SARS CoV 2 Infection Fatality Rate Estimates for South Africa

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Short Report

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This is a brief report. The intention is simply to communicate findings and thereby trigger discussion and further work – not to provide a substantial contextual, comparative, or interpretive narrative.

It is of course important to ascertain the risk of death that comes with SARS-CoV-2 infection (the ‘Infection Fatality Rate’ or IFR) but it is difficult to observe directly, as the majority of infections go undiagnosed. Using a positive clinical diagnosis as the defining element of a ‘case’, leads to the related ‘Case fatality Rate’, or CFR. While CFR is relatively simple to assess, within a straightforward study or a stable clinical record keeping system, it is less clear what it means, and its meaning will inevitably vary from place to place, due to structural inequities; and from time to time, as testing systems adapt to the evolving epidemic.

There has been some speculation that African countries in particular, and some other developing nations more broadly, have been affected less severely than developed countries. All along, it has also been suggested that the paucity of data and the very different age structures of the populations in different parts of the world might go a long way to explaining differences (apparently) seen in crude differences in CFR, which mask distributions of (primarily) age and other key risk factors for severe disease from SARS-CoV-2 infection.

The Blood Services in South Africa (SANBS and WCBS) have just recently published national covid seroprevalence estimates based on a substantial, approximately nationally representative sample of blood donors [1]. This analysis indicates no dependence of seroprevalence on sex or age (in the sampled age range of 16 to 80), but alas, as is typical for many health and welfare indicators in South Africa, Race and Province are strong predictors of seroprevalence.

The Medical Research Council has been producing weekly excess deaths estimates for some time. These are not disaggregated by either race or age. As it is well known that age is a very strong, indeed probably the strongest, predictor of severity of Covid-19, it is largely meaningless to discuss CFR or IFR without paying attention to age.

Given that the just-published donor-based South African prevalence estimates vary sharply by race, and substantially by province, and that we know fatality depends strongly on age, it would be optimal to have excess deaths reported by race, precise age, and province. We understand that the vital registration system in South Africa does not report deaths, for research purposes, by race, and that the MRC only occasionally publishes disaggregation by age. Indeed we are aware of a single

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South African report on excess deaths by age [2] and even then only in decade age bands, and not simultaneously by province.

It would be a simple matter to estimate age specific IFR, nationally averaged, if the excess deaths estimates and the prevalence estimates applied to the same point in time. As it is, the published, age disaggregated excess deaths estimates are as of the end of 2020, and our prevalence estimates are representative of the period of January to May 2021 – which we will interpret, for the present purposes, as an estimate applicable to late March. Incidence was not very high from January to May, as this was between the second and third wave – but the delay seen with deaths means that deaths more than doubled between December and March.

For the sake of this preliminary estimate, we rescale the December 2020 age specific excess deaths by a factor of 2.12, to obtain a cumulative, national, excess deaths estimate which has the correct total for March 2021. For provincial, age aggregated estimates, we use the provincial cumulative deaths reported by the MRC in March 2021 – not rescaled provincial estimates from December 2020.

We are choosing to use the reported estimated excess natural deaths as Covid deaths. As far as we can tell, this could as credibly be argued to be an under- or over-estimate. Some have highlighted collateral deaths of various kinds, and others have noted the reduction in other infection related deaths during lockdown periods.

In order to have a well-defined age aggregated IFR, we allocated neither cases nor deaths to the age group <10 years, and we allocated the observed (non age dependent) prevalence from the blood donor study to all ages from 10 up. These estimates, then, are a population averaged IFR for persons aged 10 and over.

Table 1 indicates our nationally aggregated, age disaggregated, infection fatality rates, which used the population estimates from [3]. These IFR estimates for South Africa are broadly comparable with previous estimates of which we are aware, such as in a meta analysis of estimates from global north locales [4]. For visual interpretation, we interpret the numbers from table 1 as mid-decade estimates, and fit an exponential curve (See Figure 1). It seems reasonable to say that the relationship between age and IFR is heuristically characterisable as a doubling of fatality for every ten years of age.

Table 2 shows the provincial age aggregated IFR estimates. The actual estimate, based on the available data, is the column ‘estimated IFR’. To better understand differences in IFR between provinces, we calculated a so called ‘expected IFR’ by province, which is what we would observe if provinces all share the national age dependent IFRs, in each case averaged over the province-specific age distribution. This way, we can compare the actual estimate with the ‘expected’ estimate, and thus not unnecessarily interpret a provincial IFR to be ‘relatively high’ simply because that province has a relatively older population.

