Global COVID-19 epidemic models situation report No 04 – 2021-08-28

Farshad Pourmalek MD PhD
Former lecturer, University of British Columbia, Vancouver | UBC SPPH | ORCID | PubMed
pourmalek_farshad@yahoo.com

Based on uptake 20210826 in https://github.com/pourmalek/CovidVisualizedGlobal
Study update dates in uptake 20210826:
DELP 20210826, *IHME 20210826*, IMPE 20210819, LANL 20210822, SRIV 20210826

DELP: model by Massachusetts Institute of Technology, Cambridge
IHME: model by Institute for Health Metrics and Evaluation, Seattle
IMPE: model by Imperial College, London
LANL: model by Los Alamos National Laboratories, Los Alamos
SRIV: model by Srivastava, Ajitesh, University of Southern California, Los Angeles

Executive Summary

This report shows the trajectory of daily deaths, infections, bed needs, and ICU bed needs at the global level, estimated by five international and periodically updating COVID-19 epidemic models.

The graphs show the predictions for *when* and *how much* increase/decrease in infections, deaths, and bed needs.

This report summarizes the results of a project named *CovidVisualizedGlobal*, an online tool developed to function as an early warning tool for technical advisers and health decision-makers.

Pre-print Data Note manuscript on Research Square, titled "CovidVisualized: Visualized compilation of international updating models' estimates of COVID-19 pandemic at global and country levels", 02 August 2021, PRE-PRINT (Version 1) available at Research Square [https://doi.org/10.21203/rs.3.rs-768714/v1] describes the methods and results of CovidVisualized tools: *CovidVisualizedCountry (for Canada),* CovidVisualizedGlobal (for global level), and covir2 (for Iran).

Farshad Pourmalek MD MPH PhD, who has created the CovidVisualizedGlobal tool (and *covir2* tool for Iran and CovidVisualizedCountry tool for Canada) and this report is a physician and epidemiologist who worked in School of Population and Public Health of University of British Columbia and Vancouver General Hospital, University of Washington, WHO, UNDEP, and UNICEF. ORCID ID https://orcid.org/0000-0002-2134-0771 , PubMed.

What is this report, and where does it come from?

This report is the *4th* situation report of predictions of five international and periodically updating COVID-19 epidemic models about the future trajectory of the epidemic at the global level. The report is based on the **"CovidVisualizedGlobal"** online tool, that is a GitHub repository for sharing data and codes, available at
https://github.com/pourmalek/CovidVisualizedGlobal
This report is meant to serve as an offline and stand-alone version of the online tool. Situation Reports are available online at
https://github.com/pourmalek/CovidVisualizedGlobal/tree/main/situation%20reports

Objectives of the "*CovidVisualizedGlobal*" tool are to identify international and periodically updated models of the COVID-19 epidemic, compile and visualize their estimation results, and periodically update the compilations.

The ultimate objective is to provide an ***early warning system*** for technical advisors to the decision-makers. When the predictions of one or more models show an increase in daily cases or infections, hospitalizations, or deaths in the near future, ***technical advisors to the national and subnational decision-makers*** may consider suggesting augmentation of non-pharmacologic preventive interventions and vaccination. In doing so, the strengths and weaknesses of individual models need to be considered and those of this work. Models' estimates demonstrate the trajectory of COVID-19 deaths, cases or infections, and hospital-related outcomes in one to three months into the future.

The "CovidVisualized" project includes https://github.com/pourmalek/covir2 for Iran, https://github.com/pourmalek/CovidVisualizedCountry for Canada and its provinces, and https://github.com/pourmalek/CovidVisualizedGlobal for the global level.

Methods and technical details of this work are available in a pre-print Data Note manuscript on Research Square, titled "CovidVisualized: Visualized compilation of international updating models' estimates of COVID-19 pandemic at global and country levels", 02 August 2021, PRE-PRINT (Version 1) available at Research Square [https://doi.org/10.21203/rs.3.rs-768714/v1] describes the methods and results of CovidVisualized tools: *CovidVisualizedCountry (for Canada),* CovidVisualizedGlobal (for global level), and covir2 (for Iran).

