Estimating potential excess mortality during the third (Omicron) wave of India's COVID-19 epidemic

(*Murad Banaji, Jan 24, 2022. This document will be updated if more data or information comes to light.*)

At the time of writing, India is in the midst of its third COVID-19 wave, driven by the Omicron variant of SARS-CoV-2. Case numbers and test positivity appear to be stabilising or reducing in some states, and official mortality appears, so far, to be far below what was seen in previous waves.

But, as we know, official COVID-19 deaths are only a fraction of total pandemic mortality in India. So, what might we expect in terms of mortality during this wave? Will excess mortality be visible in the data if all cause mortality statistics become available? This document presents some projections which depend on a number of factors, including assumptions about the extent of spread during this wave, and the protection afforded by vaccination and prior infection. Before attempting any predictions, we first need to look back at excess mortality in India during the pandemic so far.

1. Estimates of pandemic excess mortality during the previous waves of disease

There are now several data-driven estimates of all cause mortality during the first two waves of India's COVID-19 epidemic. These estimates (which include those of myself and Aashish Gupta), cover different periods and use data from a variety of sources, including

- the civil registration system (CRS);
- various surveys (Consumer Pyramids Household Survey (CPHS), CVoter);
- the health management information system (HMIS).

The estimates are nevertheless fairly consistent. Central estimates are summarised in the table below, in increasing order.

publication (data source)	**central estimate of excess deaths (millions) as reported in abstract/summary tables**
Leffler et al (CRS)	2.7
Jha et al (health facility, CVoter (survey), CRS)	3.2
Subramanian et al (CRS)	3.4
Banaji and Gupta (CRS)	3.8
Subramanian et al (CPHS)	4.9
Malani and Ramachandran (CPHS)	6.3

Note that the reference to Subramanian et al appears twice, as different data sources lead to fairly different estimates in this paper.

The median of the central estimates is 3.6M excess deaths. Some estimates have acknowledged biases, including cut-offs based on data availability, leading to potential underestimation. In some CRS-based estimates, there has not been full adjustment to account for incomplete coverage in the data, leading again to potential underestimation. On the other hand, CPHS-based estimates are higher than estimates based on other sources for reasons which are not entirely clear and could reflect non-representativeness of the CPHS sample.

In my preprint with Aashish Gupta, we estimated pandemic excess deaths between April 2020 and June 2021 inclusive. Apart from the central estimate of 3.8M excess deaths, we arrived at optimistic and pessimistic estimates of 2.8M and 5.2M excess deaths respectively, based on different assumptions about trends in registration, the spread of disease in states for which there is limited or no data, etc. The range 2.8-5.2M has large overlap with the range of central estimates from other papers. It seems reasonable to assume that the excess death toll during the first two waves of disease amounted to between 3 and 5 million deaths.

Most studies put second wave mortality as substantially higher than first wave mortality (Subramanian et al is an exception.) Our work estimates around 1.05M Wave 1 excess deaths and 2.75M Wave 2 excess deaths, so that the first wave accounts for around 28% of total mortality; but there are several caveats. In particular, early disruptions to death registration, and later possible recovery, could lead to underestimation of first wave mortality relative to second wave mortality based on CRS data.

Infection fatality rate (IFR) estimates. If we assume 3-5M excess deaths during the first two waves of disease, and an infection rate of around 65-70% (based on preliminary reports from the fourth national serosurvey - see the discussion in section 6.2 of Banaji and Gupta), then India's excess deaths data is consistent with an infection fatality rate (IFR) of around 0.31-0.56%. This assumes that most excess deaths were, indeed, from COVID-19. A central estimate based on 3.8M excess deaths and an infection rate of 67.5% is 0.41%. There is some indication in the data that IFR increased between the first and second waves (more on this below).

