Estimates of pandemic excess mortality in India based on civil registration data[1]

The available data from twelve states

We use civil registration data from the following twelve states to arrive at estimates of excess mortality in India: Andhra Pradesh, Bihar, Haryana, Himachal Pradesh, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Punjab, Rajasthan, Tamil Nadu and West Bengal. In these states, partial or complete death registration data is available for at least January 2018 to May 2021. Data is available for three states (Andhra Pradesh, Karnataka and Punjab) for June 2021. The full data-set on which the analysis here is based is available on github.

Population fraction. At the 2011 census these 12 states accounted for 60% of the national population (to the nearest whole number), and according to population projections, during 2019, 2020 and 2021, they accounted for 59% of the national population (to the nearest whole number).

Fraction of national registered deaths/total deaths. According to Statement 9 in the 2019 CRS report, in 2019, these twelve states accounted for 63.0% (4,811,595/7,641,076) of the registered deaths in the country. Using SRS-CRS estimated registration levels in each state during 2019 (given in Statement 21 of the 2019 CRS report), alongside the data in Statement 9, these states accounted for 59.1% (5,222,286/8,837,847) of the total estimated deaths in the country in 2019. Note that in this calculation, estimated total deaths in 2019 (8,837,847) are based on scaling for coverage at state-level rather than using the national estimate for registration coverage. The differences are explained in this discussion of registration coverage. The data from the 2019 CRS report used in these calculations is in Appendix 1.

The fact that the 12 states here account for 63% of registered deaths nationally, but only 59% of total estimated deaths, indicates that these states have slightly higher registration coverage than the national average.

Fraction of registered deaths/total deaths in the available data. The monthly registration data available from these 12 states includes 85% (4,102,882/4,811,595) of all the deaths registered in these states during 2019 according to the 2019 CRS report (see Appendix 2). The incompleteness of this data is largely because some of the data is drawn from online registration systems which do not log all death registrations. This affects Rajasthan the most (the data includes only 49% of 2019 death registrations), and Maharashtra next (the data includes only 67% of 2019 death registrations).

Once we additionally take into account incomplete registration coverage, the available monthly registration data accounts for 79% (4,102,882/5,222,286) of total estimated deaths in these states during 2019.

Excess mortality estimates relative to a 2019 baseline

The data for all 12 states from January 2019 onwards, on which the estimates relative to a 2019 baseline are based, is available in a single file here. More detailed discussion on the data for each state is contained in the state-level factsheets.

How many death registrations to expect in a 14 month period based on 2019 data. In the available data from 2019, counting April and May 2019 twice, and the remaining months once, we would expect 4,717,996 registrations in a 14 month period in these twelve states.

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1 A working document prepared on 30th August 2021 by Murad Banaji and Aashish Gupta.

How many death registrations were recorded in a 14 month pandemic period. In the 14 months from April 2020 to May 2021, there were, in fact, a total of 6,002,717 deaths recorded in the available data. This is an excess of 1,284,721 registrations relative to 2019 expectations, equivalent to a 27% increase in registrations over 2019 baseline values.

Excess deaths in a 14 month period. If we scale the excess registrations according to the estimated 2019 coverage in these states in the available data (79%), this gives an estimate of 1,635,236 (1,284,721/0.7856) excess deaths in these states relative to a 2019 baseline. However, a more correct approach is to scale the excess registered deaths in *each* state for coverage in that state to estimate excess deaths in that state (see Appendix 3), and sum the results across all 12 states.

Scaling 2019 data for coverage in each state, we would expect 6,002,729 deaths during a period of 14 months (counting April and May 2019 twice, and the rest once) in the twelve states together. On the other hand, scaling for coverage the actual registrations in each state during April 2020-May 2021, we find a total of 7,673,455 in these states during this period, giving 1,670,726 excess deaths. (Note that this is close to the aggregate estimate of 1,635,236 above.) Thus the estimated excess deaths correspond to a 28% (1,670,726/6,002,729) increase over 2019 expected deaths in these states.

Extrapolation to the country as a whole

Two approaches to extrapolation. The fact that the twelve states examined make up around 59% of the national population, and also account for around 59% of total deaths in India during normal times, implies that the estimated crude death rate in these states in pre-pandemic times is close to the national estimated crude death rate. This in turn means that if we extrapolate from these states to the country as a whole, we may do this in two different ways without getting very different estimates. In particular, we may either assume that India as a whole has seen the same number of **excess deaths per million** as these states, or that India as a whole has seen the same **percentage surge in mortality** as these states; both estimates will give similar estimates for excess deaths nationally.

