Global COVID-19 epidemic models situation report No 06 – 2021-09-16

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

Based on uptake 20210916 in https://github.com/pourmalek/CovidVisualizedGlobal
Study update dates in uptake 20210916:
DELP 20210916, ***IHME 20210916***, IMPE 20210825, LANL 20210912, SRIV 20210916

Note: IMPE update 20210825 was dead at birth for IRAN since predicted daily deaths was less than report daily deaths during the overlap interval. This does not increase accuracy of predictions for other locations.

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

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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 *6th* 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

*

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

*

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.

*

Uptakes in this repository, since April 2021

bold italic fonts show the uptake was triggered by either IHME or IMPE.

(Uptake number) uptake date: study update date, study update date

(40) uptake 20210916: DELP 20210916, ***IHME 20210916***, IMPE 20210825, LANL 20210912, SRIV 20210916
(39) uptake 20210910: DELP 20210910, ***IHME 20210910***, IMPE 20210825, LANL 20210905, SRIV 20210910
(38) uptake 20210902: DELP 20210902, ***IHME 20210902***, IMPE 20210825, LANL 20210829, SRIV 20210902
(37) uptake 20210901: DELP 20210901, IHME 20210826, ***IMPE 20210825***, LANL 20210829, SRIV 20210901
(36) uptake 20210826: DELP 20210826, ***IHME 20210826***, IMPE 20210819, LANL 20210822, SRIV 20210826
(35) uptake 20210824: DELP 20210824, IHME 20210819, ***IMPE 20210819***, LANL 20210822, SRIV 20210824
(34) uptake 20210819: DELP 20210819, ***IHME 20210819***, IMPE 20210806, LANL 20210815, SRIV 20210819
(33) uptake 20210813: DELP 20210813, IHME 20210806, ***IMPE 20210806***, LANL 20210808, SRIV 20210813
(32) uptake 20210806: DELP 20210806, ***IHME 20210806***, IMPE 20210719, LANL 20210801, SRIV 20210801
(31) uptake 20210730: DELP 20210730, ***IHME 20210730***, IMPE 20210719, LANL 20210725, SRIV 20210730
(30) uptake 20210727: DELP 20210726, IHME 20210723, ***IMPE 20210719***, LANL 20210725, SRIV 20210727
(29) uptake 20210726: DELP 20210726, ***IHME 20210723***, IMPE 20210709, LANL 20210718, SRIV 20210726
(28) uptake 20210723: DELP 20210723, ***IHME 20210723***, IMPE 20210709, LANL 20210718, SRIV 20210723
(27) uptake 20210715: DELP 20210715, ***IHME 20210715***, IMPE 20210709, LANL 20210711, SRIV 20210715
(26) uptake 20210714: DELP 20210714, IHME 20210702, ***IMPE 20210709***, LANL 20210711, SRIV 20210714
(25) uptake 20210709: DELP 20210708, IHME 20210702, ***IMPE 20210702***, LANL 20210704, SRIV 20210709
(24) uptake 20210704: DELP 20210704, IHME 20210702, ***IMPE 20210626***, LANL 20210704, SRIV 20210704
(23) uptake 20210703: DELP 20210703, ***IHME 20210702***, IMPE 20210618, LANL 20210627, SRIV 20210703
(22) uptake 20210625: DELP 20210625, ***IHME 20210625***, IMPE 20210618, LANL 20210613, SRIV 20210624
(21) uptake 20210624: DELP 20210624, IHME 20210618, ***IMPE 20210618***, LANL 20210613, SRIV 20210624
(20) uptake 20210618: DELP 20210618, ***IHME 20210618***, IMPE 20210611, LANL 20210613, SRIV 20210618
(19) uptake 20210611: DELP 20210611, IHME 20210610, ***IMPE 20210611***, LANL 20210606, SRIV 20210611
(18) uptake 20210610: DELP 20210610, ***IHME 20210610***, IMPE 20210604, LANL 20210606, SRIV 20210610
(17) uptake 20210605: DELP 20210604, IHME 20210604, ***IMPE 20210604***, LANL 20210602, SRIV 20210604
(16) uptake 20210604: DELP 20210604, ***IHME 20210604***, IMPE 20210527, LANL 20210602, SRIV 20210604
(15) uptake 20210603: DELP 20210603, IHME 20210528, ***IMPE 20210527***, LANL 20210526, SRIV 20210603
(14) uptake 20210528: DELP 20210528, ***IHME 20210528***, IMPE 20210522, LANL 20210526, SRIV 20210528
(13) uptake 20210522: DELP 20210522, IHME 20210521, ***IMPE 20210522***, LANL 20210519, SRIV 20210522
(12) uptake 20210521: DELP 20210521, ***IHME 20210521***, IMPE 20210516, LANL 20210519, SRIV 20210521
(11) uptake 20210516: DELP 20210516, IHME 20210514, ***IMPE 20210516***, LANL 20210516, SRIV 20210516
(10) uptake 20210515: DELP 20210515, IHME 20210514, ***IMPE 20210510***, LANL 20210512, SRIV 20210515
(09) uptake 20210514: DELP 20210514, ***IHME 20210514***, IMPE 20210424, LANL 20210512, SRIV 20210514
(08) uptake 20210506: DELP 20210506, ***IHME 20210506***, IMPE 20210424, LANL 20210505, SRIV 20210506
(07) uptake 20210424: DELP 20210424, IHME 20210423, ***IMPE 20210424***, LANL 20210421, SRIV 20210424
(06) uptake 20210423: DELP 20210423, ***IHME 20210423***, IMPE 2010417, LANL 20210421, SRIV 20210423

