Commentary

Measuring the Effect of COVID-19 Pandemic on Mortality: Review and Prospect — China, 2021

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ABSTRACT

Current progress in measuring the effect of the pandemic on mortality is limited. Few studies have comprehensively and systematically elucidated the mechanism through which the pandemic affects mortality and what indicators are valid to capture such an effect. This paper presents a comprehensive analysis regarding the multifaceted effects of coronavirus disease 2019 (COVID-19) on mortality and its measurements [i.e., confirmed deaths per million people (CDPMP), case fatality rate (CFR), infection fatality risk (IFR), excess mortality P-score (EMPS), and life expectancy (LE)]. It was revealed that both data collection efforts and measurements on mortality due to COVID-19 were far from perfect and discussed the importance of accurate, prompt, and accessible data by any government over the course of fighting against the COVID-19 pandemic. It is believed that the biggest challenge in measuring the effect of the COVID-19 pandemic on mortality lies not in the construction of indicators at the academic level, but in the collection of data at the practical level. Thus, it is suggested to take measures to better monitor the development of the pandemic and mitigate the increasing burdens borne by the public health systems by improving the tracking system of mortality, standardizing the diagnosis of COVID-19's deaths, and disclosing mortality data.

THE EFFECTS OF THE COVID-19 PANDEMIC ON MORTALITY

Few studies have comprehensively and systematically elucidated the mechanism through which the pandemic affects mortality. Therefore, we try to present a comprehensive analysis regarding the effect of COVID-19 on mortality and its measurement. More specifically, the multifaceted effects of the pandemic on mortality, including the positive effects and the negative effects, as well as the direct effects and the indirect effects, as is shown in Table 1. On one hand, the reduced mobility led to a decline in road traffic deaths, fewer respiratory diseases, and infectious diseases such as influenza and human hand-foot-mouth diseases (*1*–*2*). It was estimated that there were 600,000 fewer deaths from non-COVID-19 causes globally in 2020 (*3*). On the other hand, the COVID-19 pandemic also had a negative effect on mortality. According to *World Health Statistics 2021*, COVID-19 has become the leading cause of death globally. It was estimated that the total number of global excess deaths directly and indirectly attributable to the COVID-19 pandemic in 2020 was at least 3 million, far more than the 1.8 million reported COVID-19 deaths that year (*4*).

The negative effects of the pandemic on mortality can be divided into direct and indirect effects. First is death due directly to COVID-19 because of acute respiratory distress syndrome and multiple organ dysfunction syndromes. Health conditions play a key role in influencing complications severity in COVID-19. Thus, its mortality is thought to be related to public health and demographic characteristics. Take Italy as an example, its higher population of older patients with COVID-19 infection illustrates why there is higher mortality (*5*). Clinical studies also reported that pre-existing cardiovascular disease seems to be linked with an increased risk of death in patients with COVID-19 (*6*).

Second, the pandemic also has an indirect negative effect on mortality. In many countries, disease screening has been suspended and routine diagnosis has been deferred as a result of the COVID-19 pandemic. Patients who are wary of being infected appear to be more reluctant to seek healthcare services (*7*), which has led to a substantial increase in the number of avoidable deaths. In the UK, for example, a number of avoidable cancer deaths are to be expected due to delays in diagnosis (*8*). Beyond the cancer cases, inappropriate anti-pandemic policy led to the provision of suboptimal care, which may have a larger effect on the wider population of patients with various

TABLE 1. The effect of the COVID-19 pandemic on mortality.

Effect type	Manifestation	Cause
Positive effect	Decline in road traffic deaths, fewer respiratory diseases, and some infectious diseases such as influenza	Reduced mobility due to traffic control, home isolation and NPIs
Negative effect		
Direct way	Rise in the number of deaths in patients with COVID-19	Mostly because of ARDS and MODS
Indirect way	Increases risk of death in patients with non-COVID-19 complications	Inappropriate policy which affects disease screening and diagnosis

Abbreviations: COVID-19=coronavirus disease 2019; NPIs=non-pharmaceutical interventions; ARDS=acute respiratory distress syndrome; MODS=multiple organ dysfunction syndrome.

diseases, like heart disease and stroke (*9*–*10*). Therefore, improper allocation of health care resources may also lead to a public health crisis because of non-COVID-19 health complications.

