

all-cause mortality [...] and what would have otherwise been observed without the COVID-19 pandemic". For Japan, 2 836 833 deaths were observed in 2020–21. The estimate of 111 000 excess deaths thus implies 2 725 833 expected deaths. The expected deaths are 0.9% lower than the number of observed deaths in 2018–19 (2 750 245), suggesting that in the absence of the COVID-19 pandemic there would have been a drop in death counts.

However, declining deaths are not in line with the historical trend: the number of annual deaths has been growing without interruption in the past 20 years, with biannual changes in death counts from 2000 to 2019 all being between +1.5% and +7.3% (appendix 1 p 1). By contrast, expected death estimates by the World Mortality Dataset and *The Economist* do not break with the past trend. We found similarly implausible excess mortality estimates for many other countries, including Denmark, Germany, Belgium, Spain, Portugal, and Kazakhstan (appendix 1 p 1; appendix 2 p 2 for calculations). We believe that the estimates of the COVID-19 Excess Mortality Collaborators are unreliable and should not be used for any policy evaluation.

We declare no competing interests.

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1 COVID-19 Excess Mortality Collaborators. Estimating excess mortality due to the COVID-19 pandemic: a systematic analysis of COVID-19-related mortality, 2020–21. *Lancet* 2022; **399**: 1513–36.

2 The Economist. The pandemic's true death toll. 2021. *The Economist*. <https://www.economist.com/graphic-detail/coronavirus-excess-deaths-estimates> (accessed April 25, 2022).

3 Karlinsky A, Kobak D. Tracking excess mortality across countries during the COVID-19 pandemic with the World Mortality Dataset. *eLife* 2021; **10**: e69336.

The COVID-19 Excess Mortality Collaborators concluded that "The full impact of the pandemic has been much greater than what is indicated by reported deaths due to COVID-19 alone". They estimate that 18.2 million (95% CI 17.1–19.6) people died worldwide because of the pandemic (as measured by excess mortality) in 2020–21, instead of the reported COVID-19 deaths of 5.94 million worldwide during that period, as WHO claims.

I agree with the principle of estimating excess mortality due to the pandemic, not only the reported COVID-19 deaths, but the results of the authors' recalculation of deaths raise many perplexities.¹ They found that the gap between estimated excess mortality and reported COVID-19 deaths was much larger in south Asia and sub-Saharan Africa than in other regions. Therefore, the estimated excess deaths for a European country, such as Italy, should be closer to official statistical data. However, in the example of Italy, this is not the case. In Italy, the reported COVID-19 deaths are 137 000 in 2020–21, whereas the authors' estimated excess deaths are 259 000 (242 000–276 000).¹ The data published by the Italian National Institute of Statistics^{2,3} show an all-cause mortality excess of 100 526 more deaths in 2020 and 63 415 in 2021, compared with the average number of deaths in the 5-year period from 2015 to 2019. This totals to 163 941 more deaths in the 2-year period from 2020 to 2021. These deaths are 95 059 fewer than those calculated by the COVID-19 Excess Mortality Collaborators.¹ Their numbers are implausible, implying that, without the pandemic, the average mortality in Italy from 2015 to 2019 would be reduced by 7.36% in 2020–21.

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Excess mortality is an important metric summarising COVID-19 disease burden, informing public health policy and future preparedness needs.¹ However, separating the deaths that occurred from COVID-19 versus those from all other causes is challenging. Essentially, the unknowns are the counterfactual, should an infection wave not have happened. A solution to this challenge is to estimate expected number of individuals who would have died and compare this with the observed number of deaths. The estimation of expected number of deaths must consider changes in population and seasonal dynamics and be based on an appropriate reference period. The COVID-19 Excess Mortality Collaborators² present an important study that estimates 18.2 million excess deaths spread across 191 countries and territories in the first 2 years of the COVID-19 pandemic, 2020 and 2021. The authors use an ensemble-based approach to estimate global excess mortality due to data paucity in many countries. Although this global estimate might be broadly correct and serves as an important reminder of the effect of COVID-19, we strongly caution against the over-interpretation of the constituent country estimates. For European countries, we instead recommend the



See Online for appendix 1

See Online for appendix 2

use of EuroMOMO—a standard and coordinated approach for mortality monitoring in Europe. EuroMOMO estimates expected excess mortality, correcting for delay in registration and changes in population and seasonality during a 5-year reference period.³ EuroMOMO excess mortality estimates include both surplus and deficit mortality, with deficit mortality expected under stringent control restrictions. Whether the COVID-19 Excess Mortality Collaborators² consider both surplus and deficit mortality is unclear.