(05) uptake 20210417: DELP 20210417, IHME 20210416, ***IMPE 20210417***, LANL 20210414, SRIV 20210417
(04) uptake 20210416: DELP 20210416, ***IHME 20210416***, IMPE 20210406, LANL 20210414, SRIV 20210416
(03) uptake 20210409: DELP 20210409, ***IHME 20210409***, IMPE 20210406, LANL 20210407, SRIV 20210409
(02) uptake 20210406: DELP 20210406, IHME 20210401, ***IMPE 20210406***, LANL 20210404, SRIV 20210406
(01) uptake 20210401: DELP 20210401, ***IHME 20210401***, IMPE 20210329, LANL 20210331, SRIV 20210401

Graphs of epidemic trajectory at the global level till January 2022

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

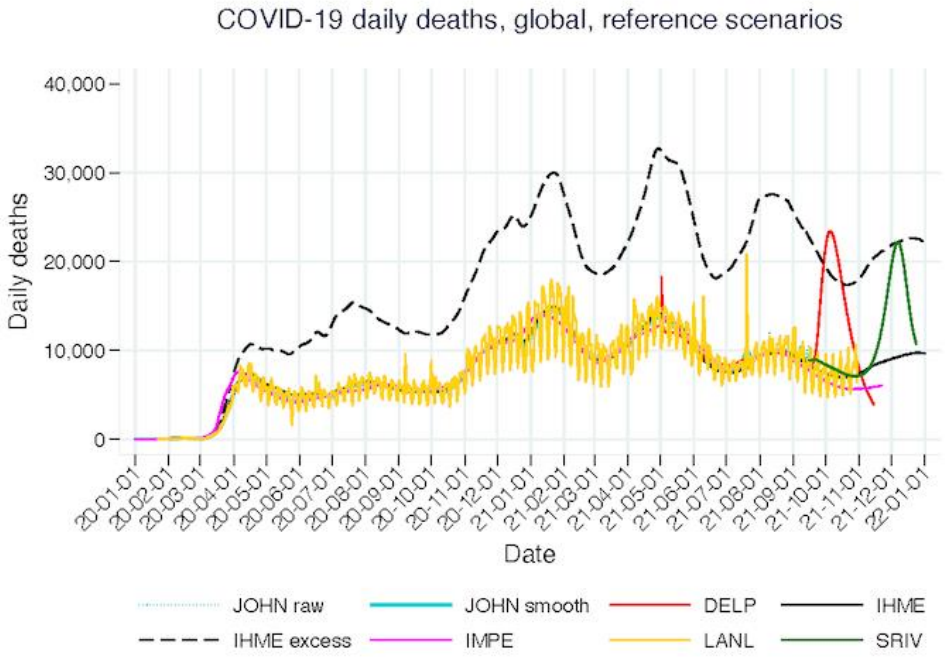
(9) Daily deaths estimated to reported, reference scenarios, 2021

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

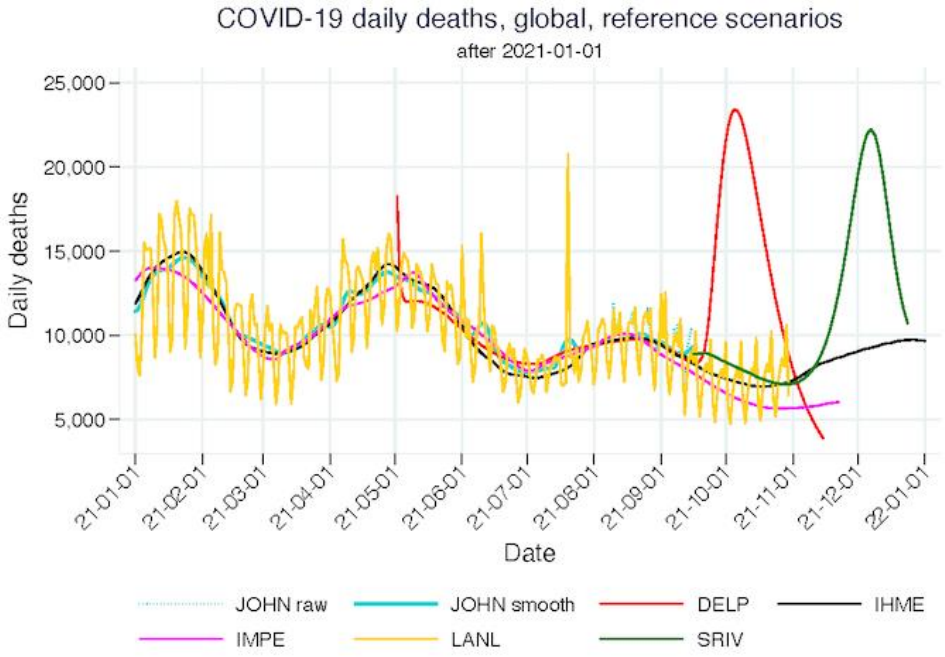
The last two variables demonstrate a rapid graphical assay of retrospective longitudinal predictive performance of the models.