Strengths and weaknesses of international and periodically updating COVID-19 epidemic models are discussed in Pourmalek F, Rezaei Hemami M, Janani L, Moradi-Lakeh M. Rapid review of COVID-19 epidemic estimation studies for Iran. BMC Public Health. 2021 Feb 1;21(1):257. doi: 10.1186/s12889-021-10183-3. PMID: 33522928.

Stata codes written and used for this whole work can be examined online and/or downloaded and re-run to check, securitize, verify, or flag any mistakes.
https://github.com/pourmalek/CovidVisualizedCountry#iii-inner-works-of-this-repository-1

Five international and periodically updating COVID-19 epidemic models:

DELP, IHME, IMPE, LANL, SRIV; and JOHN (these abbreviations are used in the graphs)

DELP: DELPHI. Differential Equations Lead to Predictions of Hospitalizations and Infections. COVID-19 pandemic model named DELPHI by Massachusetts Institute of Technology, Cambridge. *Reference:* COVID Analytics. DELPHI epidemiological case predictions. Cambridge: Operations Research Center, Massachusetts Institute of Technology. https://www.covidanalytics.io/projections and https://github.com/COVIDAnalytics/website/tree/master/data/predicted

IHME: Institute for Health Metrics and Evaluation. COVID-19 pandemic model by Institute for Health Metrics and Evaluation, Seattle. *Reference:* Institute for Health Metrics and Evaluation (IHME). COVID-19 mortality, infection, testing, hospital resource use, and social distancing projections. Seattle: Institute for Health Metrics and Evaluation (IHME), University of Washington. http://www.healthdata.org/covid/ and http://www.healthdata.org/covid/data-downloads

IMPE: Imperial. COVID-19 pandemic model by Imperial College, London. *Reference:* MRC Centre for Global Infectious Disease Analysis (MRC GIDA). Future scenarios of the healthcare burden of COVID-19 in low- or middle-income countries. London: MRC Centre for Global Infectious Disease Analysis, Imperial College London. https://mrc-ide.github.io/global-lmic-reports/ and https://github.com/mrc-ide/global-lmic-reports/tree/master/data

LANL: Los Alamos National Laboratories. COVID-19 pandemic model by Los Alamos National Laboratories, Los Alamos. *Reference:* Los Alamos National Laboratory (LANL). COVID-19 cases and deaths forecasts. Los Alamos: Los Alamos National Laboratory (LANL). https://covid-19.bsvgateway.org

SRIV: Srivastava, Ajitesh. COVID-19 pandemic model by University of Southern California, Los Angeles. *Reference:* Srivastava, Ajitesh. University of Southern California (USC). COVID-19 forecast. Los Angeles: University of Southern California. https://scc-usc.github.io/ReCOVER-COVID-19 and https://github.com/scc-usc/ReCOVER-COVID-19/tree/master/results/historical_forecasts

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JOHN: Johns Hopkins. Coronavirus resource center, Johns Hopkins University, Baltimore. Curation of official reports of countries to World Health Organization. **Ground truth for comparison**. *Reference:* Johns Hopkins University. Coronavirus resource center. https://coronavirus.jhu.edu/map.html and https://github.com/CSSEGISandData/COVID-19

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Models' updates and their acquisition in this work:

The two models with the least frequency of periodic updates of estimates are IHME and IMPE, which are updated on a weekly and bi-weekly basis, respectively. With the release of each update of either IHME or IMPE models, the whole set of the five included models are updated in the *CovidVisualizedGlobal* GitHub repository. The most recent update of each model is used.

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Graphs of epidemic trajectory at the global level till 01 December 2021

Graphs of the most recent models' updates are shown here. These graphs, as well as graphs of previous updates, are available online at https://github.com/pourmalek/CovidVisualizedGlobal

Logical order of graphs:

(1) *Outcomes*: Daily deaths, Daily cases or infections, Hospital-related outcomes, Daily deaths estimated to reported ratio, Daily cases or infections estimated to reported cases ratio.

