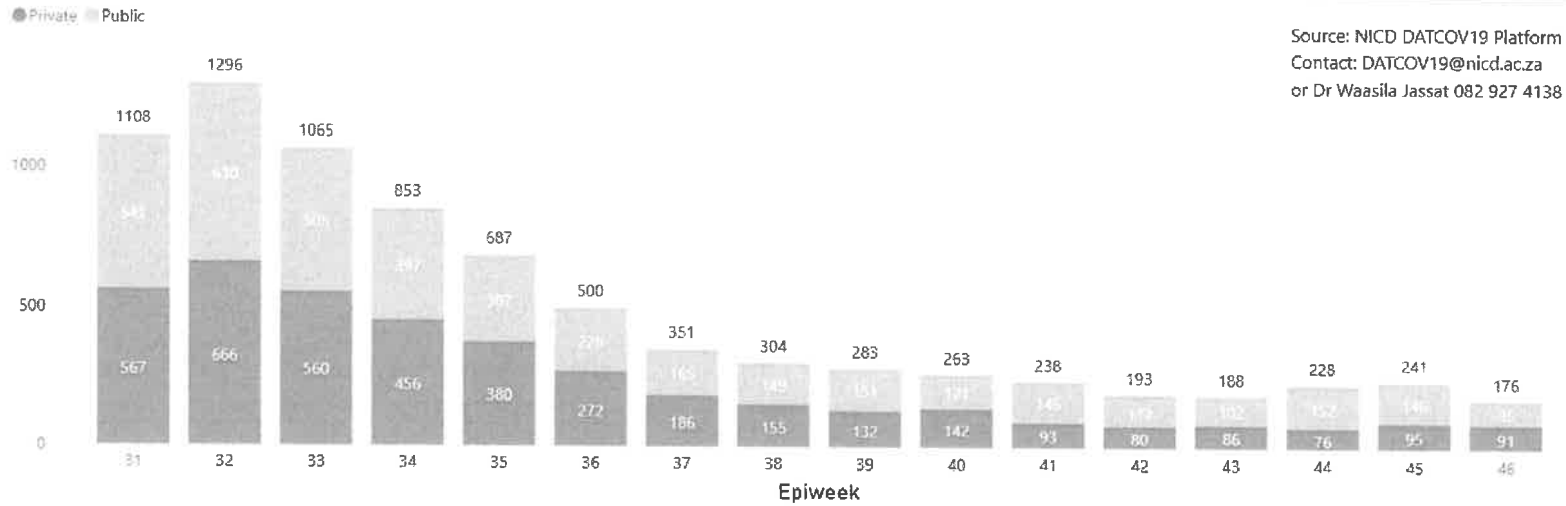
NICD COVID-19 Surveillance in Selected Hospitals

National

health
Department:
Health
REPUBLIC OF SOUTH AFRICA

This report presents data collected using clinical information from admitted patients at selected hospitals to identify trends in admissions of COVID-19 patients. Not all hospitals currently participate and new facilities continue to enroll. The data below refer to admitted patients with laboratory-confirmed COVID-19.

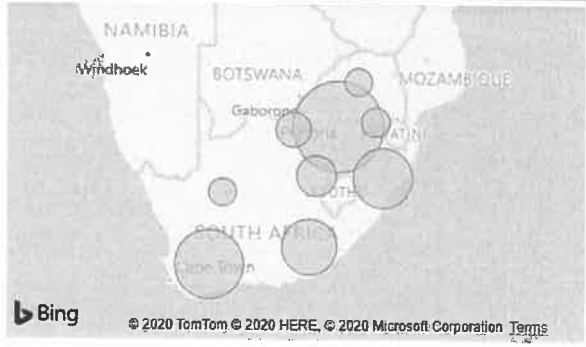
Deaths by epidemiological week and sector