Previous uptakes for the global level can be examined for a graphical assay of models' predictive performance across consecutive updates of models' estimates. Previous uptakes can be seen as linked here: RESULTS, PREVIOUS UPTAKES

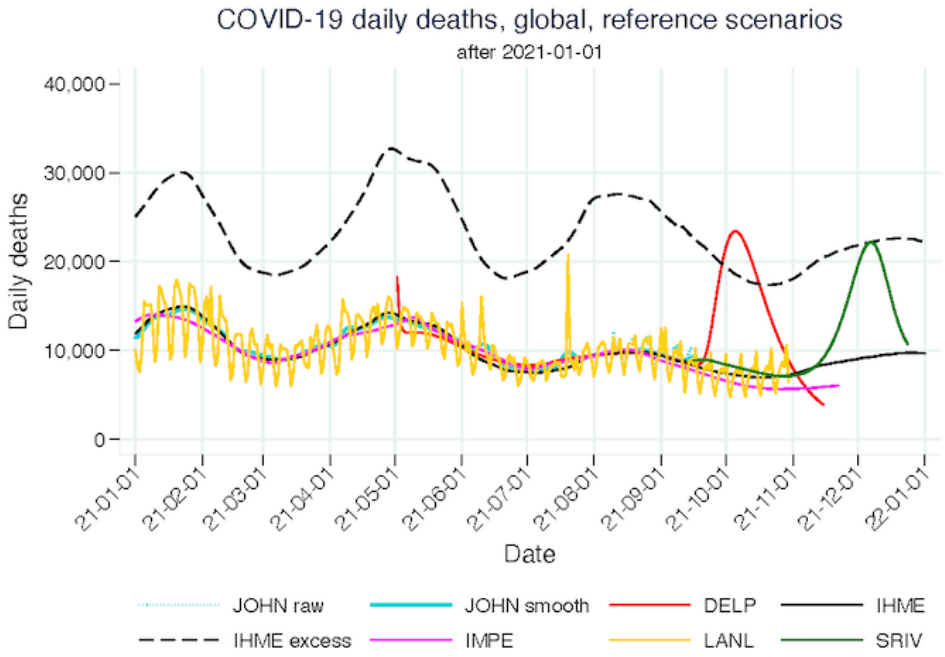
(1) Daily deaths, reference scenarios, all time



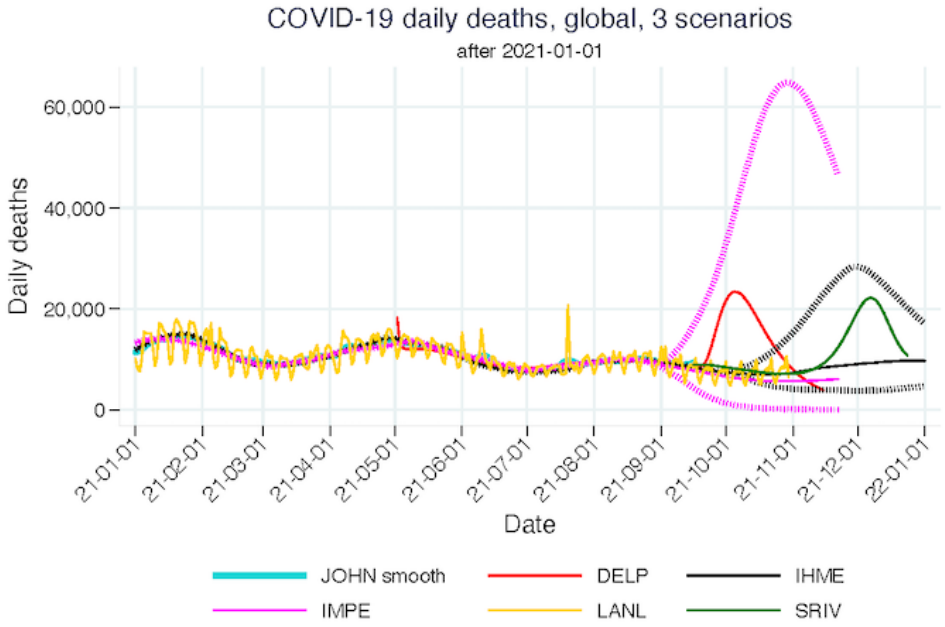
(2) Daily deaths, reference scenarios, 2021