(2) *Calendar time of estimates coverage*: All-time, followed by 2021. To view the whole epidemic trajectory and further focus on the near future.
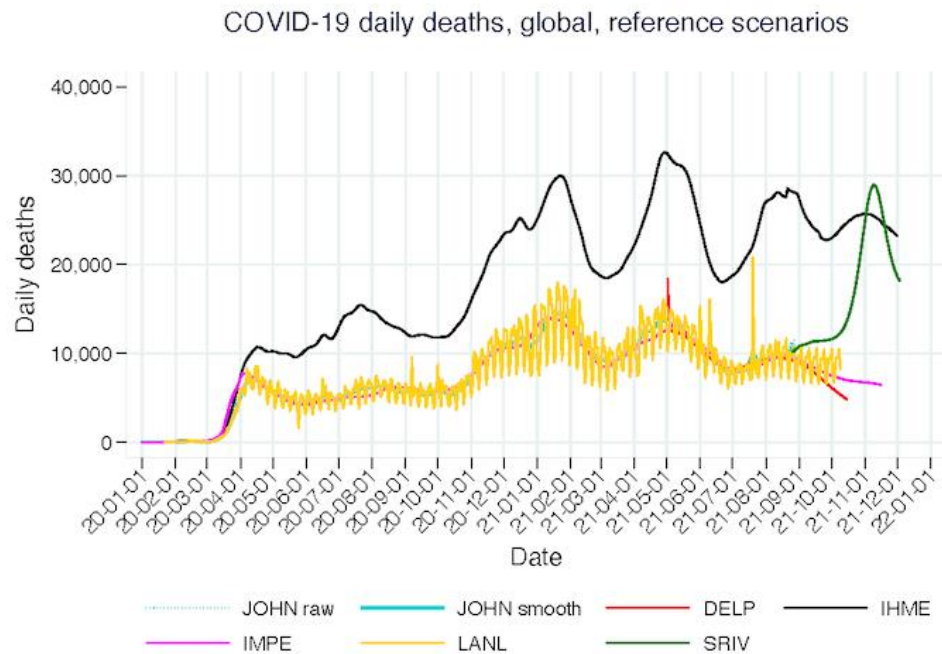
(3) *Scenarios*: Reference scenarios, followed by alternative scenarios. To examine the main or reference (aka. status quo) scenario and alternative (better and worse) scenarios.

(4) *Five models*: Different models *within* each graph (for which model estimates update release dates are maximally synchronized), plus official reports of the country to WHO (curated by Johns Hopkins University) as the under-reported benchmark for trends. To examine how heterogeneity in methods used by different models results in heterogeneous results for the same outcome (same time-place-person aggregated units)
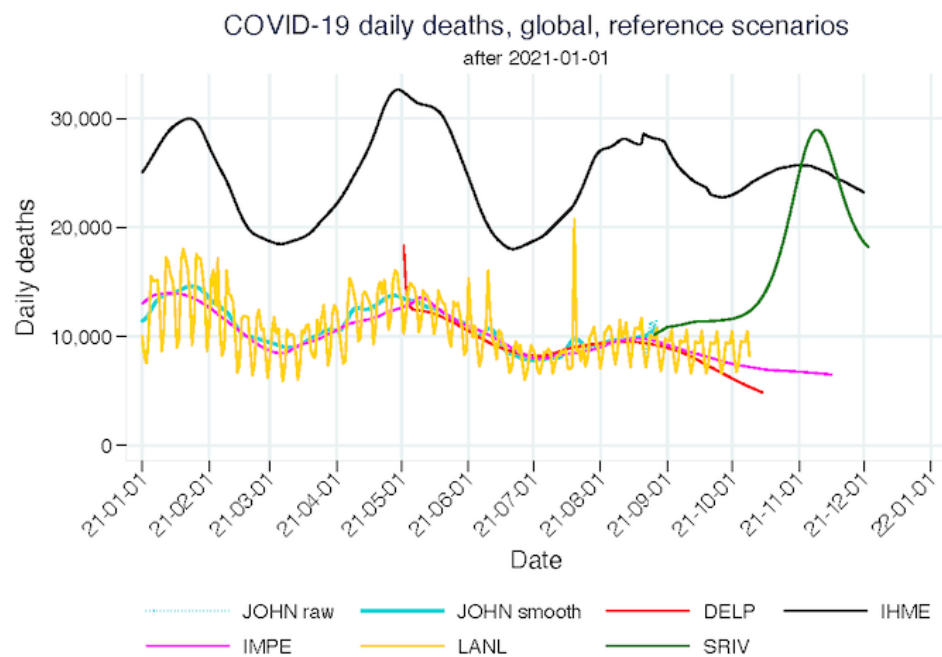
List of graphs