MAJOR INDICATORS IN MEASURING THE COVID-19 PANDEMIC EFFECT ON MORTALITY

Considering that the effect of the COVID-19 pandemic on mortality is very complicated, we used different indicators to reflect the various effects. The most common indicators are confirmed deaths per million people (CDPMP), case fatality rate (CFR), infection fatality risk (IFR), excess mortality P-score (EMPS), and life expectancy (LE). We tried to review and compare these four widely used mortality indicators regarding their efficacy in gauging the effect of COVID-19 on mortality and the appropriate contexts for using these indicators.

CDPMR is the simplest indicator. The number of confirmed COVID-19 deaths reflects the direct loss of life caused by the disease. It is often needed to adjust for the size of the population by dividing by one million, especially when comparing countries. CFR and IFR are the most widely discussed indicators during the pandemic. Of the two, CFR is the proportion of confirmed COVID-19 deaths within a defined follow-up population (i.e., actual infections), mainly reflecting the severity of COVID-19 that causes death. However, CFR only focuses on confirmed cases, which may omit statistics on minor infections. Therefore, it may be better for us to use IFR, the ratio of death cases to all cases (including undetected instances), to reflect the risk of dying from COVID-19.

Although these three indicators quantify the overall scale of COVID-19 to a certain extent, they are limited as comprehensive measures, since they can only reflect the negative effect of the COVID-19 pandemic on mortality in a direct way. From this perspective, EMPS and LE are the more comprehensive measures reflecting the total effect of the pandemic on mortality.

EMPS is calculated based on excess deaths, the number of all-cause deaths during the pandemic period beyond the expected deaths under non-COVID-19 conditions, measured as the difference between reported deaths and expected deaths. Hence, it is only needed to count all the deaths within the year, without distinguishing the cause of deaths, whereas it is hard to ensure the accuracy of the numerator and the denominator in estimating CFR and IFR. For better comparisons across countries when there are large differences in population, it is required to divide the excess deaths by the expected deaths to get P-Score. Hence, the formula of EMPS is written as "EMPS = (reported deaths – expected deaths) / expected deaths × 100". However, demographic differences also add to the complexity in drawing comparisons when using EMPS. In this case, it is helpful to use the LE indicator to investigate the total effect of the COVID-19 pandemic on mortality. Unlike other indicators, LE is not affected by demographic characteristics, as it is calculated based on age-specific mortality rates by sex, so it could be used for direct comparison between different populations.

These indicators have been applied to measure the COVID-19 pandemic effect on mortality to varying degrees worldwide since the outbreak of the COVID-19, but the progress is still very limited. We believe that the fundamental problem lies in the operation of population statistics.

INSUFFICIENT TESTING VOLUMES IN LOW- AND LOWER MIDDLE-INCOME COUNTRIES

Although testing capacity has increased substantially worldwide, access to COVID-19 testing in most low- and lower middle-income countries is still in shortage due to high costs. Take Kenya as an example, the average cost for a patient seeking a test reached $11,

the equivalent of 6 days' wages for a Kenyan living in extreme poverty (*11*). A special survey conducted by the COVID-19 Clinical Research Coalition showed that low access outside major cities and shortage of test kits also added obstacles to COVID-19 testing in such countries. Nearly 90% of the subjects believed that diagnostics needed to be used more widely and made more available (*12*). The limited testing would lead to huge differences between reported confirmed deaths and actual deaths, which has leaved an adverse effect on the assessment and response to the pandemic.

