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Under-reporting of deaths limits our understanding of true burden of covid-19

Charles Whittaker and colleagues argue that accurate mortality data are essential for a fair, just, and equitable response to pandemics and suggest how to obtain them

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Estimating mortality attributable to different diseases, risk factors, or events is pivotal to inform resource allocation and evaluate public health interventions. Information on death rates and burden also supports wider aims of societal governance, public accountability, and memorialisation. Recent examples of mortality estimation include the true toll of hurricane Maria in Puerto Rico,[1] mortality during famine in Somalia,[2] and the war in South Sudan.[3]

Mortality data have also been essential in understanding the spread of covid-19. However, under-reporting in official death records has greatly obscured this understanding. We explore why under-reporting of deaths should have been expected, examine how use of alternative mortality sources can help advocate for a more equitable pandemic response, and highlight the crucial need for increased investment into civil registration and vital statistics systems before the next pandemic.

Importance of accurate covid-19 mortality data

Accurate understanding of the spread of covid-19 is crucial in navigating the trade-offs that underlie political decision making, including considerations of public health, economic growth, and civil liberties that must be integrated into pandemic responses at the national level.[4] Internationally, it is equally crucial in justifying and framing decisions surrounding global allocation of limited resources such as vaccines and therapeutics. Using case data as a metric for appraising control measures and tracking local epidemics is challenging since the frequency of asymptomatic infections,[5] non-specific symptoms of mild disease[6] and limitations in testing capacity result in substantial underascertainment of cases.[7] Mortality data on covid-19 are thought to be less susceptible to underascertainment than case numbers and have therefore been widely used to understand the dynamics of the pandemic and inform public health responses.

Underascertainment of mortality is common in infectious diseases

A recent global assessment of global health system capacity by the World Health Organization suggested that almost 40% of the world's deaths (irrespective of cause, and in non-pandemic periods) are not registered.[8] Understanding the true extent of mortality associated with infectious diseases is complex and challenging, most notably in resource poor settings where limited diagnostic capacity[9] and access to healthcare[10] mean many deaths are missed. For malaria, less than a quarter of estimated deaths appear in official national statistics[11]; for yellow fever, less than 1% of the estimated 50 000 deaths a year across Africa are reported[12]; for tuberculosis, both global estimates[13] and hospital postmortem studies suggest large numbers of deaths are not correctly attributed to the disease.[14] All of this suggests that relying solely on official mortality statistics for any of these diseases would lead to an incomplete and deeply biased understanding of their impact.

Is this any different for covid-19? The answer, we argue, is no. Accumulating evidence suggests officially reported covid-19 deaths provide an inadequate picture of the true dynamics of SARS-CoV-2 epidemics (table 1). This obscures our ability to understand the true burden of the pandemic, evaluate the complex trade-offs surrounding control of transmission, and advocate for a globally equitable and effective pandemic response.

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Table 1 | Estimates of reporting of covid-19 mortality in official figures and sources of data used to produce the estimate

Setting	% of deaths reported*	Timing	Data source
Damascus[15]	1.25	First wave	Obituary notifications
Aden[16]	1.5	First wave	Satellite imagery of cemeteries
Damascus[15]	5.75	Overall	Obituary notifications
Lusaka[17]	7	First wave	Postmortem PCR
Egypt[18]	7.5	First wave	Excess mortality
Jakarta[19]	25	First wave	Funerals
Iran[20]	41.5	Overall	Seasonal excess mortality
Mexico[18 21]	45	Overall	Excess mortality
Spain[18]	53	First wave	Excess mortality
US[22]	78	First wave	Excess mortality
Addis Ababa[23]	82	Jul-Sep 2020	Cemetery burials
New Zealand	100	Overall	Excess mortality

* See individual references for sources of data and different methods deployed to estimate reporting fractions. Data for New Zealand are assumed based on very low covid-19 deaths.

Global variation in underascertainment

Evidence for widespread underascertainment of covid-19 deaths come from various sources. Excess death statistics (total mortality compared with baselines from previous years) have been widely used since the beginning of the pandemic. Although the proportion of excess deaths caused by covid-19 or indirect effects of the pandemic remains uncertain, excess mortality is often viewed as a more objective indicator of the pandemic death toll than officially reported deaths from covid-19.[24]

Modelling of excess mortality trends suggests that at least half of covid-19 deaths have been missed globally and, at worst, 75%.[25] This global estimate, however, masks wide variation between countries. Results from multiple European countries suggest at least 75% of covid-19 deaths feature in official reports,[26] but in other settings this proportion is far lower. In Peru, reanalysis of death certificates and covid-19 case definitions resulted in a tripling of official covid-19 death rates and closer alignment with excess mortality.[27] Across South Africa, estimates of the number of excess deaths have also reached more than three times the number of officially confirmed covid-19 deaths,[28] and estimation from multiple sources in India suggests that only 10% of covid-19 deaths have been officially reported.[29] In Brazil, by contrast, surveillance of severe acute respiratory infections suggests roughly 80% of covid-19 deaths have been recorded.[30]