(1) Daily deaths, reference scenarios, all time

(2) Daily deaths, reference scenarios, 2021

(3) Daily deaths, 3 scenarios, 2021

(3b) Daily deaths, 3 scenarios, 2021, IHME

(3c) Daily deaths, 3 scenarios, 2021, IMPE
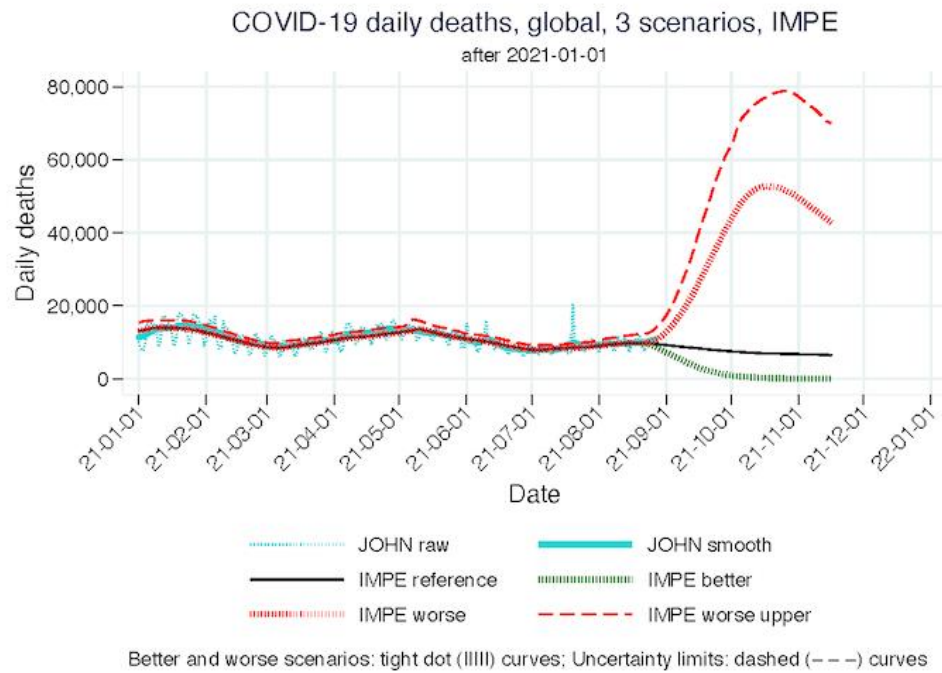