Summary of reported COVID-19 admissions by province, by sector

Province	Facilities reporting	Admissions to date	Deaths to date	Discharged to date	Currently admitted	Currently in ICU	Currently ventilated
Eastern Cape	98	14067	3667	9364	983	46	49
Free State	55	7410	1373	5666	328	14	15
Gauteng	128	29582	4156	23746	1671	155	81
KwaZulu-Natal	107	15886	2444	12889	544	64	22
Limpopo	40	1814	312	1380	119	11	6
Mpumalanga	34	2616	377	2088	148	27	18
North West	24	5341	528	4599	206	24	20
Northern Cape	22	2052	293	1517	227	11	22
Western Cape	96	20120	3723	15734	662	70	20
Total	**604**	**98888**	**16873**	**76983**	**4888**	**422**	**253**

Admissions by District



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prokureurs • attorneys

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URGENT

Our ref. DJ Eloff / MAT3179

20 October 2020

Nkosazana Clarice Dlamini-Zuma
Minister of Cooperative Governance and Traditional Affairs
87 Hamilton Street
Arcadia
Pretoria
RSA
0002

By email: info@cogta.gov.za

Dear Minister Dlamini-Zuma,

RE: DEAR SA // MINISTER OF COOPERATIVE GOVERNANCE AND TRADITIONAL AFFAIRS – EXTENSON OF THE NATIONAL STATE OF DISASTER

1. With reference to the above mentioned as well the extension of the national state of disaster (COVID-19) published on 14 October 2020 in the Government Gazette Nr. 43808.

2. We confirm that we act on behalf of Dear SA, a registered national not-for-profit company and civil rights organisation. Our client acts in the interest of its supporters as well as in the interest of the public through active participation and advocacy.

3. This letter is directed to the Minister of Minister of Cooperative Governance and Traditional Affairs as designated in terms of section 3 of the Disaster Management Act (No. 57 of 2002).

4. The purpose of this letter is to express concern with the above-mentioned extension of the national state of disaster. Since the initial declaration of the national state of disaster, the South African landscape regarding COVID-19 has drastically changed and therefore the initiating circumstances that prompted the initial declaration have consequently largely disappeared.

BACKGROUND

5. We briefly describe the circumstances around 15 March 2020 that, in our client's view, prompted the initial national state of disaster, which have now largely disappeared or have been rendered irrelevant:

   5.1. At the time, the severity and infectiousness of the COVID-19 virus was mostly unclear and uncertain. Moreover, it was uncertain how the virus affected different age groups and particular health demographics.

   5.2. It was uncertain what the impact of measures to address the outbreak might be on lives and livelihoods.

   5.3. Our healthcare system's ability to effectively deal with the outbreak was unsure and time was needed to prepare for the wave of infections that was expected.

   5.4. South Africa's means to efficiently track and trace the spread of the disease was limited.

   5.5. The ability of government to communicate health and safety precautions effectively was uncertain. The magnitude of the infections of COVID-19 the South Africa was still unclear.

   5.6. SACEMA projected the number of deaths at 351 000 if 40% of the population became infected.

   5.7. The WHO estimated the mortality rate of the virus at 3.4%.

6. Since 15 March 2020 and through the experience gained during the past seven months the above listed uncertainties have been resolved and conclusively answered.

7. As you are undoubtedly aware, you declared a national state of disaster on **15 March 2020** through Notice No. 313 and published in the Government Gazette No. 43096. This state of disaster has subsequently been extended five separate times, each time for another month, as required by section 27(5)(c) of the Disaster Management Act, No. 57 of 2002 (hereafter 'the Act'). The last extension was issued through Notice No. 995 and published in Government Gazette No. 43713 on 14 September 2020.

8. At the time when the national state of disaster was declared South Africa was facing an unknown threat in the form of the COVID-19 virus.

9. The initial declaration of the national state of disaster was said to be enacted due to "*special circumstances* [that] *exist to warrant the declaration*" as well as due to "*the need to augment the existing measures undertaken by organs of state to deal with the pandemic*".

10. Section 27(2) of the Act authorises the making of regulations or issuing of directions or authorises the issuing of directions concerning matters listed in the regulations or directions, only to the extent that it is necessary for the purposes of:

    10.1. assisting and protecting the public;
    10.2. providing relief to the public;
    10.3. protecting property;
    10.4. preventing or combatting disruption; or
    10.5. dealing with the destructive and other effects of the disaster.