(2b) Daily deaths, reference scenarios, 2021, with IHME excess deaths

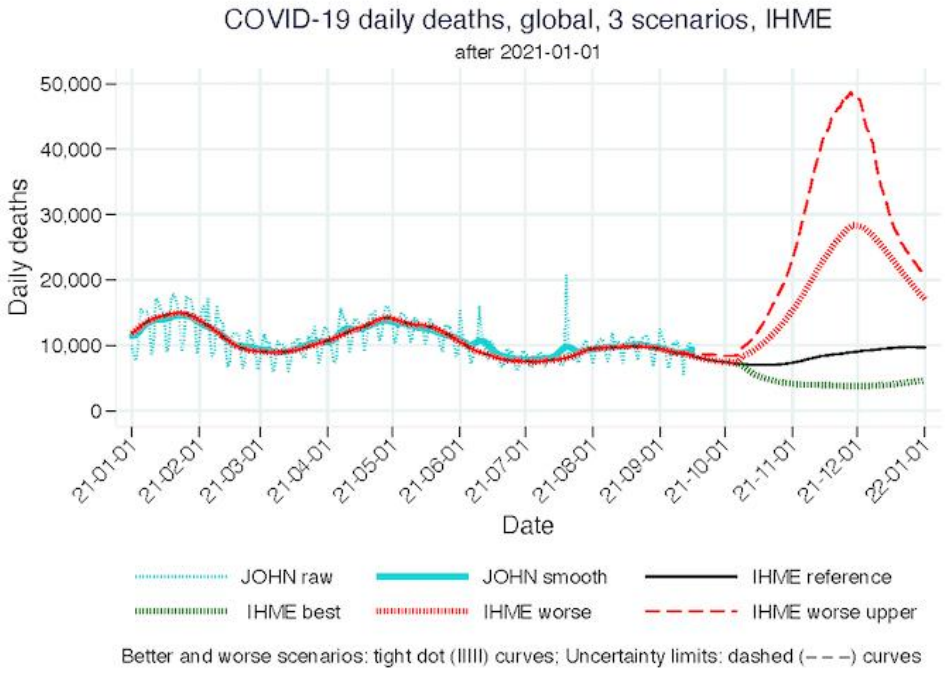


(3) Daily deaths, 3 scenarios, 2021

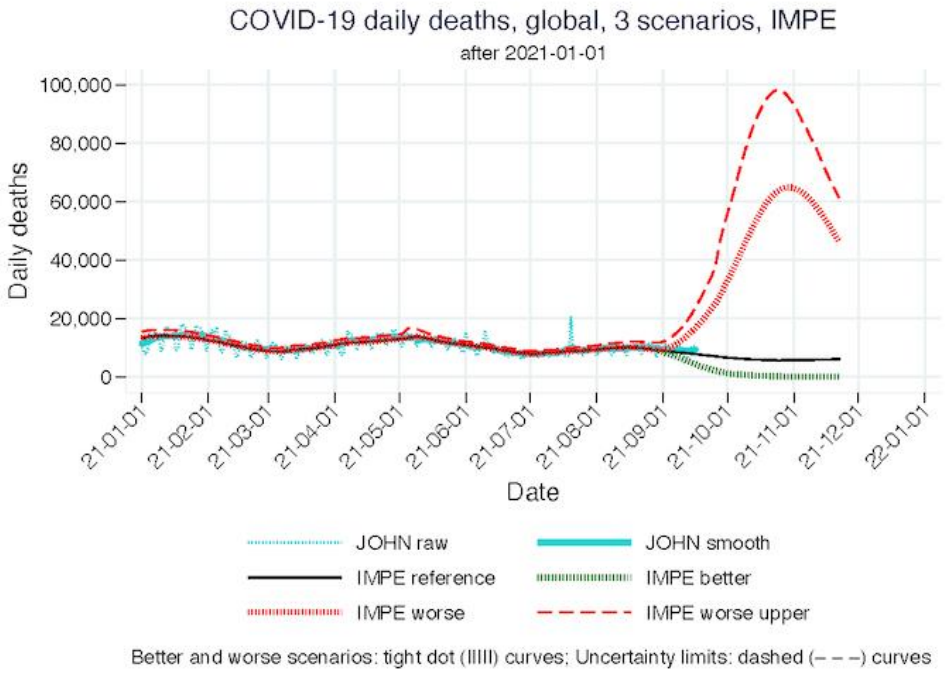


Better and worse scenarios: tight dot (IIIII) curves; IHME and IMPE

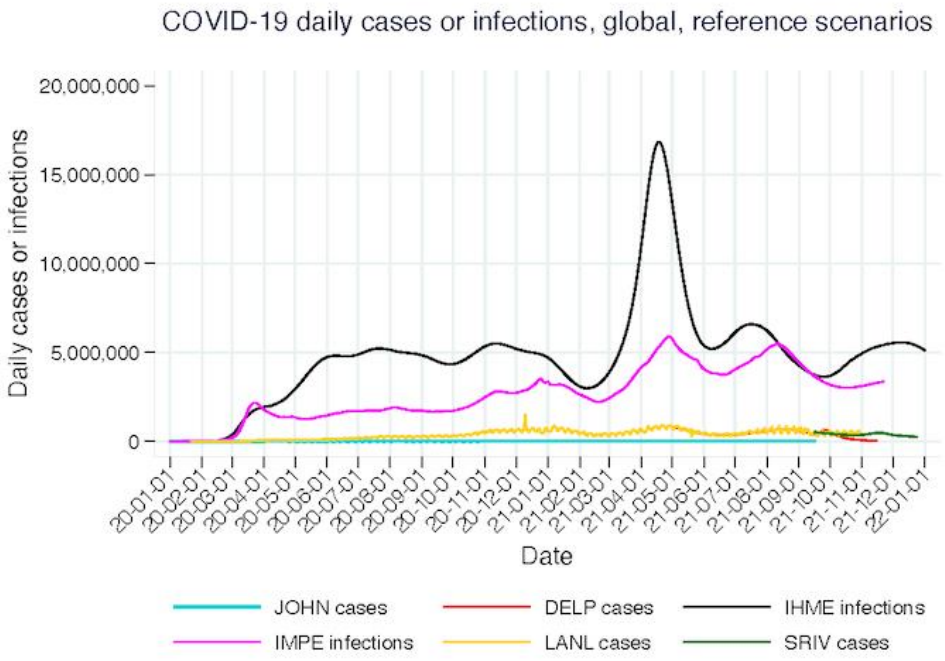
(3b) Daily deaths, 3 scenarios, 2021, IHME