What is not clear is to what extent these various indicators reflect 1) differences in the relationship between blood donors and the provincial population which bias the provincial seroprevalence estimates in different ways, 2) differences in actual age specific fatality between provinces, and 3) differences in quality of death data.

In fact, we are also not sure whether deaths may end up being allocated to provinces differently than the provincial allocation of the deceased persons during life, given significant mobility of people of working age.
Our analysis is not quite optimal, given the noted limitations in timing and detail of data which we can currently access. When these limitations are addressed, it is hard to imagine that the fatality rate estimates will change significantly. Since estimates of IFR are clearly important as part of the overall epidemiological assessment, scenario projections, and health system evaluation, we are disseminating these estimates at the present time in the hope that they will stimulate discussion and epidemiological thinking.

The form of the excess deaths data which one would ideally use is clearly nominally available, as it is the basis of the routine MRC analysis, and we see no reason why this data should not be publicly available.

Acknowledgements

Even though the present analysis relies only on publicly available data ([1], [2] and [3]), we would not be doing this analysis now if not for our collaborators in the blood services (Russell Cable, Charl Coleman, Tanya Glatt, Nadia Pietersen, Ronel Swanevelder, Wendy Sykes, Karin van den Berg) whose efforts led to the crucial new results (prevalence estimates [1]) that make this analysis possible (excess deaths estimates [2], and of course, population size estimates [3], having been previously available).

Conflicts of Interest

The Authors affirm they have no conflicts of interest with regard to this publication.

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Table 1: Age specific estimates of SARS-CoV-2 Infection Fatality Rates in South Africa, as of March 2021

| Age Range | Population Size | Excess Natural Deaths | Scaled Excess Natural Deaths | SARS-CoV-2 Infections | IFR (%) |
|-----------|-----------------|-----------------------|-----------------------------|-----------------------|---------|
| 1-9       | 11,217,099      | 0                     | 0                           | 0                     | N/A     |
| 10-19     | 10,280,989      | 332                   | 705                         | 4,873,189             | 0.014   |
| 20-29     | 9,954,072       | 1,194                 | 2,535                       | 4,718,230             | 0.054   |
| 30-39     | 10,333,318      | 4,213                 | 8,944                       | 4,897,993             | 0.183   |
| 40-49     | 7,211,051       | 6,509                 | 13,819                      | 3,418,038             | 0.404   |
| 50-59     | 5,020,135       | 13,881                | 29,470                      | 2,379,544             | 1.238   |
| 60-69     | 3,327,195       | 19,724                | 41,875                      | 1,577,090             | 2.655   |
| 70-79     | 1,602,572       | 14,102                | 29,939                      | 759,619               | 3.941   |
| 80-       | 725,977         | 11,010                | 23,375                      | 344,113               | 6.793   |
| Total     | 59,672,408      | 70,965                | 150,663                     | 22,967,816            | 0.656   |
Figure 1: Fitted SARS-CoV-2 Infection Fatality Rate as an exponential function of age, in South Africa, as of March 2021
Table 2: South African Provincial, age aggregated, SARS-CoV-2 Infection Fatality Rates. The ‘expected IFR’ column indicates what the provincial IFR would be if the national age specific IFR estimates apply to each province, and are adapted to the province only by age-averaging the IFR using the provincial age distribution.

| Province       | Population Size | Excess Natural Deaths | COVID Cases   | Estimated IFR (%) | Expected IFR (%) |
|----------------|-----------------|-----------------------|---------------|-------------------|-----------------|
| Eastern Cape   | 5,430,323       | 33,900                | 3,392,727     | 0.999             | 0.771           |
| Free State     | 2,353,101       | 6,884                 | 1,077,680     | 0.639             | 0.654           |
| Gauteng        | 12,907,289      | 24,411                | 5,661,984     | 0.431             | 0.615           |
| Limpopo        | 4,610,507       | 13,731                | 2,132,791     | 0.644             | 0.736           |
| Mpumalanga     | 3,874,435       | 10,617                | 1,846,066     | 0.575             | 0.617           |
| Northern Cape  | 919,620         | 3,067                 | 29,253        | 1.048             | 0.697           |
| North West     | 3,255,572       | 5,212                 | 1,580,355     | 0.330             | 0.641           |
| Western Cape   | 5,882,400       | 16,179                | 2,200,998     | 0.735             | 0.720           |
| KwaZulu Natal  | 9,222,061       | 36,661                | 4,802,063     | 0.763             | 0.583           |