National estimates are likely to mask further local variation in covid-19 deaths—regional estimates of excess deaths across South Africa highlighted substantial variation among provinces, with covid-19 accounting for 11-68% of excess deaths.[31]

Covid-19 mortality can be estimated from excess deaths only when reliable mortality data are routinely available. In many settings estimates of the number of unreported covid-19 deaths must rely on alternative sources, including data from burials, cemeteries, and crematoriums as well as postmortem surveillance studies from hospital mortuaries (box 1). These unofficial sources confirm substantial variation in the under-reporting of covid-19 deaths across settings without routine collection of mortality data. In addition, these studies help identify the factors that lead to covid-19 deaths being undetected, such as lack of diagnostic testing or limited access to secondary healthcare (leading to deaths from covid-19 in the community).

Box 1: Alternative sources of data on deaths

Burial patterns

In one study from Jakarta, Indonesia, officially reported covid-19 deaths accounted for about 25% of recorded funerals of people who had had confirmed or probable covid-19.[19] Other analyses showed there were 61% more burials in Jakarta from January-October 2020 compared with the same period in 2015-19.[32]

Analyses of city burials have been used in multiple settings in the absence of all-cause mortality data. Rapid mortality surveillance from Addis Ababa, Ethiopia, suggested only limited underascertainment, with covid-19 deaths representing 82% of excess mortality in the third quarter of 2020.[23] Before data on excess mortality were available, crematorium reports during the second wave in India were the first source that indicated extensive underascertainment of deaths, with as few as 1% of covid-19 deaths reported in some places.[33]

Postmortem diagnosis

In Lusaka, Zambia, a postmortem survey in the country's largest tertiary care hospital suggested that only about 10% of people whose deaths were recorded as related to covid-19 had had a diagnostic test before death.[17] Additionally, 73% of the covid-19 deaths captured by the study had occurred in the community, where none of the deceased had had a covid-19 test, highlighting how treatment seeking behaviour can lead to important gaps in surveillance.

Further analysis revealed that covid-19 mortality in Lusaka was highly skewed towards younger age groups compared with higher income countries.[34] This shows how auxiliary data can provide a more complete picture of covid-19 morbidity and mortality than use of officially reported cases and deaths alone.

Gaps in covid-19 surveillance are likely to be even more prevalent in countries affected by conflict, where governance of health systems is often challenged, weakened, or even absent. Recording and sharing information is often difficult in these settings, hindering accountability, accessibility, and transparency.[35] These obstacles have motivated citizen science initiatives operated through social media to identify unreported covid-19 deaths. Such activities often reveal extensive under-reporting of covid-19 deaths (box 2). While unconfirmed covid-19 deaths ascertained from alternative sources should be treated with caution, these results highlight the extent to which covid-19 might have spread unobserved across many parts of the world where surveillance of community deaths is weak or absent, such as Yemen and Syria.

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Box 2: Citizen science initiatives

Citizen science initiatives have been relied on in some settings to shed light on the scale of the pandemic. These include drone footage of cemeteries in Aden, Yemen, which provided one of the first indications of under-reporting in the city[36] and later prompted the use of satellite imagery to quantify burials.[16]

Similarly, satellite imagery of mass graves in Damascus, Syria, hinted at higher covid-19 death tolls than officially reported.[37] The images prompted an investigation using obituary certificates uploaded by citizens to model the epidemic in Damascus.[15]

The two studies suggested that as few as 1 in 80 covid-19 deaths feature in officially reported mortality statistics in Damascus[38] and Aden.[16]

In other countries, hackers gained access to non-public datasets to reveal the true scale of mortality during the pandemic. In Belarus, the hacker group Cyberpartisans gained access to data showing that excess deaths between March 2020 and March 2021 were 14 times higher than official covid-19 death tolls.[39] In Mexico, two citizens used a forced browsing approach to access mortality data for Mexico City, uncovering that excess deaths for the city were more than double the official covid-19 death toll by February 2021.