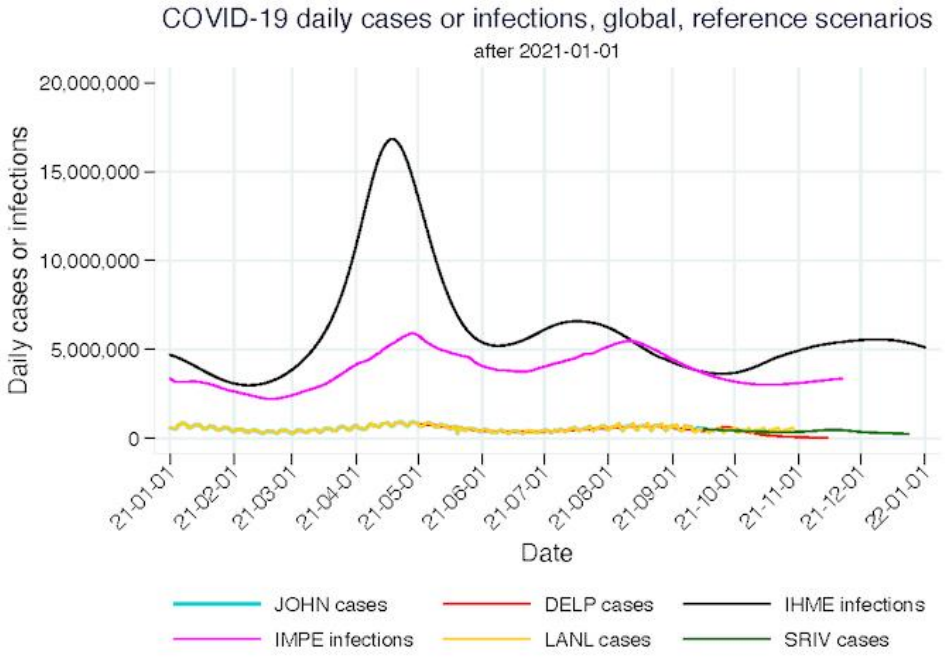
(3c) Daily deaths, 3 scenarios, 2021, IMPE



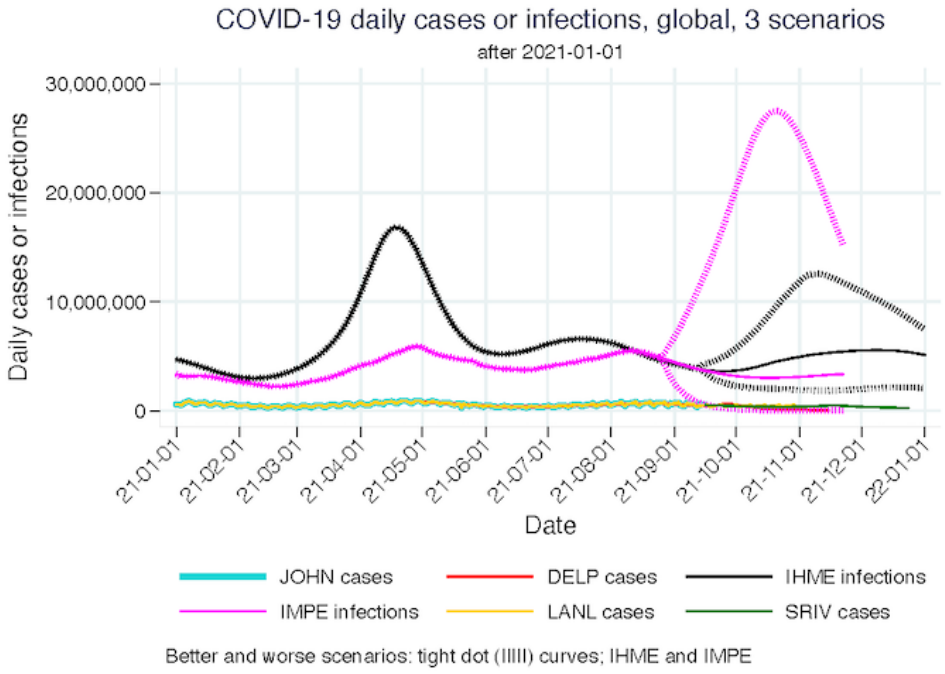
(4) Daily cases or infections, reference scenarios, all time



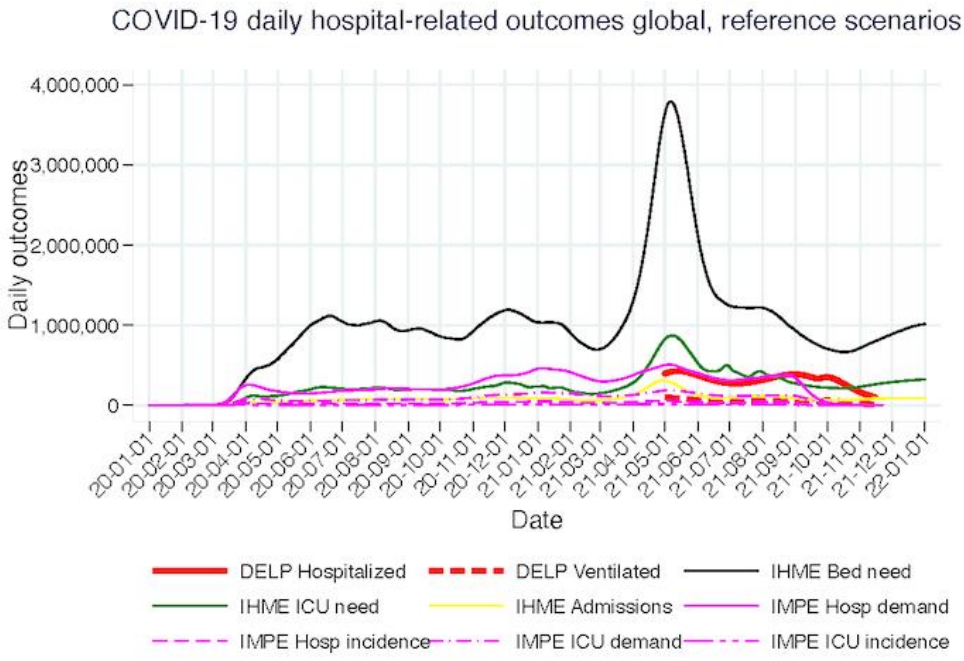
(5) Daily cases or infections, reference scenarios, 2021



