Point estimates of COVID-19 infection fatality rate in Andhra Pradesh

(Murad Banaji, June 21, 2021, updated June 29, 2021)

According to MoHFW population projections, Andhra Pradesh had an estimated population of 52.6 million in 2020, rising in 2021 to 52.9 million. According to the same projections, an estimated 65% of the state's population lives in rural areas as of 2021.

We can use seroprevalence data, official COVID-19 fatality data, and all cause mortality data, to estimate COVID-19 infection fatality rate (IFR) in Andhra Pradesh. If we assume that most excess deaths in the state have been due to COVID-19, then there is evidence that IFR has risen during the latest wave. There is also evidence that underreporting of COVID-19 deaths, which was already high, rose during the second wave.

It is worth noting that the relative transparency of Andhra Pradesh's all cause mortality data allows the estimates here.

Expected IFR in Andhra Pradesh based on international meta-analyses

We can use Andhra Pradesh's projected 2021 age pyramid to compute estimated COVID-19 IFR using data from different sources. Data from the meta-analysis of O'Driscoll *et al* gives an estimated IFR of 0.30%, while the formula derived from the meta-analysis in Levin *et al* gives an estimated IFR of 0.51%.

Note that these estimates are based on age-stratified fatality rates from 2020, and presumably reflect the lethality of the variants circulating during 2020. They assume that disease spreads evenly across all age groups, and likely reflect IFR in circumstances where routine medical care is available.

IFR estimates based on a statewide serosurvey in August, 2020

According to media reports, a state-wide seroprevalence survey which sampled 5000 individuals in each of the state's 13 districts in August 2020 found that 19.7% of those sampled had developed antibodies to SARS-CoV-2. The survey is assumed to have a mid-point of August 19, 2020. Few technical details of this serosurvey could be found, so we have little choice but to take the estimate at face value.

By August 26, 2020, the state had officially recorded 3541 COVID-19 fatalities (according to data on covid19india.org), and by September 9, 2020, this had risen to 4634 official fatalities. We can use these values to get **naive IFR** values of **0.034%** (using fatalities from August 26) and **0.045%** (using fatalities from September 9).

According to the 2018 CRS report, death registration in Andhra Pradesh was complete by 2018. Here we assume complete death registration, although the NFHS-5 fact sheet (2019-20) suggests that only 80.2% of deaths were registered in the state in the three years prior to the survey.

All cause mortality data for Andhra Pradesh based on the civil registration system was recently reported in Scroll. The state saw high excess mortality during 2020, and a massive surge in mortality during the second COVID-19 wave in 2021.

During January-March, 2020, Andhra Pradesh saw fewer deaths than during the corresponding period in 2019, suggesting there was no rise in death registrations during pre-COVID months of 2020 compared to the previous year. We can thus use 2019 values as our baseline for mortality. Alternatively, we can use estimates based on the 2018 SRS estimate of the state's crude death rate. The baseline estimates are close in both cases.

To compute excess mortality we consider registered deaths from May 2020 onwards. May-August, 2020 saw around 28,942 excess deaths (relative to 2019 baseline); or 28,312 (relative to SRS-based baseline). Taking the seroprevalence of 19.7% at face value, and excess mortality to be 28,500 gives an **excess-deaths based IFR** estimate of **0.28%** in the state.

Given uncertainties about the timing of seroconversion and death registration, we can extend the period over which we consider registered deaths to September 15. From May to September 15, the state saw 43,668 excess deaths (2019 baseline) or 40,502 (SRS baseline) giving an **excess-deaths based IFR** of **0.39-0.42%**.

Thus at the time of the state-wide serosurvey in August 2020, we get IFR estimates of

- 0.034-0.045% (naive)
- 0.28-0.42% (using excess mortality)

Of course, given the lack of technical detail about the serosurvey, we cannot put credible confidence intervals on the seroprevalence value reported. We also cannot be certain that all excess deaths were from COVID-19. But, assuming most excess mortality was from COVID-19, IFR was around 0.3% or higher in the state during the first wave of COVID-19 in 2020, and only around 10% of COVID-19 fatalities were being recorded in the state.

IFR estimates based on a serosurvey in April, 2021

A serosurvey in Andhra Pradesh from April, 2021 which reportedly included 46,991 individuals found that around 59% of these individuals were seropositive. The survey does not appear to have been widely reported, and no technical detail is available.

