

Systematic Review of Excess Mortality in India during the Covid-19 Pandemic with Differentiation between Model-Based and Data-Based Mortality Estimates

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Abstract

Background: COVID-19 has proven to be the worst pandemic in the history of mankind. While the pandemic still continues to perplex scientists globally, attempts are being made to quantify the mortality caused by the pandemic. Official COVID-19 figures in India grossly understate the true scale of the pandemic in the country. Fatality rates help us understand the severity of a disease, identify at risk populations, and evaluate quality of healthcare. Official COVID-19 mortality figures in India grossly understate the true scale of the pandemic in the country. A COVID-19 death is defined for surveillance purposes as a death resulting from a clinically compatible illness in a probable or confirmed COVID-19 case, unless there is a clear alternative cause of death that cannot be related to COVID-19 disease (e.g., trauma) and excess mortality is defined as the difference in the total number of deaths in a crisis compared to those expected under normal conditions. **Materials and Methods:** We did a systematic review of multiple papers on PubMed, Medline, Embase, MedRxiv pre print on excess mortality. Differentiation between model based estimated excess mortality and data based excess mortality was studied. **Results:** All the studies showed that the excess mortality was to the tune of almost three times the official figures. The model based excess mortality assumptions showed higher deaths as compared to the data based one. However, there were a lot of discrepancies in the data provided by various states along with variations observed between the two waves as well. Health survey data suggested higher mortality rate as compared to data compiled from the civil registration system. Additionally, in the second wave, a small but a significant number of deaths occurred due to non availability of oxygen and beds in the hospitals. **Conclusions:** Official COVID-19 deaths have entirely failed to capture the scale of pandemic excess mortality in India. If most excess deaths were, indeed, from COVID-19 then under ascertainment of COVID-19 deaths has been high, with around 8-10 excess deaths for every recorded COVID-19 death.

Keywords: Covid19, deaths, excess mortality, India, mortality

INTRODUCTION

COVID-19 caused by the deadly SARS-CoV-2 has proven to be the worst pandemic in the history of mankind. While the pandemic still continues to perplex scientists globally, attempts are being made to quantify the mortality caused by the pandemic. The official COVID-19 figures in India are a gross mismatch with the true scale of the pandemic in the country. Fatality rates reflect a true measure to understand the severity of a disease, identify at-risk populations, and evaluate quality of healthcare. For COVID-19, the actual level of transmission has been underestimated because a substantial proportion of people with the infection are undetected either

because they are asymptomatic or have only mild symptoms and thus typically fail to present at healthcare facilities^[1]

Definition

A COVID-19 death^[2] is defined for surveillance purposes as a death resulting from a clinically compatible illness in a probable or confirmed COVID-19 case, unless there is

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How to cite this article: Natarajan S, Subramanian P. Systematic review of excess mortality in India during the Covid-19 pandemic with differentiation between model-based and data-based mortality estimates. Indian J Community Med 2022;47:491-4.

Received: 05-01-22, **Accepted:** 19-04-22, **Published:** 14-12-22

Access this article online

Quick Response Code:



Website:
www.ijcm.org.in

DOI:
10.4103/ijcm.ijcm_11_22

a clear alternative cause of death that cannot be related to COVID-19 disease (e.g., trauma). There should be no period of complete recovery between the illness and death.

Excess mortality^[3] is defined as the difference in the total number of deaths in a crisis compared to those expected under normal conditions. COVID-19 excess mortality accounts for both the total number of deaths directly attributed to the virus as well as the indirect impact, such as disruption to essential health services or travel disruptions.

Two measures have been used to assess the proportion of infected individuals with fatal outcomes in most of the studies. The first is infection fatality ratio^[4] (IFR), which estimates this proportion of deaths among all infected individuals. The second is case fatality ratio^[4] (CFR), which estimates the proportion of deaths among identified confirmed cases.

Daily deaths is the best indicator of the progression of the pandemic, although there is generally a 17–21-day lag between infection and deaths^[4]

Case underreporting factor^[5] (CURF) is defined as the estimated total cumulative infections divided by the reported (i.e., observed) cumulative cases at the indicated date.