Extrapolation based on excess deaths per million. In the first case we find 2,811,703 excess deaths nationally. This is obtained simply by dividing the estimated excess deaths in the twelve states by the population fraction in these states (1,670,726/0.594). We use estimated 2020 populations in this calculation.

Extrapolation based on the measured surge in mortality. In the second case we get 2,869,788 excess deaths (1,670,726/6,002,729*8,837,847*14/12) nationally. In this case, as we don't have monthly data nationally, to get estimated baseline deaths over a 14 month period, we simply scale national annual 2019 estimated deaths by 14/12.

Thus, using either approach over the period April 2020-May 2021 we estimate around 2.8-2.9M excess deaths nationally, amounting to a 27-28% surge in mortality relative to 2019 baseline.

Extending the estimates to June 2021

Data from only three states. Data for June 2021 is currently only available for three states: Andhra Pradesh, Karnataka, and Punjab. (There is some additional data from Tamil Nadu indicating that there were probably a large number of excess deaths in June 2020, but the available data does not indicate how we might allocate the excess deaths to different months.) After scaling for coverage,

Andhra Pradesh, Karnataka and Punjab together saw an estimated 87,424 deaths in June 2019, and an estimated 195,110 deaths in June 2021. This gives an excess of 107,687 deaths, amounting to an increase of 123% above baseline expectations.

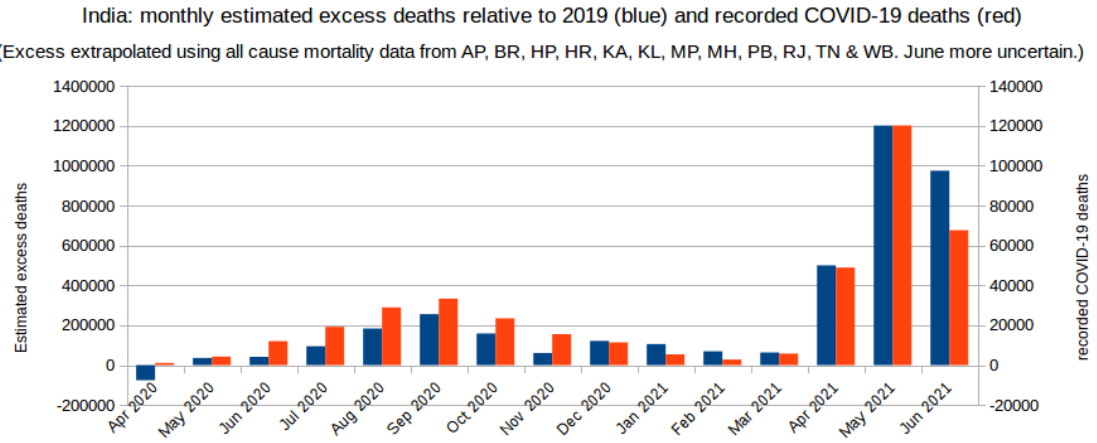
Extrapolating to get national excess mortality in June. If we extrapolate June 2021 excess deaths per million in Andhra Pradesh, Karnataka, and Punjab to the whole country (which is, of course, risky, as these states only hold around 11% of the national population), this would increase the estimated national excess death toll by around 974K (1,076,87/0.1106). Alternatively we can use the percentage surge in mortality in these three states to obtain an excess of around 907K (107,687/ 87,424*8,837,847/12) in June 2021 nationally.

Adding June estimates to the estimates for April 2020-May 2021, we obtain estimates of national excess deaths during April 2020-June 2021 from 3,718,892 (2,811,703+907,189) to 3,843,884 (2,869,788 + 974,096). This amounts to a surge of 34-35% over deaths expected during a 15 month from 2019 data (8,837,847*15/12).

Another way of looking at these estimates is in terms of excess deaths as a fraction of annual estimated deaths. 3.7-3.8M deaths during the pandemic period corresponds to excess deaths totalling around 42-43% of total annual deaths. Using comparisons with international data on pandemic excess deaths as a percentage of annual deaths, this places India amongst some of the hardest hit countries in the world, on par with Brazil, South Africa and Iran.