Understanding the past, advocating for an equitable future

These realities paint a complex picture of the spread of covid-19 around the world—one that is fundamentally different from many prevailing narratives. Underascertainment of covid-19 mortality obscures our understanding of the pandemic's progression, the effectiveness of interventions, and the optimal allocation of resources. Modelling studies in Jakarta found that the effect of city-wide physical control measures is most clearly visible in data on excess funerals rather than official cases or deaths.[19]

Accurate mortality data also help track the pandemic's maturity and assess the relative contributions of physical control measures and population level immunity in declining transmission. This in turn helps inform the most appropriate level of interventions and enables more accurate weighing of the benefits of maintaining social distancing against the societal costs of continued closure of schools or workplaces.[40]

The accuracy of mortality data also has consequences for the distribution of vaccines.[41] To date, covid-19 vaccines have overwhelmingly been delivered to higher income countries,[42] and initiatives supporting equitable distribution (such as the Covax facility) have been unable to ensure adequate population coverage elsewhere. This unequal distribution reflects stark global disparities in the access to healthcare resources. A more accurate understanding of the global burden of covid-19 would not wave away the non-technical, structural, and political reasons that have seen many poorer countries excluded from timely access to vaccinations and other resources. But the situation has not been helped by narratives based on inaccurate official covid-19 mortality statistics suggesting some countries have been largely "spared" from the worst effects of the pandemic. These inaccurate data obscure the true picture, both by hiding deaths and by underestimating the effectiveness of interventions in settings that successfully limited transmission of covid-19 through timely implementation of control measures. This perpetuated the myth that public health and social measures were not critical to pandemic control, contributing to the collapse of numerous health systems during successive epidemic waves.

What can and should be done?

Collection and analysis of accurate population mortality data should be urgently scaled up in settings lacking reliable death registration systems. This will prevent existing global inequities in surveillance from conspiring further with parallel inequities in access to treatments and wider determinants of health. Rapid, retrospective, or prospective collection of mortality data is possible and, although not as accurate as estimates of excess mortality, can provide useful, timely, and actionable information in crisis settings. Examples include rapid household surveys,[43 44] records from burial sites[45] or their remote analysis through satellite imagery,[16] key informant studies and capture-recapture analysis of lists of deaths,[46] and verbal autopsy surveys.[47] Social media or other civil society sources can also be used to reconstruct mortality trends in the absence of complete mortality data.[15]

The most suitable method will vary between settings—for example, civilians or social media groups may only collect lists of deaths in response to conflict or in the context of particular religious practices. The use of satellite imagery will be effective only in locations with geolocated and regularly used cemeteries, while postmortem surveys (primarily implemented in urban settings) are unlikely to be representative if people dying in the community are not routinely brought to mortuaries (as is more common in rural areas).

Such data gathering exercises should be seen as short term solutions and not as a substitute for long term investment in civil registration and vital statistics systems. Better death registration and certification should be a cornerstone of future pandemic preparedness plans and is essential for achieving the mission set out in the sustainable development goals to "leave no-one behind."[48] This will require engagement and effort to improve the coverage and capacity of existing registration systems, the establishment of global standards for defining and reporting pandemic deaths, and the creation of robust governance frameworks that help mitigate political interferences in the collation of sensitive data.

Recent efforts by WHO, including its technical advisory group on covid-19 mortality assessment and the report on global health systems capacity,[8] are encouraging. Comprehensive descriptions of the status quo are a good start but must be accompanied by investment to improve civil registration capacity and coverage, targeted implementation of technological innovation, and tailored solutions to overcome the economic, political, and sociostructural barriers that limit progress in each setting.[49]

Equally important is establishing robust safeguards to avoid distortion of official statistics for political motives. Post-disaster death tolls are an important tool for evaluating government responses and are consequently politically sensitive if they expose poor governance. Politicisation of covid-19 death reporting is common and influences how deaths are defined and whether they feature in official statistics.[50] Authorities in many countries have charged citizens under criminal defamation laws for criticising government responses to covid-19.[51] Improvements to registration systems alone are therefore unlikely to resolve the many remaining problems with death ascertainment. A robust governance framework is therefore equally critical and must accompany any future improvements to system capacity to help mitigate potential political influences on how reporting occurs, and what gets reported.

Without these improvements, biases in surveillance that cause the greatest underestimation of cases and deaths where access to care is lowest will continue to obscure our understanding of this pandemic and hinder efforts to prepare more equitably for the next.

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Key messages

- Mortality data are considered more complete than case data for covid-19, but official statistics often undercount the true number of deaths
- Underascertainment varies globally but is highest in low income and fragile settings
- Underascertainment biases our understanding of the pandemic's progression and has important consequences for allocation of resources such as vaccines
- Investment in vital registration systems and robust governance are needed to ensure a fair, just, and equitable response to this and future pandemics

Contributors and sources: The authors have been modelling the global spread of the covid-19 pandemic for over a year and investigating the under-reporting of covid-19 mortality. Their specialisms include disease modelling and public health measurement of disease control in crisis settings. All authors contributed to the writing of the paper and sourcing of the references. OW is the guarantor.

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