REFLECTING ACTUAL RISK OF DYING FROM COVID-19

With the rapid progress of vaccine coverage, it is particularly important to do the assessment of mortality risk and the evaluation of pandemic prevention and control effects, which may guide the allocation of vaccines around the world. However, it is difficult to measure and compare the true mortality risk of COVID-19 across countries. One reason is that the mortality risk varied with time and populations vastly. For example, CFR and IFR reported by many countries have varied substantially over time. According to Johns Hopkins CSSE, the CFR of Germany population has ranged from 0.17% to 4.70%, while that of Italy has ranged from 1.94% to 14.52% from February 21, 2020 to November 6, 2021. Meanwhile, findings from seroprevalence data showed that IFR ranged from 0 to 1.63% among 74 estimates and the medium rate was 0.27% (*13*). Another example might be the evidence that minority ethnic groups are at a higher risk of catching and dying from COVID-19. Data from the United Kingdom Office for National Statistics showed that the risk of dying from COVID-19 for black people was more than 4 times the white population in England and Wales (*14*). The changes in CFR and IFR are thought to be associated with many factors like demographic, economic, and political variables (*15*–*16*). The variability of CFR and IFR added to the difficulty in the evaluation and management of the pandemic.

LIMITED PROGRESS IN THE COLLECTION AND PUBLISHING OF ALL-CAUSE DEATH DATA

The analysis of the overall effect of the COVID-19 pandemic on mortality was based on the collection and publication of all-cause death data. Take the indicator LE as an example, only some countries have published the data of LE in 2020 so far, although such work is beneficial for managing the pandemic. According to Eurostat, LE at birth fell in the vast majority of European Union due to the COVID-19 pandemic. The largest decreases were recorded in Spain (-1.6 years compared with 2019), followed by Bulgaria (-1.5). The indicator LE clearly reflected the offsetting effect of the pandemic on the positive progress of public health in EU countries (*17*). However, we still lacked official statistics on LE for more countries to understand the global situation. Up to now, there have been two main databases publishing all-cause death data regularly, the Human Mortality Database (HMD) and the World Mortality Dataset (WMD). WMD has been publishing updates since January 2021 for 108 countries and regions currently. However, the data is not broken down by age and published either weekly or monthly. HMD has been publishing relatively detailed updates since May 2020, but it has only involved 41 countries or areas so far. Lack of timely, detailed data sources will no doubt hinder the application of EMPS and LE as well as understanding the ongoing pandemic, eventually turning into a major problem for researchers and policymakers.

DISCUSSCION AND FUTURE DIRECTIONS

We need more timely, accurate, and accessible COVID-19 mortality data from surveillance systems to aid in the evaluation and management of the pandemic. Especially as variants such as Omicron become dominant, many countries across the world have experienced a surge in deaths since 2021. Although EMPS and LE were less susceptible to limitations in these systems based on COVID-19 diagnosis, they did not realize the expected value in understanding the burden of COVID-19, because of limited collection of all-cause death data in most developing countries. Therefore, further investment to improve the timely recording and cause diagnosis of deaths is a vital part of pandemic preparedness for most countries.

First, equitable access to vaccines and diagnostics in low- and lower middle-income countries must be ensured. Research showed a sustained reduction in COVID-19 mortality corresponding to increasing vaccines coverage and testing volumes (*18*–*19*).

However, the production and purchasing capacity of vaccines and diagnostics varies vastly in high- and low-income countries, leaving a negative effect on the evaluation and management of the pandemic across countries.

Second, proper death certification and registration should be encouraged for every country. The accuracy of the confirmed COVID-19 death data remains to be discussed, due to the limited testing and challenges in the attribution of the cause of deaths. Improper death certification and registration will reduce the data quality and limit the ability to track the evolving COVID-19 pandemic, which in turn adversely affect the local and national responses. So far, most countries still have been typically providing own guidance on how and when to report confirmed COVID-19 deaths, and some countries are still slow in constructing death registration systems. In order to obtain more accurate and comparable death data, countries are suggested to establish uniform standards for COVID-19 death certification while improving death registration.

Third, all-cause death data should be effectively collected and disclosed. The calculation and comparison of all-cause mortality across countries was not affected by limitations such as insufficient testing volumes. Therefore, using all-cause death data to analyze the effect of the epidemic on mortality is currently the most likely to be achieved on a global scale. Currently, the database HMD and WMD are collecting all-cause death data from various countries or regions, but this depends on the timely and transparent data released by each government.

In summary, measuring the mortality variations during the COVID-19 pandemic can contribute to control of the pandemic. This requires us to fully understand the mechanism of the effect of the COVID-19 pandemic on mortality and choose proper measurement to capture this impact. Most importantly, effective measures must be taken to effectively and promptly collect data on various measurements.

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