Comparison with recorded COVID-19 deaths (2019 baseline)

Overall, upto May 2021, excess deaths relative to a 2019 baseline are 8.5 times recorded COVID-19 deaths. Monthly estimated excess deaths align well with the time-course of COVID-19 deaths, as seen in the following plot of the two data-sets. Note the very different scales. (In this plot, the extrapolation is based on assuming the same level of excess deaths per million population nationwide as in the states whose data is used.)



During April 2020-Feb 2021, there is a strong association between excess deaths relative to a 2019 baseline and recorded COVID-19 deaths: the correlation coefficient is 0.84. If we take the period April 2020-May 2021, this rises to 0.98, and drops slightly to 0.96 over April 2020-June 2021.

The fact that predicted excess deaths during June 2021 are higher than expected from recorded COVID-19 deaths could reflect delays in death registration (some of these deaths may actually have occurred in earlier months), or that the states for which June 2021 data is available saw later or higher surges than the country as a whole.

Estimates using other baselines

In some states there are good reasons why using a 2019 baseline is not appropriate for excess mortality calculations. For example, in the available data from Kerala, excess deaths relative to a 2019 baseline are negative for much of the pandemic; and there is some evidence that this may be a consequence of a drop in registration coverage. In such circumstances we can use alternative baselines, chosen to take account of state-specific features of the data.

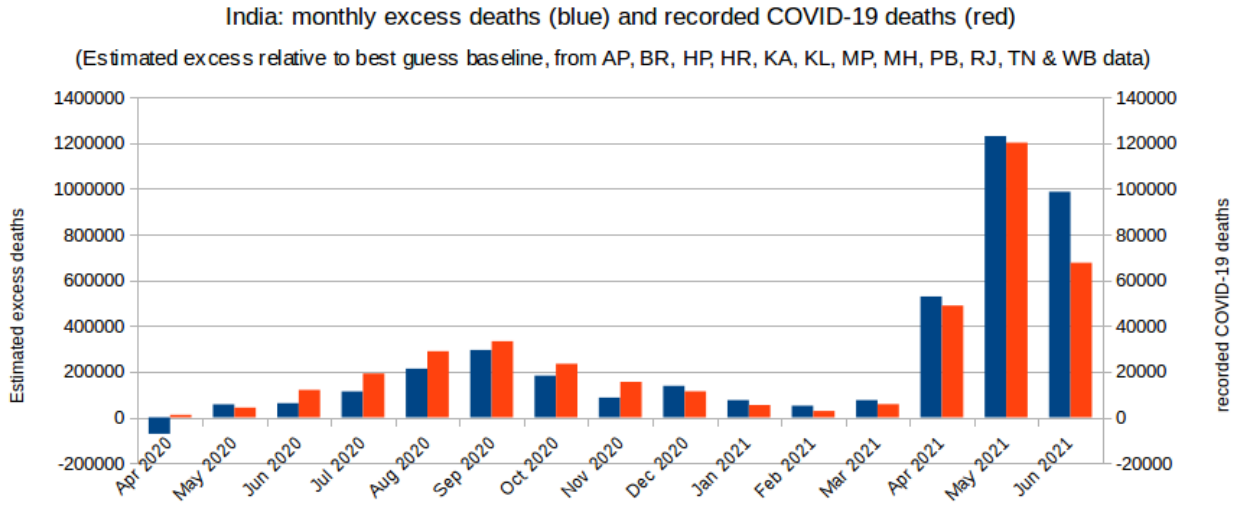
These alternative baselines are outlined in Appendix 4, and arguments for why they may be needed, are detailed in state-level factsheets on mortality and registration. In all cases except for Bihar and West Bengal the alternative baselines increase excess deaths, although in several cases the change is marginal.

Following identical procedures to those involving a 2019 baseline, and basing the extrapolation to India as a whole on excess deaths per million, we estimate 3,070,871 excess deaths nationwide during April 2020-May 2021, rising to 4,057,161 during April 2020-June 2021. The latter figure corresponds to a 37% increase over baseline mortality over a 15 month period (4,057,161/ (8,837,847*15/12)). The excess deaths over April 2020-June 2021 amount to 46% (4,057,161/8,837,847) of annual deaths.