11. Moreover, in terms of section 27(1) of the Act, a state of disaster may only be declared if existing legislation and contingency arrangements do not adequately provide for the national executive to deal effectively with the disaster or other special circumstances warrant the declaration of the national state of disaster.

12. It follows that an extension of a national state of disaster in terms of section 27(5)(c) of the Act is subject to the same limitations and requirements listed in the empowering provision, namely section 27(1) and (2) of the Act, that allows for the declaration of the national state of disaster.

IRRATIONAL EXTENSION OF NATIONAL STATE OF DISASTER

13. Our client is of the firm view that the decision to extend the national state of disaster is not rationally connected to the purpose for which it was taken nor was it rationally connected to the empowering provision, namely section 27(1) and (2) of the Act. Our client wishes to highlight the following:

13.1. We have since the start of the pandemic gained valuable and insightful expert knowledge regarding the severity and infectiousness of the COVID-19. Our medical experts and epidemiologists have determined which groups are most at risk when contracting the virus and we have conclusively seen that the virus poses limited risks to minors. We also know that the vast majority of people are not susceptible to infection, something that was confirmed in March already by the Diamond Princess cruise ship data. The case fatality rate ("**CFR**") for children under 19 is 0%, and for adults under 50, it is less than 0.5%.[1]

13.2. The lockdown measures have had a devastating impact on the South African economy. During April, May and June, when the most severe lockdown restrictions were in place, gross domestic product contracted by over 16% giving an annualised decline of -51%. By comparison, in 2009, during the global financial crisis the annualised decline was -6.1%. Prior to the fourth quarter of 2020, the worst decline in recorded South African history was in 1982 when gross domestic product declined by -8.2%. Household spending has slumped by 49.8%.[2] In the second quarter of 2020 alone, South Africa shed 2.2 million jobs. Economic factors have been shown to have a calculable negative consequence on health outcomes with poorer people living shorter lives. In addition, the lockdown restrictions have led directly to a negative health impact. 57% of people who needed hospital care in South Africa were apprehensive to attend hospital during lockdown. There have been drastic reductions in attendance at TB and HIV clinics as

1 https://ourworldindata.org/mortality-risk-covid
2 http://www.statssa.gov.za/?p=13601

well as Cancer diagnoses. Research shows a decline in mental health and increases in calls to suicide lines during lockdown. Excess deaths in South Africa suggest that the impact of lockdown on mortality is already being experienced.

13.3. Seven months has granted our healthcare system the opportunity to prepare for peak infections. Treatment has improved enormously in that time with many new techniques reducing the mortality rate. Moreover, the peak of the so-called COVID-19 wave passed months ago. As in other countries, most field hospitals and temporary facilities providing additional beds for infected people proved to be unnecessary and have been closed, undoubtedly because the wave has passed. It is irrational to suggest, in the context of these facts, that the healthcare system is still being prepared for a peak.

13.4. Through community healthcare workers and stringent screening requirements, South Africa has developed the means to efficiently track and trace the spread of the disease. Approximately 4.5 million COVID-19 tests have been conducted, making South Africa one of the world leaders in tracking the virus.

13.5. South Africans have been effectively educated on proper sanitising and the steps that should be taken when a person suspects that they may have contracted the virus. There is a relatively high level of compliance with recommendations and a low level of law enforcement required. Curfews have been shortened, the deployment of law enforcement reduced. The lowering of the lockdown stringency levels has not resulted in any material increase in mortality or infections.

13.6. The peak of the COVID-19 wave passed in August and we now have clear data for public health experts to track and predict future infections. At the time of writing this letter, South Africa has had an average of approximately 50 000 active cases of COVID-19 over the course of the past week, which is considerably lower than the peak of 173 590 active cases experienced on 20 July 2020. At the peak, South Africa was recording approximately 300 deaths *per day*. In the five days running up to the extension of the disaster, NICD figures showed that only 51 COVID-19 deaths occurred across the whole country, for an average of around 10 deaths per day. Influenza kills approximately 23 South Africans per day. TB kills more than 300 South Africans per day, AIDS another 300 South Africans per day.