(4) Daily cases or infections, reference scenarios, all time
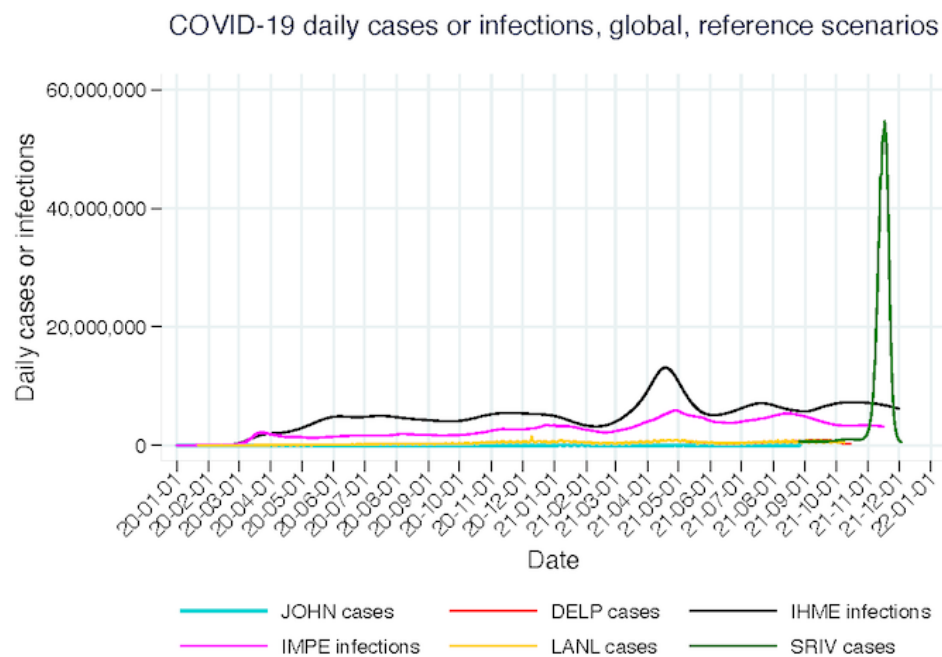
(5) Daily cases or infections, reference scenarios, 2021
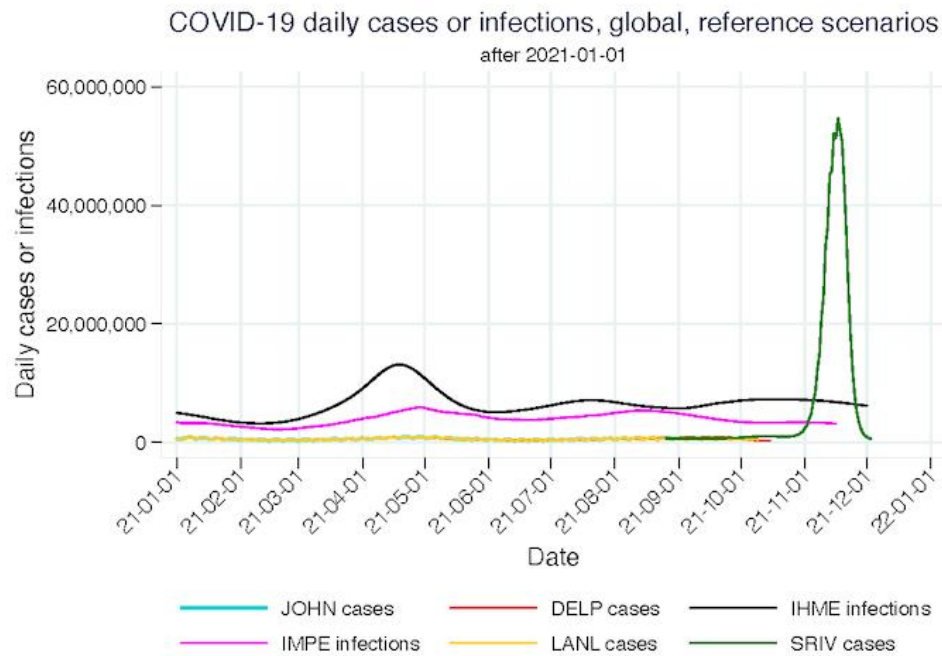
(6) Daily cases or infections, 3 scenarios, 2021