Thus the alternative baselines increase estimates of excess mortality during April 2020-June 2021 by around 9%. While using additional contextual information to reset baselines at state-level can make a significant difference to the story in a given state, it does not make a huge difference to estimated total excess deaths at national level.

Comparison with recorded COVID-19 deaths (alternative baselines)

Overall, upto May 2021, excess deaths relative to the alternative baselines are 9.1 times recorded COVID-19 deaths. Monthly estimated excess deaths align well with the time-course of COVID-19 deaths, as seen in the following plot of the two data-sets. (Note again the very different scales.)



During April 2020-Feb 2021, the association between excess deaths and recorded COVID-19 deaths is even stronger than in the case of a 2019 baseline: the correlation coefficient is now 0.91. If we take the period April 2020-May 2021, this rises to 0.99. It drops slightly to 0.97 over April 2020-June 2021.

Estimates of COVID-19 infection fatality rate based on excess deaths

Wave 1. If we take the first wave of COVID-19 infection to be April 2020-February 2021, then during this period the country saw roughly 1.05M excess deaths (relative to a 2019 baseline) or 1.20M excess deaths (relative to the alternative baselines). Suppose that, roughly based on the results of the third national serosurvey, we assume there had been 250-400M COVID-19 infections in the country by February 2021. Suppose, also, that we assume that all of the estimated excess deaths were from COVID-19. This would give us estimates of COVID-19 infection fatality rate (IFR) from 0.26% (1.05/400) to 0.48% (1.20/250).

The whole pandemic period upto June 2021. Suppose that, roughly consistent with preliminary results from the fourth national serosurvey, we assume there had been 750-1000M COVID-19 infections in the country by June 2021. Suppose, further, that we assume that all of the estimated 3.8-4.1M excess deaths were from COVID-19. This would give us estimates of COVID-19 infection fatality rate (IFR) ranging from 0.38% (3.8/1000) to 0.55% (4.1/750).

We can compare these estimates with values from various meta-analyses. Based on India's estimated 2021 age-structure, the meta-analysis of O'Driscoll *et al* predicts a COVID-19 IFR of 0.245%, while the meta-analysis of Levin *et al* predicts COVID-19 IFRs of 0.42%-0.50% depending on the assumed age-distribution of the over-80s. The meta-analyses are based on 2020 COVID-19 fatality data, and the predictions for India assume even spread across different age groups.

Thus estimates of India's COVID-19 IFR based on excess deaths during the pandemic are towards the upper end of estimates based on international meta-analyses. The data is consistent with:

- The majority of excess deaths being COVID-19 deaths
- A significant minority of excess deaths being either avoidable COVID-19 deaths (caused, for example, by unavailability of medical care or oxygen); or additional non-COVID-19 deaths.
- Possibly, the circulation of more lethal variants during the second wave of infection, driving up IFR despite increasing vaccination coverage.

While the data suggests that COVID-19 IFR *may* have increased during the second wave, we need to treat this with some caution: registration disruption may have been particularly acute during national lockdown and the early part of the pandemic, leading to underestimation of first wave excess mortality, and consequently underestimation of first-wave IFR.

Summary of findings and list of potential biases

The calculations here give national estimates of around 2.8-3.1M excess deaths during April 2020-May 2020, rising to 3.8-4.1M excess deaths during April 2020-June 2020. The latter figures correspond to a surge of 34%-37% above expected mortality during a 15 month period. Equivalently, estimated excess deaths during April 2020-June 2020 total 43-46% of estimated annual mortality. This places India amongst the hardest hit countries in the world during the COVID-19 pandemic.

Looked at relative to India's population, we find 280-300 excess deaths per 100,000 population. This measure is not particularly appropriate for comparison between countries given very different age-structures; but by this measure, *despite* India's younger population, its excess mortality has been considerably higher than much of Europe or the USA.

All estimates here are provisional and are likely to change. There are several uncertainties and potential biases in the estimates: these are listed below, along with how taking these into account would likely change the estimates.

- *The national surge may not match the surge in these 12 states*. It is **unclear** in what direction data from more states would push the estimates. Partial data suggests that some of the absent states, such as Uttar Pradesh and Gujarat, have been very badly hit during the pandemic; data from these states could push up the national estimates of excess deaths. There is no available data which suggests that including the missing states will push the national estimates significantly downwards.