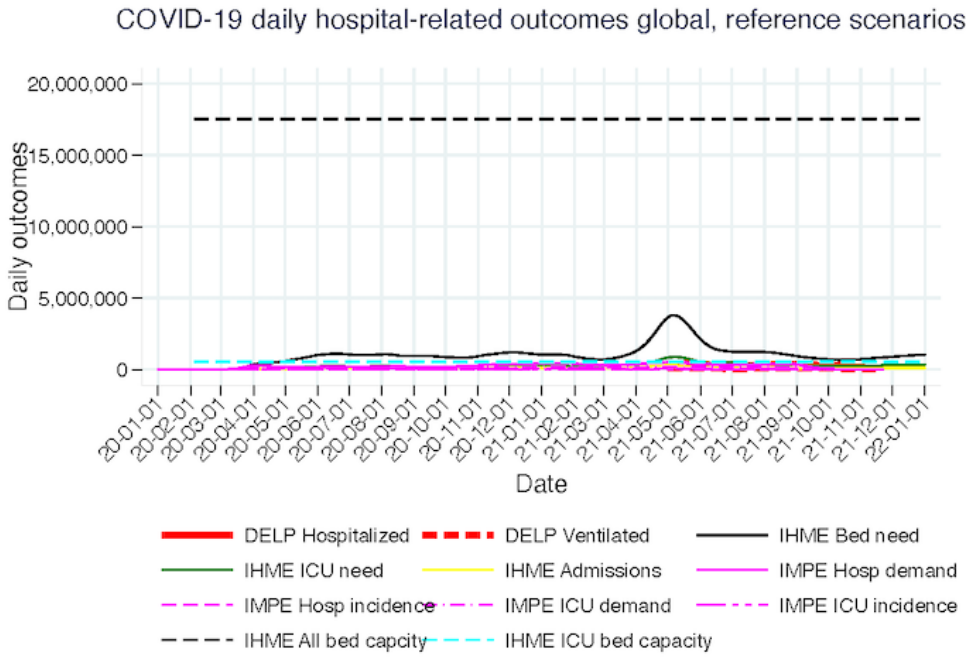
(6) Daily cases or infections, 3 scenarios, 2021



