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 Collaborators[2] 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 authors[2] 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 study[2] is inconsistent with trends reported from the Danish health authorities, the total mortality, and the EuroMOMO excess mortality. The COVID-19 Excess Mortality Collaborators[2] 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 study[2] 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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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-reviewed[2] and GATHER[5]-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.

For more on **EuroMOMO** see: https://www.euromomo.eu/]

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.

See **Online** for appendix

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

during the pandemic, COVID-19 seroprevalence rate is perhaps the single most crucial driving force in the estimation of excess mortality in such countries, including countries from sub-Saharan Africa. The COVID-19 forecast project at the Institute for Health Metrics and Evaluation, from which we drew our COVID-19-related covariates, provides the most comprehensive and internally consistent estimates on incidence and prevalence of COVID-19 infections—also peer-reviewed[6] and GATHER-compliant. In situations without available all-cause mortality data, our estimated excess mortality provides the best metric on the effect of the pandemic in such countries.

Jonas Schöley, Mark Woolhouse, Desmond O'Neill, Alberto Donzelli, Peter Bager, and colleagues have pointed out the difference in our estimates compared with those provided by *The Economist*,[3] The World Mortality Dataset,[7] and WHO.[4] Aside from our assessment accounting for under-registration and late registration, a far more prevalent issue, even in low sociodemographic index countries, is how many weeks or months of observed data from before the pandemic are used as a baseline for extrapolation (eg, there is a 20-week delay in vital registration data being complete in the USA). How we extrapolate data and the division timepoint between baseline and extrapolation all contribute greatly to the estimated expected mortality and the resulting excess mortality. Research has and will continue to estimate the toll of the ongoing COVID-19 pandemic.[8] Our current research focuses on further refining country-specific specifications in improving long-term mortality extrapolation for countries to iteratively improve the methods, as data from all countries become more complete. These data are essential for the next iteration of the Global Burden of Disease Study.[9]

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Department of Error

Forrest IS, Petrazzini BO, Duffyet Á, et al. Machine learning-based marker for coronary artery disease:derivation and validation in twolongitudinal cohorts. Lancet *2023; **401:** 215–25* —The codes for the CAD case definition in the appendix have been updated. The appendix of this Article has been corrected as of Feb 9, 2023.

Samarasekera U. Lynette Denny: women's cancer researcher with global impact. Lancet *2023; **401:** 261*—In this Profile, HPV-negative has been corrected to HIV-negative in the sixth sentence of the second paragraph. The online version has been corrected as of Feb 9, 2023.