- *The data for June 2021 is from only three states.* It is **unclear** in what direction taking this into consideration would push the estimates, but it could push the estimates **down**. It is possible that Andhra Pradesh, Karnataka, and Punjab saw infection continue to spread later than many other states, in which case June data from more states could push down the estimates. For example, assuming that June saw the same ratio of excess deaths to recorded COVID-19 deaths as May would push down estimates of national excess deaths by June by around 300K (using either set of baselines). However, we should remember that there are considerable delays in registration in some states, and many of the excess deaths predicted for June 2021 may actually have occurred in May or earlier.

- *The data used is not up to date*. Related to the last point, more up-to-date data would almost certainly push estimates of total excess deaths **up**. Delays in registration, and continued spread of disease, mean that we should expect further increases in excess deaths. As some of the data we use is recorded by date of death (rather than date of registration), totals for months where we already have data are likely to rise.

- *Death registration levels could have increased during the pandemic*. If so, then taking this into account would push the estimates of excess mortality **down**. Going through the data state by state, as detailed in the state-level factsheets, we find that only in a few states is there some evidence of a possible increase in registrations during the pandemic; on the other hand, in several states, there is evidence of a possible sustained drop in registrations during the pandemic. How these effects sum, and whether there was, overall, an increase in registration levels is hard to say. However, the fact that, according to these estimates, excess deaths returned fairly close to zero during January-March 2021 when the first wave had subsided suggests that if there were improvements in death registration coverage, they were fairly marginal.

- *There was disruption to death registration during the pandemic, especially in the early period*. Taking this into account would push the estimates of excess mortality **up**. This disruption is not factored in when we use a 2019 baseline, and is only partially factored in by the alternative baselines: using either set of baselines cumulative excess deaths remained negative until June 2020, even though cities such as Mumbai, Hyderabad and Chennai had recorded significant excess mortality by this point. In order to try and estimate the scale of the disruption we would need additional data such as on birth registrations, or from mortality surveys.

- *The surge in unregistered deaths may not match the surge in registered deaths*. This would most likely push estimates of excess mortality **up**. We know that COVID-19 has hit marginalised communities very hard and that these are the communities where death registration is also weakest. This would tend to bias estimates of excess mortality based on CRS data downwards. There is some evidence, for example from Bihar, that the surge in mortality in marginalised communities may have been greater than the surge observed in CRS data. Further data from surveys could help assess the scale of such an effect.

- *There may be natural increases in yearly deaths on account of population growth and an ageing population*. Taking these into account would push estimates of excess deaths **down**, but probably quite marginally. According to UN estimates (reported by The World Bank here), India's estimated crude death rate remained virtually unchanged over several years prior to 2019, falling prior to 2015 and then seeing a 1% increase during 2015-2019. Meanwhile, population projections suggest that the national population has been growing by around 1% per year. Taking both effects into account, we would expect a yearly increase in deaths of around 1.5%.

- *Death registration coverage prior to the pandemic may have been overestimated*. Taking this into account would push estimates of excess mortality **up**, but perhaps only by a few percent. In brief, it is highly likely that death registration coverage at the national level is overestimated in the 2019 CRS report. However, our calculations here use the subnational estimates from this same report; and these appear, overall, to be more consistent with other data, for example from NFHS-5, although there are still some discrepancies. The details are discussed here.

None of the biases listed above should cause major changes to the estimated excess deaths. It is hard to imagine any new data which would put national excess deaths during April 2020-June 2021 at below than 3 million (around 34% of estimated annual deaths), even after factoring in natural increases in mortality and population, and possible increases in registration coverage. On the other hand, in order to obtain estimates of excess deaths during April 2020-June 2021 greater than 5 million (around 57% of estimated annual deaths), we would need to assume that:

- the remaining states have been hit considerably harder than the ones we cover; and/or
- baseline mortality has been substantially underestimated; and/or
- the surge in unregistered deaths has been much greater than the surge in registered deaths.

As more data becomes available, some of the uncertainties may resolve themselves; for example data will likely become available from more states, and more up-to-date data may also become available. This document will be updated as more data becomes available.

Appendix 1. Registered deaths and estimated registration coverage in states and Union Territories in 2019. From Statements 9 and 21 in the 2019 CRS report.