We find conflicting estimates of excess mortality for several countries with reliable and near complete mortality reporting. For example, for Denmark, the authors² predicted an excess mortality of 203% higher than the estimate from EuroMOMO. The trend in increasing excess mortality in the later part of 2021 estimated by the study² is inconsistent with trends reported from the Danish health authorities, the total mortality, and the EuroMOMO excess mortality. The COVID-19 Excess Mortality Collaborators² do not provide details on these discrepancies and do not provide their weights and background estimates for all countries. Because of the inconsistencies shown in our table (appendix p 1), we caution both the use and over-interpretation of individual country estimates from the study.² Although the estimates from this study² are important in a global perspective, for individual countries with good health-care reporting, nationally reported estimates (eg, from EuroMOMO) are probably more reliable.

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- 2 COVID-19 Excess Mortality Collaborators. Estimating excess mortality due to the COVID-19 pandemic: a systematic analysis of COVID-19-related mortality, 2020–21. *Lancet* 2022; **399**: 1513–36.
- 3 Nielsen J, Mazick A, Andrews N, et al. Pooling European all-cause mortality: methodology and findings for the seasons 2008/2009 to 2010/2011. *Epidemiol Infect* 2013; **141**: 1996–2010.

Authors' reply

The COVID-19 pandemic has caused almost 8 million reported deaths worldwide since late 2019.¹ Although this is a staggering loss of human lives, 8 million is a vast under-estimation of the true toll of the pandemic. In addition to under-reporting and misclassification of COVID-19 deaths, the pandemic has also resulted in loss of lives due to stressed health-care systems. Excess mortality due to the COVID-19 pandemic, a measurement of net changes in all-cause mortality during the pandemic compared with levels before the pandemic, is widely considered the best measurement of the overall effect of the pandemic and is increasingly a metric used to compare country performance with expectations. Indeed, massive media coverage has been given to excess mortality estimates provided by the COVID-19 Excess Mortality Collaborators,² *The Economist*,³ and WHO.⁴

In all cases, both input data processing and modelling approaches have a substantial effect on estimated excess mortality for countries with or without reported vital registration data during the pandemic. In our peer-reviewed² and GATHER⁵-compliant work, we attempted to account for both under-registration and late registration, a far more common issue even for high-income countries, in addition to correcting for data

affected by the summer heatwaves in both Europe and North America. To our knowledge, our estimation pipeline is the only one that accounted for such input data issues that would bias excess mortality estimates for countries affected. In addition, an ensemble of six different models was developed to estimate expected all-cause mortality in the absence of the pandemic. Weights for each candidate model were generated with out-of-sample predictive validity testing. We opted for such a modelling approach, recognising that the choice of a model configuration has a substantial effect on the estimated expected mortality, and thus the estimated excess mortality. We are aware of no such caution in other estimations.

To estimate excess mortality for the entirety of the pandemic for both groups of countries, with or without reported vital registration data before and during the pandemic, we developed a parsimonious regression model in which 15 covariates related to both the COVID-19 pandemic (such as reported COVID-19 death rate, seroprevalence, and infection-detection rate) and background population health indicators (eg, Universal Health Coverage index, proportion of population older than 75 years, and prevalence of diabetes and cigarette smoking) were chosen on the basis of a rigorous covariate selection process. Candidate covariates were selected after evaluating background population health conditions associated with mortality during the pandemic, on the basis of a meta-analysis done by the US Centers for Disease Control and Prevention. The same prediction model is used for all locations that are based on the ensemble model, including those contributed empirical excess mortality estimates, to account for any dropped time period due to the heatwave or late registration.

For countries without reported all-cause mortality data to help guide the estimation of excess mortality

For more on EuroMOMO see: <https://www.euromomo.eu/>

See Online for appendix