Death underreporting factor^[5] (DURF) is defined as the estimated total cumulative deaths divided by the reported (i.e., observed) cumulative deaths at the indicated date, as collected 14 days after the date indicated.

METHODS

This was a systematic review study wherein both the authors were independently involved in the search, review, and synthesis of the articles. We researched multiple papers on PubMed, Medline, Embase, MedRxiv pre-print, World Health Organization's database Global Index Medicus, as well as BioRxiv and SSRN through isearch. Papers pertaining to India were filtered and studied. Search criteria were limited to titles, abstracts and keywords showing the words excess mortality, excess deaths, India, and COVID-19. Studies were filtered further with search within options in the search tools of the above-mentioned databases. Many articles were filtered for not aligning with our search criteria. Differentiation between model-based estimated excess mortality and data-based excess mortality was studied.

RESULTS

The official death count in the world due to COVID-19 is 5.4 million as of 24th December 2021 and that of India is 4.79 lakhs.^[6] The deaths per capita^[7] for India is 0.29 whereas the numbers for the other countries are far greater, in excess of more than 3. We have had quite a few estimates by various organizations. The *New York Times*^[8] published an article which assumed a wide varying figure of somewhere between 6 lakhs to 40 lakhs, depending on the conservative to worst case scenario. However, they were based on hypothetical infection and infection fatality rates that were not linked to Indian data per se.

WHO^[3] estimated that the excess mortality till 31 December 2020 was at least 1.2 million more all over the world. This was before the Delta wave which struck the world after March 2021 originating in India. Longitudinal sero-prevalence studies in Switzerland^[9] have determined that the IFR should approximately converge at 0.5%–1%.

In the COVID-19 pandemic, broad variations in naïve estimations of CFR^[3] have been seen that may be misleading. Also, the risk of mortality is higher with different variants. As of this writing, delta has so far been the most deadly variant of COVID-19. It was estimated that the mortality hazard ratio associated with infection with alpha variant compared with infection with previously circulating variants was 1.64 (95% confidence interval (CI) 1.32 to 2.04) in patients who tested positive for COVID-19 infection. This represents an increase in deaths from 2.5 to 4.1 per 1,000 detected cases.^[10]

The Institute of Health Metrics and Evaluation (IHME)^[11] reported the excess mortality based on reported deaths in the civil registration system for periods during the first and second waves of COVID-19 from nine states in India. From 1 March 2020 to 26 September 2021, using 100 draws of covariates for this cumulative period and the draw-level model coefficients and residuals, IHME predicted that the excess mortality in India could vary between 100 to 300 deaths per 100,000 population. The estimated ratio of total COVID deaths to reported deaths could have been as high as 10 to 25. To sum it up, the IHME^[12] said that the total number of COVID deaths between March 2020 and May 2021 could be 6.5 lakhs whence the official data was just 2.21 lakhs. These were model-based estimates for all-cause mortality.

The first data-based estimates were undertaken by Banaji *et al.*^[13,14] They reported all-cause mortality data from India's civil registration system (CRS)^[14] to understand the scale and evolution of excess mortality in India during the COVID-19 pandemic. They estimated that 12 states which consisted of 60% of the total population saw around 28% more deaths than expected from historical data between April 2020 and May 2021. They estimated that there could have been 38 lakhs of excess deaths in the months between April 2020 and June 2021 with a range between 28 and 52 lakhs. A significant minority of excess deaths may have been either avoidable COVID-19 deaths (caused, for example, by unavailability of medical care or oxygen) or non-COVID-19 deaths caused, for example, by disruptions to healthcare, which was what the authors mentioned in their pre-print. To sum it up, calculations show 2.1 excess deaths per 1,000 population during the period April 2020 to May 2021 [Figure 1].