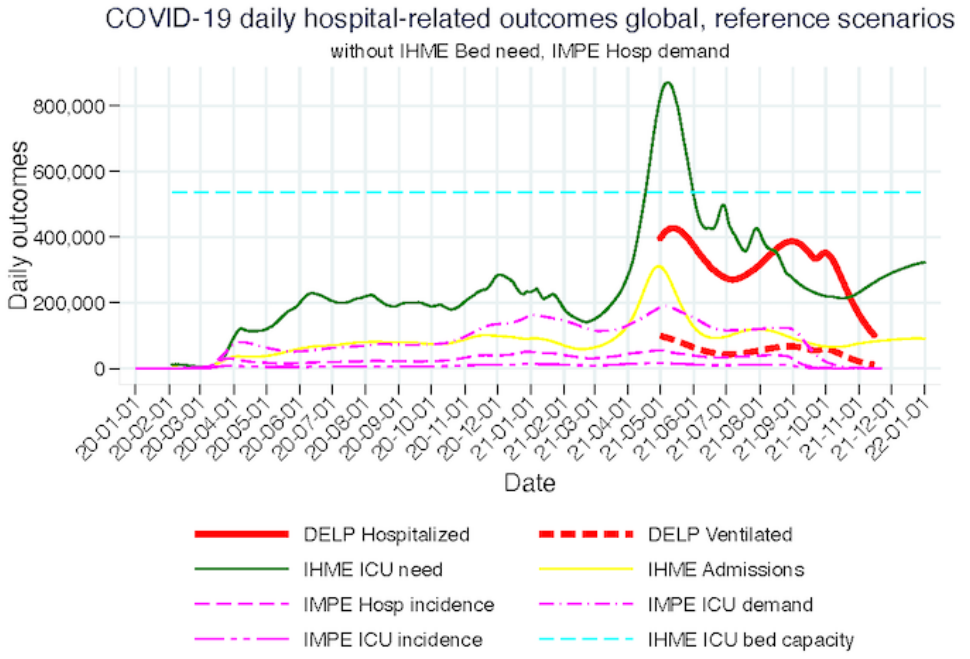
(7) Hospital-related outcomes, all time



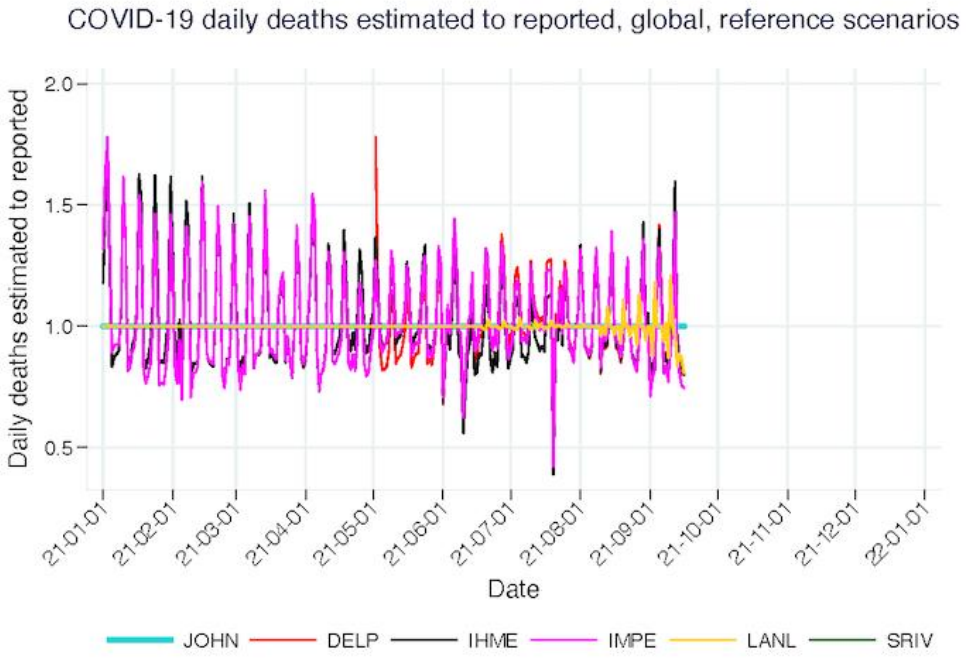
(7b) Hospital-related outcomes, all time, with IHME All bed capacity and ICU bed capacity



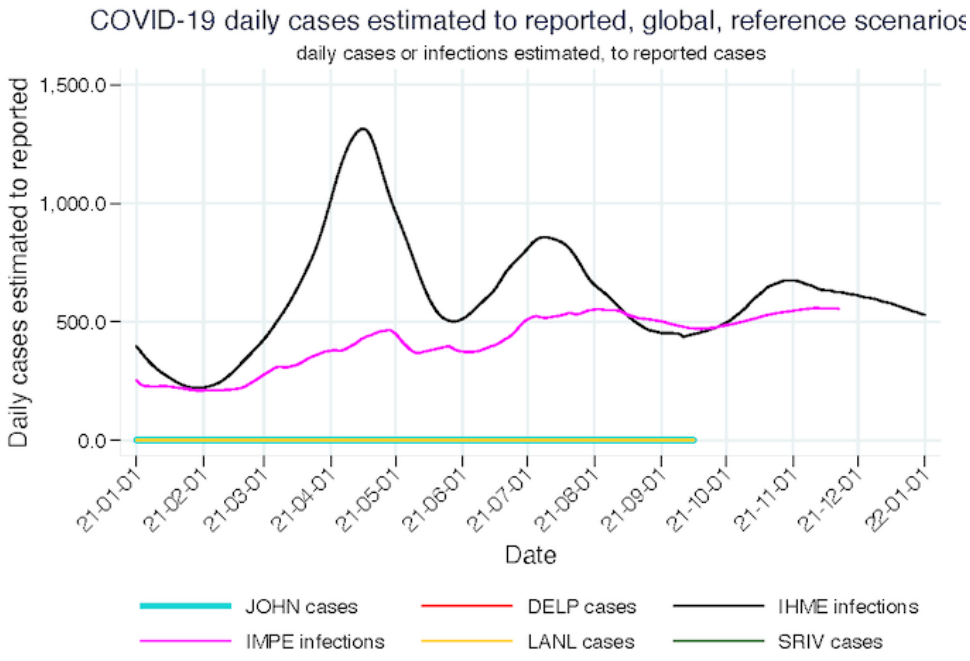
(8) Hospital-related outcomes, 2021, without IHME Bed need and IMPE Hospital demand