(7) Hospital-related outcomes, all time
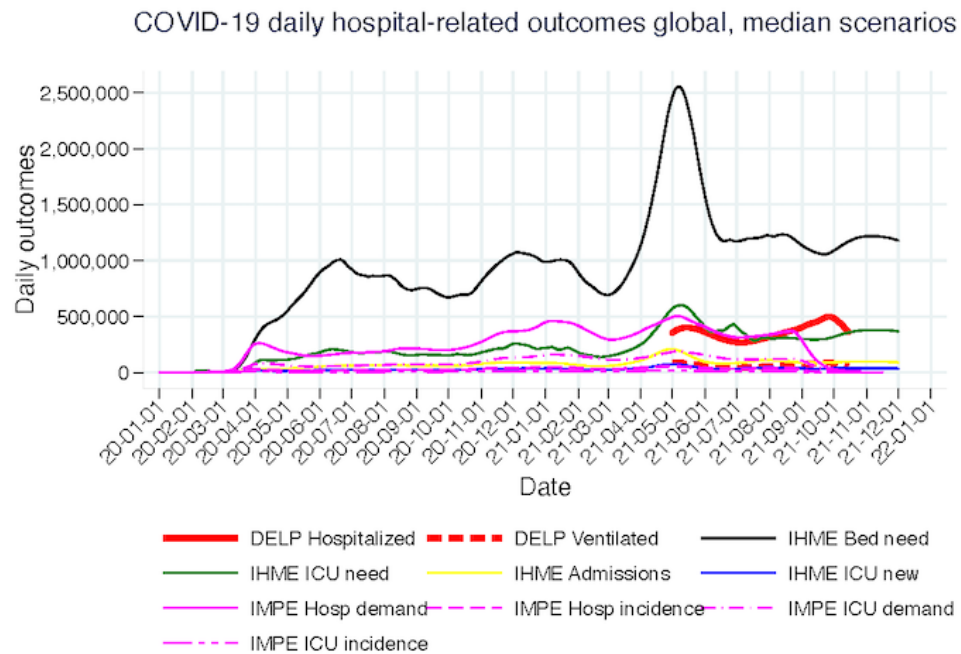
(8) Hospital-related outcomes, 2021, without IHME Bed need and IMPE Hospital demand
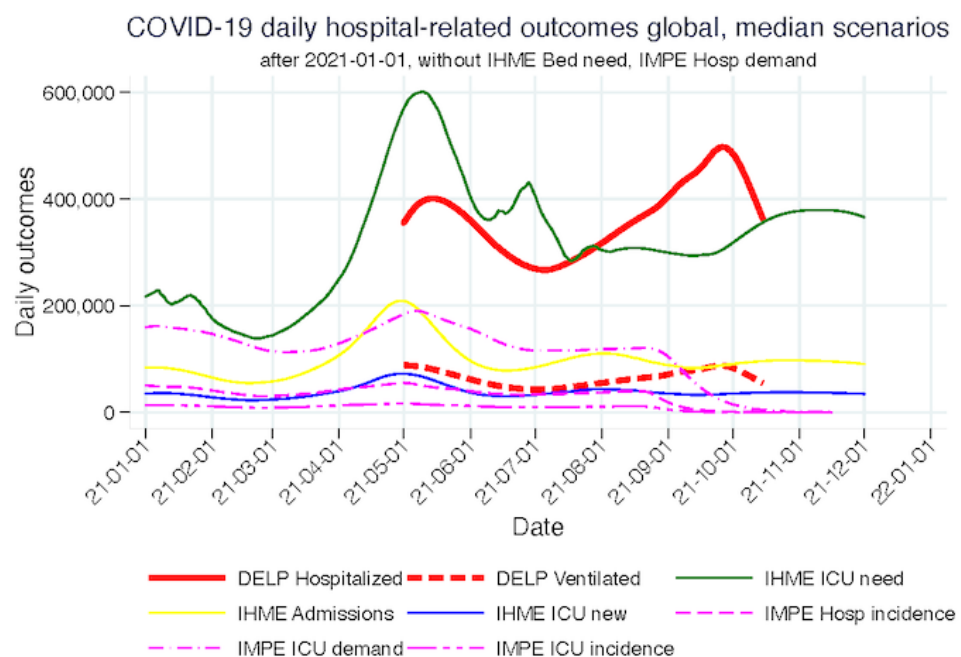
(9) Daily deaths estimated to reported, reference scenarios, 2021