Globally, there are many studies^[15,16] on excess mortality caused due to COVID-19. The meta-analysis of O'Driscoll *et al.*^[16] predicted a COVID-19 infection fatality rate (IFR) of 0.25%, while the meta-analysis of Levin *et al.*^[15] predicted COVID-19 IFRs of 0.42%–0.50% depending on the age distribution. However, these are just mortality estimates of the original strain and the first waves. The second wave caused by the delta strain, which originated in India, was more infectious and devastating globally. However, the morbidity and mortality estimates are yet to be ascertained, as the delta wave still continues to rampage the

world at the time of writing this article. Using comparisons with international data on excess pandemic deaths as a percentage of annual deaths, even the lowest of these estimates places India among some of the hardest hit countries in the world.^[17]

Estimates based on the Consumer Pyramids Household Survey (CPHS)^[7,18] suggest that the first wave was deadlier than the second wave and an estimated 3.4 million people succumbed to the disease in the first wave while 1.5 million people died in the second wave. This data stops in the month of June 2021 for the second wave. The first wave, according to this survey, was probably more lethal. Because it was spread over a period of 11 months, from the start of the pandemic till December 2020, unlike the sudden and concentrated surge of the second wave, mortality in the first wave falsely appeared reasonable for a global pandemic. Combining the Indian sero-prevalence data and applying the globally agreed age-specific IFRs to the Indian demography and sero-prevalence patterns, the authors arrived at a figure of 1.5 million and 2.4 million in the two waves for excess deaths, respectively. Together, the toll of COVID-19 until June 2021 was estimated to be 4 million.^[7] Even though the second wave encompassed three months compared to eleven months for the first, the estimated death toll was significantly greater. The second wave witnessed more infections (about 41%) compared to the first wave (25%).

Figure 2 clearly explains the excess mortality over months during the pandemic.^[7] Another study by Ramachandran and Malani^[19] based on CPHS suggested that COVID increased the all-cause death rate by 17.3%. The estimated excess deaths were 3.36 million (95% CI: 2.08–4.63 million), implying 8.4 times more people died than the official COVID deaths through June 2021. Leffler *et al.*^[20] estimated the excess mortality in 17 states having a combined population of 1.26 billion. The pandemic-related mortality was estimated to be 132.9 to 194.4 per 100,000 population. If these rates were applied to India as a whole, then about 1.80 to 2.63 million people may have perished in India as a result of the COVID-19 pandemic till 30 June 2021. Higher mortality rates were observed in Maharashtra, Delhi, and Punjab. Figure 3 shows the excess mortality in absolute numbers and per one lakh population.

Deshmukh *et al.*^[21] studied the excess deaths in three different ways, of which a national representative survey by Cvoter India Omnibus estimated a sharp increase in adults reporting a COVID death from 19 April to 27 June 2021, reaching peaks close to 6%, or an average of 3.5% over the 2.3 months. A smaller peak occurred over 10 days from 24 September to 4 October 2020. An adjusted

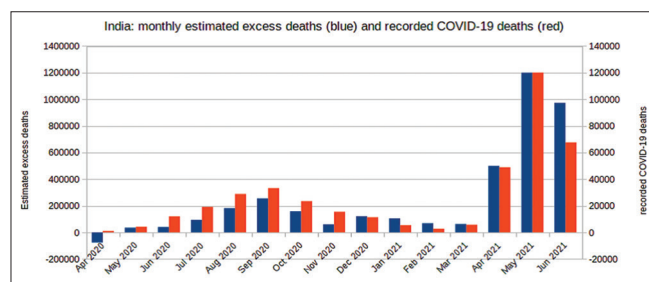


Figure 1: Estimated monthly excess deaths in India relative to a 2019 baseline, alongside recorded COVID-19 deaths

proportion of adults reporting COVID deaths^[21] yielded a lower and upper estimate of 3.1 to 3.4 million excess deaths from 1 June 2020, to 27 June 2021, over a period of thirteen months. Figure 4 shows in brief the nationwide excess deaths and death underreporting factors for the whole nation in waves 1, 2 and combined.

Zimmermann *et al.*^[5] published a systematic review and meta-analysis of the infection fatality rates in India by September 2021. They studied almost 4,765 records from various databases and included 17 studies in their quantitative analysis. The meta-analyzed cumulative infection fatality rate in India varied from 0.36%–0.48%, with a case underreporting factor ranged from 25–30 and a death underreporting factor ranged from 4–12. This implied that by 30 June 2021, India may have seen nearly 900 million infections and 1.7–4.9 million deaths when the reported numbers^[6] stood at 30.4 million cases and 412,000 deaths with an observed case fatality rate (CFR) of 1.35%.