2. Surveillance and official deaths

A total of 3-5M excess deaths during the first two waves of India's pandemic contrasts with around 450K official COVID-19 deaths during this period (according to data on covid19bharat.org). With these estimates, excess deaths are 7 to 11 times official COVID-19 deaths in India. The median estimate in Banaji and Gupta of 3.8M excess deaths puts excess deaths at around **8.4 times** official COVID-19 deaths in India to date. Moreover, there are strong indications that ascertainment got worse during the devastating second wave of disease, when infection penetrated more deeply into rural areas.

The pattern of very high under-ascertainment of pandemic deaths is not reflected in all low-to-middle-income countries (LMICs). By contrast to India, we have:

- **South Africa**. Excess deaths in South Africa are around **3.1 times** the official COVID-19 toll. On Jan 16, 2022, there had been 290,252 excess deaths according to SAMRC, and 93,278 official COVID-19 deaths according to Google using data from various sources.
- **Iran**. Excess deaths in Iran are around **1.9 times** official COVID-19 deaths. On Jan 16, 2022 the World mortality data-set reported that Iran had seen around 250K pandemic excess deaths, while Google reported 132K official COVID-19 deaths.

It seems important to understand why India's official toll underestimates its pandemic toll so badly, even relative to other LMICs such as Iran and South Africa. It seems clear that some combination of poor health infrastructure and access to hospital care, weak testing outside a few urban areas, inadequate systems in place for recording COVID-19 deaths, and deliberate data manipulation, all played a part in keeping India's official death toll low. Government policies which encouraged underreporting and focussed on underplaying of the toll of the pandemic, are likely to have encouraged local authorities to manipulate their data. Stories of deliberate manipulation abound in the media. The relative contribution of structural factors, policy decisions, and deliberate obfuscation in pandemic death under-ascertainment remains unclear.

3. What Kerala's data tells us about India's COVID-19 mortality

It is instructive to revisit mortality data from Kerala, which tops the Human Development Index (HDI) ranking in India. Kerala has recently undertaken a major updating of its official COVID-19 deaths, leading to the addition of a large number of old deaths. (Unfortunately, dates for these deaths have not been made available.) I had, in July 2021, estimated that, by the end of May 2021, Kerala had seen around 35K pandemic excess deaths. These estimates were based on tracking pre-pandemic trends in death registration, in contrast to various other analyses of all-cause mortality data from Kerala which suggested much lower excess mortality. At that point, however, Kerala had recorded only around 9K official COVID-19 deaths. According to my analysis it appeared that even the most developed state in India could be failing to record about three quarters of its pandemic deaths as such.

Indeed subsequent events have borne this out. The situation today is rather diferent: with major, ongoing reconciliations, the state now (Jan 24, 2022) has officially recorded around 52K COVID-19 deaths. How closely might this reflect its true toll? Between the end of May 2021 and the end of 2021, cumulative COVID-19 cases in Kerala approximately doubled. Reliable recent all cause mortality data for Kerala is not available. But, if we assume that the detection rate of infections did not change, and that the ratio of infections to excess deaths also remained unchanged, then we might expect excess mortality to have doubled to around 70K by now. Indeed, it is plausible that the increase could be less, given the likely reduction in COVID-19 IFR afforded by a reasonable level of vaccine coverage in the state (the great majority of the adult population are at least singly vaccinated, and over half of the eligible population were fully vaccinated by the end of November).

In any case, with over 50K official COVID-19 deaths, Kerala becomes the only major state or territory in India where the official COVID-19 toll is actually plausible and could be comparable to its excess death toll. Indeed, it is possible that ascertainment of COVID-19 deaths in Kerala is now higher than in Iran.