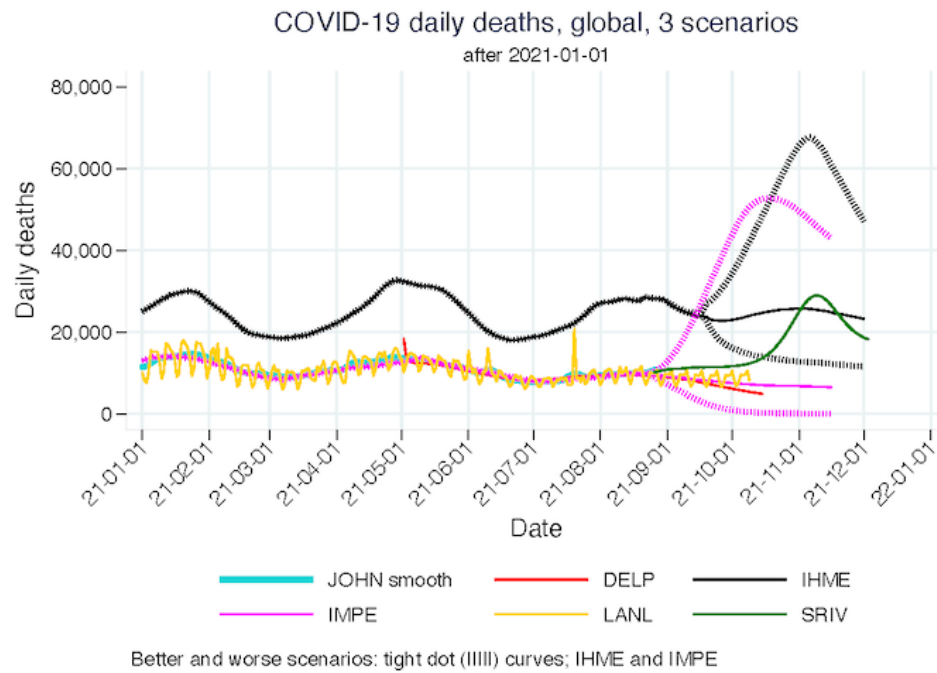(10) Daily cases or infections estimated to reported cases, reference scenarios, 2021
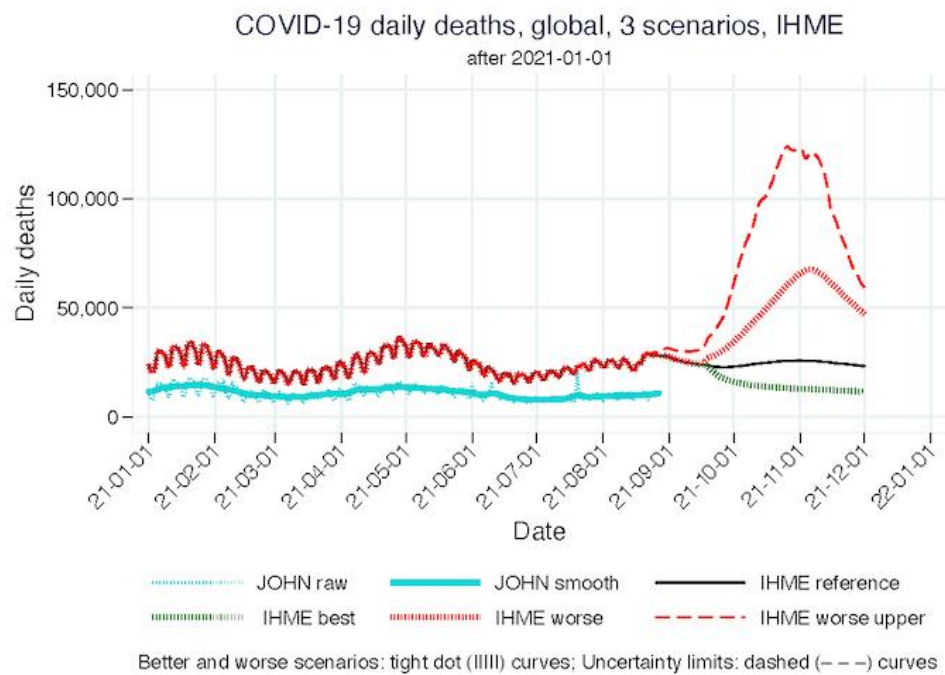
(1) <u>Daily deaths, reference scenarios, all time</u>