13.7. SACEMA abandoned its model soon after it was published and has advised that the model was not intended as a tool for decision-making. That model's replacement, the National Institutes for Communicable Diseases' "Epi Model" has not been updated since June and also appears to have been abandoned. When last updated, it forecast 40,000 deaths by the end of November. The Epi Model's performance against reality is being tracked[3] and it has proven to be wildly inaccurate. The Actuarial Society of South Africa's model has been slashed from its original projections and the lower estimate is now 27,000 deaths. PANDA – Pandemics and Data and Analytics, whose model is updated regularly, estimates 20,000 deaths by the end of the year and plots real world data against the prediction which suggests this number to be accurate. [4]

13.8. The WHO recently published a paper by world famous epidemiologist John Ioannidis which estimates the Infection Fatality Rate of the virus is less than 0.2%.[5]

13.9. The number of recorded Covid-19 deaths has been far lower than expected and currently totals just over 18 000 deaths.

14. As is evident from the above synopsis, South Africa is no longer faced with the uncertainties that it was confronted with when the initial state of disaster was enacted and declared. Consequently, the circumstances that prompted the declaration have disappeared and therefore the underlying motivation for the national state of disaster has as well. There is also patently no requirement to augment existing measures and the State has reduced such measures over time with no material impact on infections or mortality.

15. The motivation for the state of disaster references the life of the nation being threatened by COVID-19, a natural disaster. Amongst the steps implemented were steps to restore and maintain peace and order, including the deployment of the National Defence Force and the imposition of curfews. In its implementation, the state of disaster is a state of emergency by a

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3 See page 3 of the document at https://app.powerbi.com/view?r=eyJrIjoiMGVjYjhkMjMtMzhjMy00OWRkLWJlNWItNjM0NzI0NjhiNTlkIiwidCI6IjlkZWYwNTBlLTExMDUtNDk1ZC1iNzUzLWRhOGRiZTc5MGVmNyJ9.

4 See page 2 of the document at https://app.powerbi.com/view?r=eyJrIjoiMGVjYjhkMjMtMzhjMy00OWRkLWJlNWItNjM0NzI0NjhiNTlkIiwidCI6IjlkZWYwNTBlLTExMDUtNDk1ZC1iNzUzLWRhOGRiZTc5MGVmNyJ9.

5 Bulletin of the World Health Organization, John P A Ioannidis, Infection fatality rate of COVID-19 inferred from seroprevalence data, page 9.

different name. In terms of Section 37 of the Constitution, a state of emergency may only be maintained for 90 days before its extension must be approved by Parliament. No such parliamentary approval has been obtained for the latest extension.

REQUEST

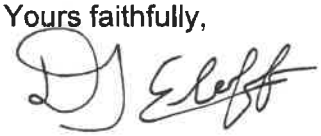
16. In light of the above, our client believes that the extension published on 14 October 2020 is irrational, unlawful, unreasonable, and therefore reviewable. Our client therefore requests the following:

    16.1. To be provided with written reasons why the national state of disaster was extended;
    16.2. To be provided with the documents and supporting documents, expert reports, evidence and data which supports the decision to extend the national state of disaster;
    16.3. That the national state of disaster be terminated in terms of section 27(5)(b) of the Act with immediate effect; and
    16.4. An undertaking that there will be no further extensions of the current state of disaster.

17. Our client requests your urgent response by close of business **30 October 2020**. Should our client not receive a response by the above-mentioned date, it will be compelled to approach the High Court for appropriate relief.

18. Our client wishes to remind you of the obligation placed on organs of state and particularly members of cabinet to respond to correspondence directed to it which obligation is further accentuated by the constitutional nature of the central topic of this letter.

Yours faithfully,



HURTER SPIES INC
Per. Daniël Eloff

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