Kerala's relatively high quality surveillance provides additional evidence of the massive underreporting of COVID-19 deaths across the rest of India. If Kerala's official COVID-19 death-rate per million population was repeated across the country, then India's official COVID-19 deaths would number around 2M, roughly four times the actual figure of 0.49M (as of January 2022). However we must bear in mind that: (i) Kerala has an older population than the national average, giving an expected COVID-19 IFR based on international age-stratified meta-analyses around 60% higher than the national average (see indiacovidmapping.org); (ii) it has considerably better health infrastructure than the national average; (iii) the state managed to control COVID-19 spread more effectively as evidenced by all seroprevalence surveys; this allowed more time for vaccination to increase protection during the state's Delta wave. Overall, assuming factors (ii) and (iii) are the most important, it seems likely that Kerala's COVID-19 mortality rate (in the sense of COVID-19 deaths per million population) could be lower than that of the country as a whole.

In fact, Kerala's data is consistent with the estimates of 3-5M pandemic excess deaths nationally during the first two waves of the epidemic. Suppose, for example, Kerala's official COVID-19 deaths are now 70% of its pandemic excess deaths, and the excess mortality rate nationwide is 50% higher than in Kerala on account of more successful infection control in Kerala; then Kerala's data would imply around 4M excess deaths nationwide so far. This is very much in the range estimated from data.

4. Expected mortality during the Omicron wave

Predicting mortality during the current wave is challenging for many reasons. Nevertheless, it is worth setting out the broad framework for such predictions. One approach is to estimate:

1. What fraction of the population are susceptible to infection during this wave;
2. What the attack rate will be amongst those susceptible to infection;
3. What we believe IFR of the current variant would be in a naive population;
4. How much we expect the IFR amongst those who are susceptible to infection to be reduced as a consequence of vaccination and prior infection.

There is necessarily going to be considerable guesswork and crude estimation involved. Let us suppose that (more detailed explanations and justifications later):

1. 70-90% of the population are vulnerable to infection, consistent with the ease with which this variant spreads amongst previously vaccinated and infected populations;
2. Amongst those vulnerable to infection, the attack rate will be 40-60%, consistent with fairly deep spread into rural India, as seen during the last wave;
3. The IFR for this variant *in a naive population* would be 0.2-0.4% in India, somewhat lower than the estimates for previous waves of the disease based on excess deaths data;
4. We expect a reduction in IFR of 75-95% in the susceptible population on account of vaccination and prior infection.

These assumptions give a large range for predicted excess deaths during the current wave: between 0.04M to 0.73M. Putting flat priors on all of these quantities and running some Monte-Carlo simulations results in median excess deaths during this wave of 0.23M, with a 95% CI of 0.09M-0.45M. Based on our central estimates above, 230K excess deaths would amount to around 6% of the total pandemic excess mortality prior to this wave. The optimistic estimate of 0.09M excess deaths would amount to around 2% of total pandemic excess mortality prior to this wave, and the pessimistic estimate of 0.45M would amount to around 12% of pandemic excess mortality prior to this wave. It is worth observing that so far during this wave South Africa has seen excess mortality amouting to around 5% of all its previous pandemic excess mortality; but excess deaths related to this wave are still very much occurring (as of Jan 24, 2022).

Let us unpack some of the assumptions behind these estimates a little.

Susceptibility. The assumption that 70-90% of the population is vulnerable to infection reflects the assumption that previous infection and vaccination afford full sterilising immunity against Omicron to a relatively small fraction of the population. Although, there is little data on risks of infection, UK data suggests that single or double vaccination reduces the probability of symptomatic disease upon exposure to Omicron by 26% or less, and negligibly for vaccinations which took place 6 or more months ago. According to one study from Qatar, prior infection reduced the probability of symptomatic infection upon exposure to Omicron by a more optimistic 56%. On the other hand, analysis from Imperial College, London suggested that protection against reinfection (not necessarily symptomatic) by Omicron could be as low as 19%. (These studies agreed that the relative decrease in protection against Omicron infection relative to Delta infection was very significant; the discrepancy arises because of differing estimates of protection against Delta infection.)