DISCUSSION

Different studies have estimated the excess mortality in different ways but have concluded that a large number of deaths and cases have been underreported or not reported at all. Poor quality of case and death reporting will mask the true fatality rate as well as hamper epidemiological investigations. India should have a robust reporting mechanism and a strong nationwide surveillance system which would enable timely and pointed interventions to prevent further overload of healthcare systems and deaths due to inability to access overburdened health care during the peak of the waves. Infection fatality ratio should also be utilized in public health programming and policy decision-making. Based on the reported death figures alone, the economic cost of COVID-induced mortality comes to around 9% of India's annual GDP. The model-based estimates or the lower end of the range of excess death estimates, could translate to a notional cost of 30%–40% of their annual GDP. On the current background of an impending third wave looming with the omicron variant, active surveillance measures and mistakes that were made in the past pertaining to deaths and reporting should be immediately rectified and timely action and notifications should be made compulsory by both government and private healthcare officials and organizations.

CONCLUSION

Official COVID-19 deaths have completely failed to assess

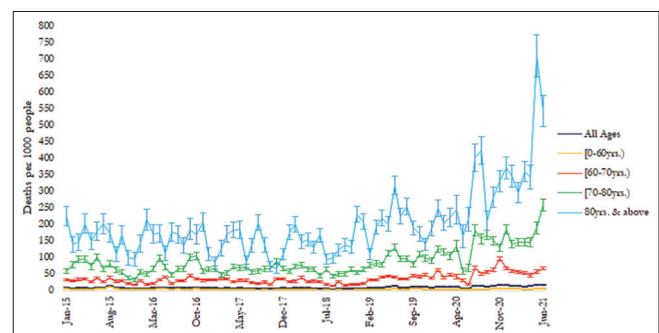


Figure 2: Monthly mortality CHPS, May 2015 to June 2021

Reference Loeffler et al.				
	Estimated Covid Mortality (per 100,000)		Covid-19 deaths (estimated)	
	Median	Range	Median	Range
2020	64.266	47.496 - 79.341	869,289	642,451-1,073,200
2021	134.416	98.632 - 184.443	1,818,168	1,334,138-2,494,854
Both years	198.682	146.128 - 263.784	2,687,457	1,976,589-3,568,054

Assumes population of India of 1,352,642,280. Per-capita excess mortality based on all states analyzed except Uttar Pradesh.
Source: Reference 20

Figure 3: Estimated excess mortality in India till 31 August 2021

Ref/First Author	Time Period	Wave 1 (Apr 2020-Jan 2021)			Wave 2 (Feb-Aug 2021)			Combined across Waves 1 and 2 (Apr 2020-Aug 2021)				
		Excess Deaths (M)	COVID-19 Reported Deaths ¹	Under Reporting Factor ²	Time Period	Excess Deaths (M)	COVID-19 Reported Deaths ¹	Under Reporting Factor ²	Time Period	Excess Deaths (M)	COVID-19 Reported Deaths ¹	Under Reporting Factor ²
(22) Deshmukh	Jun '20-Jan '21	Low: 595 th High: 658 th	155,769	Low: 3.8 High: 4.2	Apr-Jun 2021	Low: 2.51 High: 2.77	249,059	Low: 10.1 High: 11.2	Jun '20-Jun '21	Low: 3.11 High: 3.43	412,019	Low: 7.5 High: 8.3

Figure 4: Excess mortality in India from Deshmukh *et al*

the true scale of pandemic excess mortality in India. The under-ascertainment of COVID-19 deaths has been high, with around 8–10 excess deaths for every recorded COVID-19 death. Additional surveys and sero-prevalence data can supplement the estimates from death registrations. Time alone will unfold what the true death toll has been. Mortality data will be central to help assess and control the inevitable third viral wave due to Omicron variant expected in India. In the longer term, India must expand and improve its death registration and medical certification system.

Limitations

Studies which were unable to publish in the above-mentioned online databases may have been missed. Many of the studies have made assumptions of CFR, IFR based on global studies which may be different from Indian context due to geographical and racial variations.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

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