The value of seropositivity in this serosurvey comes with considerable uncertainty. It is, however, approximately consistent with the rise in cases between the two serosurveys: between the end of August 2020, and the end of April 2021, recorded COVID-19 cases in the state increased from around 434,000 to around 1.1 million, roughly consistent with the rise in seropositivity.

By April 30, 2021, there had been 7992 official COVID-19 fatalities in the state. By May 21 this had risen to 9904. If we take the seroprevalence value at face value get a **naive IFR** of **0.026%** (April 30 fatalities as numerator), or **0.032%** (May 21 fatalities as numerator).

However, during the period May 2020 to April 2021 inclusive, there were a total of around 100,950 excess deaths in the state (2019 baseline) or 110,691 (SRS baseline), giving **excess-deaths based IFR** values of **0.32%** or **0.35%**. If we extend the period to May 15, 2021, we find 121,171 excess deaths (2019 baseline) and 131,139 (SRS baseline), giving **excess-deaths based IFR** values of **0.39%** or **0.42%**.

By April, 2021, the estimates of IFR based on excess deaths were still close to earlier estimates from 2020, bearing in mind the wide uncertainties. The estimates suggest that somewhat under 10% of COVID-19 fatalities had been recorded in the state up to April, 2021.

IFR estimates which include May, 2021

There was a large rise in excess mortality in May 2021, amounting to around 100,000 excess registered deaths in a single month (relative to either 2019 or SRS baseline).

Adding these in, during May 2020 to May 2021 inclusive, the state saw a total of 201,909 excess deaths (2019 baseline) or 212,105 excess deaths (SRS baseline). These correspond to **excess mortality of 0.38% or 0.40%** during the course of the pandemic up to the end of May 2021.

By May 31, recorded COVID-19 fatalities in the state stood at 10,930. Taking total infections in the state which led to these fatalities to lie between 34 and 42 million (equal to between 65% and 80% of the state's population) would give naive IFR values in the range 0.026-0.032%, consistent with the values obtained up to April, 2021.

If we attribute most of the excess mortality upto the end of May, 2021, to COVID-19, the data indicates that IFR has risen during this wave. For example, assuming that total infections in the state (leading to deaths by the end of May) amounted to 34 million (65% of the state's population), the figures would imply an overall **excess-deaths based IFR** of around **0.58%** (2019 baseline) and **0.61%** (SRS baseline) to date. If total infections were 42 million (80% of the state's population) this would give overall **excess-deaths based IFR** of around **0.47%** (2019 baseline) and **0.50%** (SRS baseline) to date.

Considering the 100,000 or so excess registered deaths registered in May, 2021 alone (relative to either baseline), we can ask what number of new infections these correspond to. During May, the state added close to 600,000 COVID-19 cases to the total (around 35% of its total cases up to the end of May). Ignoring delays, and assuming that between 16 and 21 million infections (corresponding to between 30% and 40% of the state's residents) led to deaths in May, this would correspond to an **excess-deaths based IFR** of **0.47-0.63%** during May, 2021.

If we assume that all excess mortality in the state up to the end of May was associated with COVID-19, then only around 5% (i.e., around 11,000 out of 205,000) of all COVID-19 deaths in the state had made it into the recorded death count. This indicates that undercounting of COVID-19 deaths likely increased during the second wave.

Summary table of estimates

The estimates of IFR for August 2020 and April 2021 take seroprevalence values at face value. The range of values for excess-deaths based IFR estimates arise from different approaches to calculating excess mortality, and different assumptions about delays as discussed in the text.

date (from May 2020 up to end of...)	**seroprevalence**	**naive IFR estimates**	**excess-deaths based IFR estimates**
August 2020	19.7%	0.034-0.045%	0.28-0.42%
April 2021	59%	0.026-0.032%	0.32-0.42%
May 2021	65-80% (assumed)	0.026-0.032%	0.47-0.61%

Conclusions

Different calculations are consistent: excess mortality during the pandemic had already reached around 0.4% by the end of May. Based on limited data available so far from June, this figure will continue to rise.

We see what appears to be a pattern of rising COVID-19 IFR in Andhra Pradesh. First wave excess-deaths based IFR estimates were around 0.3-0.4%, while second wave estimates are likely to be over 0.5%.

Of course we cannot know the extent to which excess mortality reflects deaths due to COVID-19, as opposed to deaths due to other causes exacerbated by the huge second surge. We also cannot know how many excess deaths were avoidable during either surge. But, however we look at it, COVID-19 has had a huge impact on mortality in the state.