Attack rate. Assuming an attack rate of 40-60% amongst those vulnerable to infection is effectively to assume that disease will spread widely during the current wave, to an extent which resembles India's second wave. During India's second wave seroprevalence data indicates that 40% or more of the population was infected. During the current wave, attempts to control the spread of infection have been even more limited, and there are impending elections in several states. The

dominant narratives about this wave mean there is little pressure towards infection control. The median scenario: 80% of the population are susceptible and the attack rate in the susceptible population is 50%, amounts to infection of around 40% the country during this wave.

IFR in a naive population. Assuming an IFR in the absence of vaccination or prior infection of 0.2-0.4% is consistent with Omicron severity being lower than that of Delta, but comparable to that of pre-Delta variants in India. Excess deaths data from India's first wave gives a median IFR estimate of around 0.32%, based on estimates of around 320 million infections, and around 1.05 million excess deaths during the first wave. This compares to second wave IFR of around 0.45-0.50% based on the central excess deaths estimates and data from the fourth national serosurvey.

Risk reduction on account of previous infection and/or vaccination. Finally, we expect the reduction in *risk of death* afforded by vaccination and prior infection amongst those exposed to the disease to be much higher than the reduction in the *risk of infection*. We know that vaccine effectiveness against death is high - likely over 90% even some months after vaccination. We can assume that prior infection affords high protection against death; and sadly a significant fraction of those most vulnerable to severe disease and death have perished during earlier waves of the disease. The challenge is that in India there are multiple sub-populations, including those who have both been previously infected and partially or fully vaccinated, those who are only partially vaccinated, unvaccinated but infected, and so forth. A 70-90% vulnerability to infection and reduction in IFR of 75-95% amounts to a fatality rate *amongst those exposed to Omicron infection today* which is 3.5% to 22.5% of what would be seen in a naive population, with a product of median values of 12%. Equivalently the risk of death on exposure is reduced by around 88% (range: 77.5-96.5%) relative to what would be seen if Omicron had spread in India during the early days. This seems neither unduly optimistic nor unduly pessimistic.

To summarise so far: given multiple uncertainties it seems reasonable to expect between 0.09M and 0.45M excess deaths during this wave with a median estimate of around 0.23M (i.e., 230K) excess deaths. While not on the scale of the last catastrophic wave, such a toll is not be negligible.

What would this mean for official COVID-19 deaths? If around 1 in 8 deaths is ascertained during this wave, roughly as we have seen up to now, then this wave could see between around 10K and 60K official COVID-19 deaths. There is currently no reason to believe that ascertainment will be any higher during this wave than during previous waves, given there has been little official acknowledgement of undercounting of COVID-19 deaths (except perhaps in Kerala where the reconciliation can be seen as effectively acknowledging this fact). In fact, misleading narratives about the "mildness" of Omicron could lead to increasing under-ascertainment as awareness of possible COVID-19 deaths is further reduced.

Will excess mortality during this wave be visible in all cause mortality data if this becomes available? It is possible - but not certain - that excess deaths will be visible in all cause mortality data - and in particular, in death registration data. The median estimate of 0.23M excess deaths, if spread over a period of two months nationally, would amount to a 15% surge in deaths each month (this assumes an expected annual total of 9M deaths in normal times - see the estimates here). A 15% surge over two months could be visible in all-cause mortality data where this becomes available, but we should bear in mind that this assumes that this level of mortality occurs in areas with relatively reliable death registration. Further, the excess deaths signal could be "smeared" by delays, making it harder to distinguish in the data. So, it is hard to be confident that even the median scenario will become visible in death registration data.

5. Summary

It is likely that the current wave of COVID-19 infections in India - unfolding during January 2022 - will have a greatly reduced mortality impact compared to the previous two waves of disease. But there may, nevertheless, be significant excess mortality. My median estimate of around 230K excess deaths during this wave would amount to around 6% of pandemic excess mortality prior to the Omicron wave. In normal times such a surge in mortality would undoubtedly warrant more attention. But these are not normal times. It seems plausible that official data will largely miss the mortality impact of this wave; but the impact could nevertheless show up in excess deaths data when such data becomes available.