	2019 registered deaths	2019 estimated registration coverage (%)	2019 estimated deaths
India	7641076	92	8305517
Andhra Pradesh	401472	100	401472
Arunachal Pradesh	3490	38.6	9041
Assam	163057	74	220347
Bihar	359349	51.6	696413
Chhattisgarh	188211	81.5	230934
Goa	13851	100	13851
Gujarat	462284	100	462284
Haryana	188910	100	188910
Himachal Pradesh	43633	86.4	50501
Jammu & Kashmir	44227	66.7	66307
Jharkhand	119374	58.8	203017
Karnataka	508584	100	508584
Kerala	270567	100	270567
Madhya Pradesh	493328	89.1	553679
Maharashtra	693800	100	693800
Manipur	2990	21.4	13972
Meghalaya	18298	97.6	18748
Mizoram	6606	100	6606
Nagaland	2266	30	7553
Odisha	342947	100	342947
Punjab	215045	100	215045
Rajasthan	451315	98.6	457723
Sikkim	3308	100	3308
Tamil Nadu	633897	100	633897
Telangana	228294	97.2	234870
Tripura	30419	100	30419
Uttarakhand	66313	95.6	69365
Uttar Pradesh	944596	63.3	1492253
West Bengal	551695	100	551695
A & N Islands	2616	100	2616
Chandigarh	23592	100	23592
D & N Haveli	2705	100	2705
Daman & Diu	1162	61	1905
Delhi	145284	100	145284
Lakshadweep	336	88.2	381
Puducherry	13255	100	13255
India reconstructed	7641076	86.46	8837847

Appendix 2. Registration coverage and available death registration data for 2019 in the twelve states considered

	2019 registered deaths	2019 estimated registration coverage (%)	2019 estimated deaths	2019 deaths in recorded in the available data	2019 estimated coverage in the available data (%)
Andhra Pradesh	401472	100	401472	363649	90.58
Bihar	359349	51.6	696413	351248	50.44
Haryana	188910	100	188910	183795	97.29
Himachal Pradesh	43633	86.4	50501	40970	81.13
Karnataka	508584	100	508584	508584	100.00
Kerala	270567	100	270567	264071	97.60
Madhya Pradesh	493328	89.1	553679	449819	81.24
Maharashtra	693800	100	693800	462028	66.59
Punjab	215045	100	215045	213122	99.11
Rajasthan	451315	98.6	457723	219814	48.02
Tamil Nadu	633897	100	633897	588221	92.79
West Bengal	551695	100	551695	457561	82.94
Total	**4811595**	**92.1**	**5222286**	**4102882**	**78.56**

Appendix 3. Scaling excess deaths for registration coverage: some examples

When we wish to estimate excess deaths based on death registrations, perhaps from an online system which does not capture all registrations and/or in a state where registration coverage is not complete, we are forced to do some extrapolation. We refer to this process as "rescaling for coverage" and illustrate it here via an example.

Consider deaths registered in Rajasthan's Pehchaan portal during January 2018 to May 2021, shown in the table below. (This data was reported in The Hindu and is available here.)

	2018	**2019**	**2020**	**2021**
January	20798	20239	21954	19622
February	18301	18089	18056	14860
March	18921	17784	16378	16084
April	18018	16651	17596	26251
May	19446	17603	20582	49046
June	17048	19766	17959	
July	15640	15656	17151	
August	16023	17569	17918	
September	15812	19291	18719	
October	17226	17924	18405	
November	17489	17794	21265	
December	21648	21448	23581	
Total	216370	219814	228564	

Suppose that, in order to estimate excess deaths in the state during the pandemic period, we decide to use average deaths in a given month of 2018 and 2019 to set our baseline expectations for deaths during this month in 2020. (Of course, this is just one choice; we could make many others.)

According to the 2019 CRS report, Rajasthan saw 443,173 registered deaths in 2018 and 451,315 in 2019. Moreover (according to the same report) 98.1% and 98.6% of deaths in Rajasthan were estimated to have been registered in 2018 and 2019 respectively. This would imply that a total of 443,173/0.981 = 451756 deaths were assumed to have occurred in 2018, and similarly 457,723 were assumed to have occurred in 2019, giving an assumed total of 909479 deaths in the state during these two years.