COVID-19 daily deaths, global, reference scenarios

(2) <u>Daily deaths, reference scenarios, 2021</u>

COVID-19 daily deaths, global, reference scenarios
after 2021-01-01

(3) Daily deaths, 3 scenarios, 2021

COVID-19 daily deaths, global, 3 scenarios
after 2021-01-01

Better and worse scenarios: tight dot (lllll) curves; IHME and IMPE

(3b) Daily deaths, 3 scenarios, 2021, IHME

COVID-19 daily deaths, global, 3 scenarios, IHME
after 2021-01-01

Better and worse scenarios: tight dot (lllll) curves; Uncertainty limits: dashed (− − −) curves

(3c) Daily deaths, 3 scenarios, 2021, IMPE

COVID-19 daily deaths, global, 3 scenarios, IMPE
after 2021-01-01

Better and worse scenarios: tight dot (IIIII) curves; Uncertainty limits: dashed (– – –) curves

(4) Daily cases or infections, reference scenarios, all time
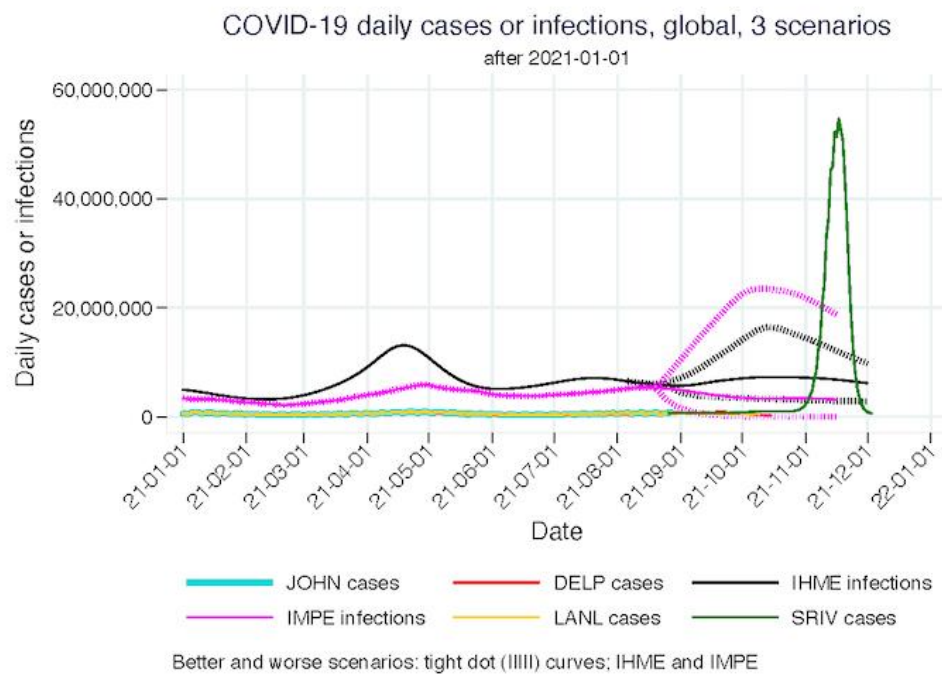
COVID-19 daily cases or infections, global, reference scenarios

(5) [Daily cases or infections, reference scenarios, 2021](#)

COVID-19 daily cases or infections, global, reference scenarios
after 2021-01-01

(6) [Daily cases or infections, 3 scenarios, 2021](#)

COVID-19 daily cases or infections, global, 3 scenarios
after 2021-01-01

Better and worse scenarios: tight dot (lllll) curves; IHME and IMPE

(7) Hospital-related outcomes, all time

COVID-19 daily hospital-related outcomes global, median scenarios

Legend:
— DELP Hospitalized   ▪▪▪ DELP Ventilated   — IHME Bed need
— IHME ICU need   — IHME Admissions   — IHME ICU new
— IMPE Hosp demand   ▪▪▪ IMPE Hosp incidence ·—· IMPE ICU demand
·▪· IMPE ICU incidence

(8) Hospital-related outcomes, 2021, without IHME Bed need and IMPE Hospital demand

COVID-19 daily hospital-related outcomes global, median scenarios
after 2021-01-01, without IHME Bed need, IMPE Hosp demand

Legend:
— DELP Hospitalized   ▪▪▪ DELP Ventilated   — IHME ICU need
— IHME Admissions   — IHME ICU new   ▪▪▪ IMPE Hosp incidence
·—· IMPE ICU demand   ·▪· IMPE ICU incidence

(9) [Daily deaths estimated to reported, reference scenarios, 2021](#)

COVID-19 daily deaths estimated to reported, global, reference scenarios

(10) [Daily cases or infections estimated to reported cases, reference scenarios, 2021](#)

COVID-19 daily cases estimated to reported, global, reference scenarios
daily cases or infections estimated, to reported cases