If we accept this estimate of total deaths during these two years, then the 436,184 deaths registered in the Pehchaan portal during 2018-2019 were out of an estimated total of 909,479 deaths in the state. Thus registration coverage *in this portal* was 436,184/909,479 = 48.0% during these two years taken together. To estimate excess deaths in the state during, say, July 2020, we can:

1. Calculate the difference between deaths registered during July 2020 in the Pehchaan portal (17,151) and the 2018-19 average for July (15,648) to get 1503 excess registrations during July 2020.
2. Scale this according to the assumed fraction of total deaths registered in this portal to get 1503/0.48 = 3134 estimated excess deaths during July 2020.

This calculation assumes:

- No mortality trends: no changes in expected mortality between 2018-19 and 2020
- No coverage trends: no changes in the fraction of total deaths being recorded in this portal between the 2018-19 average and 2020
- An equal change in deaths not in the portal: the percentage change in deaths not registered in this portal matches the percentage change in registrations in this portal.

These are the simplest assumptions, but we can, of course, adjust the calculations if we believe any of these assumptions may have been violated. Three examples are given next.

Example 1 (trend in coverage). Suppose we believe that in the absence of the pandemic there would have been no change in expected mortality from the 2018-19 average to the pandemic period, but that during the pandemic registration coverage in the Pehchaan portal dropped. Let's say, for the sake of example, that we estimate that the fraction of total deaths registered in the Pehchaan portal saw a relative drop of 5% during the pandemic period from 48.0% down to 45.6%. We would now:

1. Set expected registrations during July 2020 to be 95% of the 2018-19 average for July, namely 0.95*15,648 = 14,866.
2. Subtract this figure from registered deaths in the Pehchaan portal during July 2020 to get 17,151-14,866 = 2285 excess registrations during July 2020.
3. Scale the excess registrations according to the assumed lower coverage in this portal (45.6%), to get 2285/0.456 = 5016 excess deaths during July 2020.

Example 2 (trend in mortality). Suppose we believe based on mortality trends that in the absence of the pandemic we should expect 2% more deaths in each month of 2020 relative to the 2018-19 average for the same month. Suppose also that we assume there was no change in registration coverage during the pandemic. We would now:

1. Set expected registrations during July 2020 to be 1.02 times the 2018-19 average for July, namely 1.02*15,648 = 15,961.
2. Subtract this figure from registered deaths in the Pehchaan portal during July 2020 to get 17,151-15,961 = 1190 excess registrations during July 2020.
3. Scale the excess registrations according to the assumed coverage in this portal (48%), to get 1190/0.48 = 2481 excess deaths during July 2020.

Example 3 (trends in both mortality and coverage). We can, potentially, take into account trends in mortality and coverage. Suppose we believe that in the absence of the pandemic we should expect 2% more deaths in each month of 2020 relative to the 2018-19 average for the same month, and also that registration coverage dropped by 5% during the pandemic. We would now:

1. Set expected registrations during July 2020 to be 1.02*0.95*15,648 = 15,163.
2. Subtract this figure from registered deaths in the Pehchaan portal during July 2020 to get 17,151-15,961 = 1988 excess registrations during July 2020.
3. Scale the excess registrations according to the assumed coverage in this portal (45.6%), to get 1988/0.456 = 4363 excess deaths during July 2020.

Note, finally, if we believe the percentage change in unregistered deaths to have been different from the percentage change in registered deaths, then this alters Step 3 in the calculations in the examples above. In this case, we cannot simply scale excess registrations according to registration coverage to get excess deaths.

Appendix 4. Alternative baselines for excess deaths calculations

The following baselines are used as alternatives to a 2019 baseline in the second set of calculations. The factsheets discussing the baselines are linked.

2018-19 average in Andhra Pradesh, Haryana, Maharashtra, Rajasthan and Tamil Nadu.

Bihar: 2019 as a baseline for April-December 2020; January-May 2020 as a baseline for the same period in 2021.

Himachal Pradesh: average of 2018-19 with an assumed drop in registration coverage of 5% during the pandemic period.

Karnataka: 2017-19 average

Kerala: 2015-2019 average with an assumed drop in registration coverage of 5.5% during the pandemic period.

Madhya Pradesh: 2019, with an assumed drop in registration coverage of 5% during 2020 only, and recovery to 2019 levels during 2021.

Punjab: 2016-19 average

West Bengal: no alternative baseline is used (i.e., 2019 baseline is used in the alternative calculations).