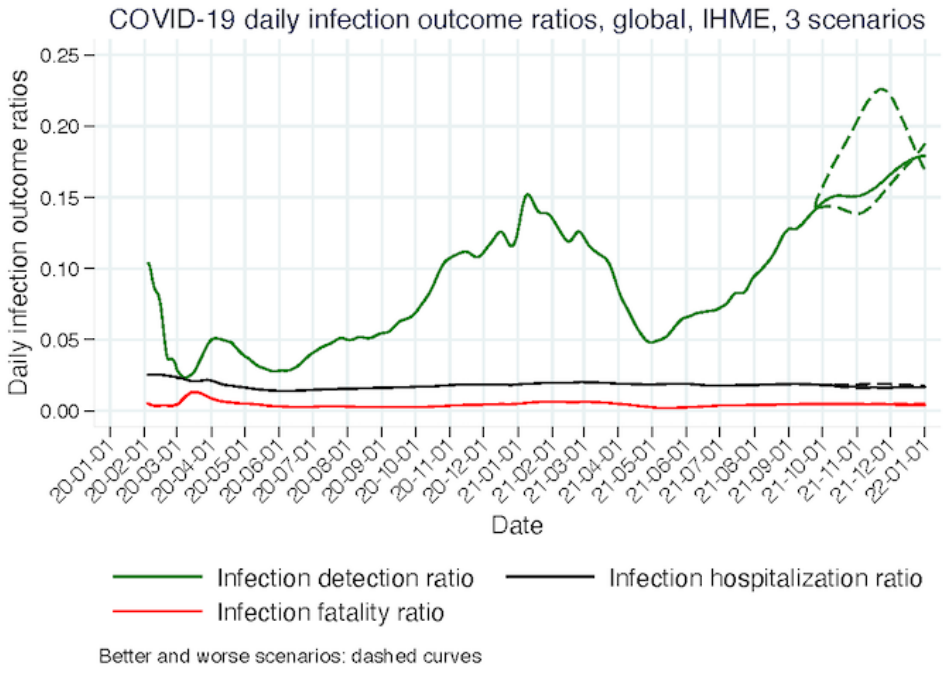
(9) [Daily deaths estimated to reported, reference scenarios, 2021]



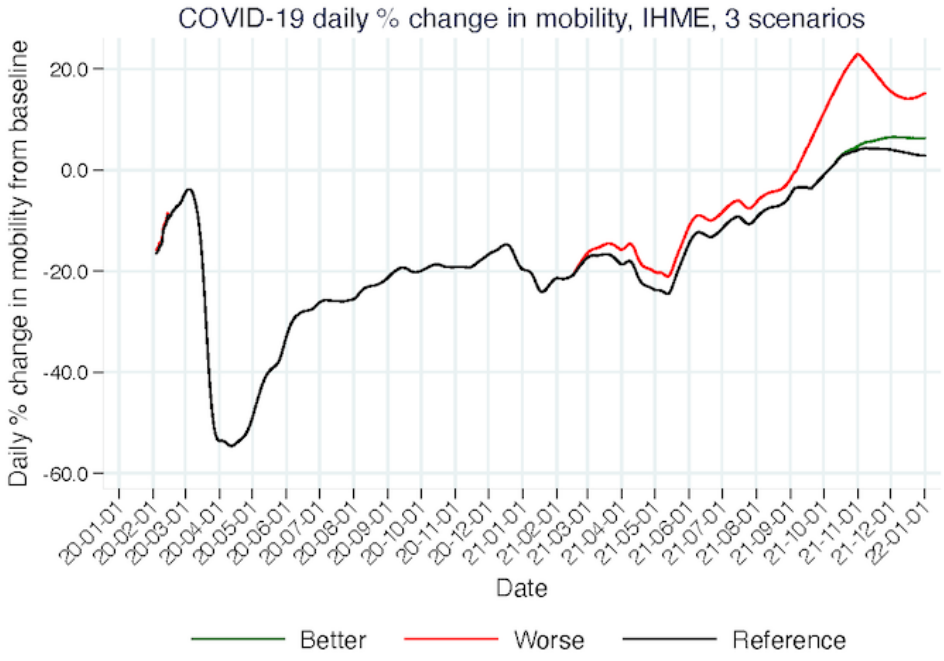
(10) [Daily cases or infections estimated to reported cases, reference scenarios, 2021]



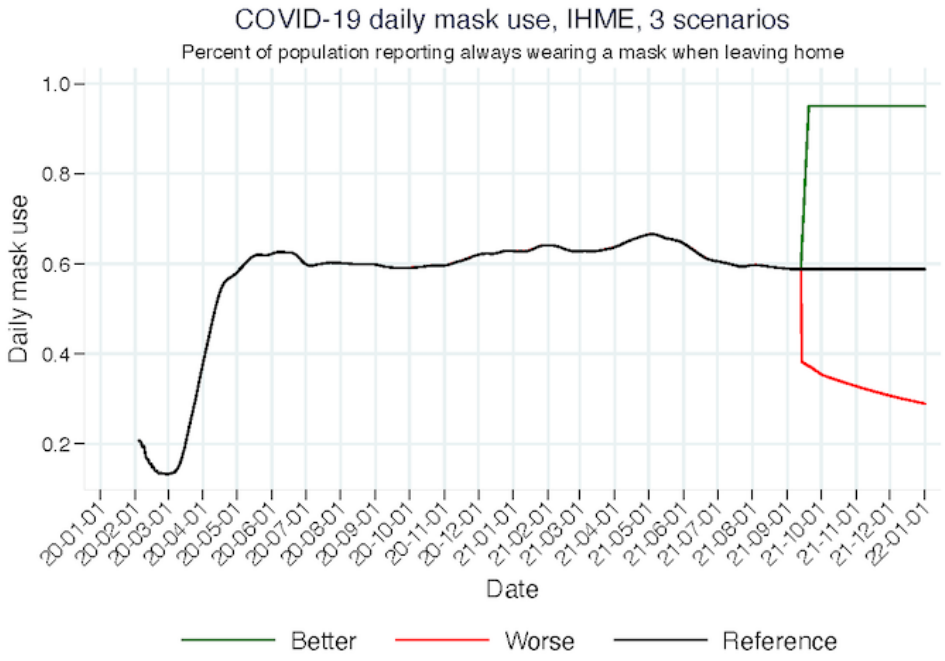
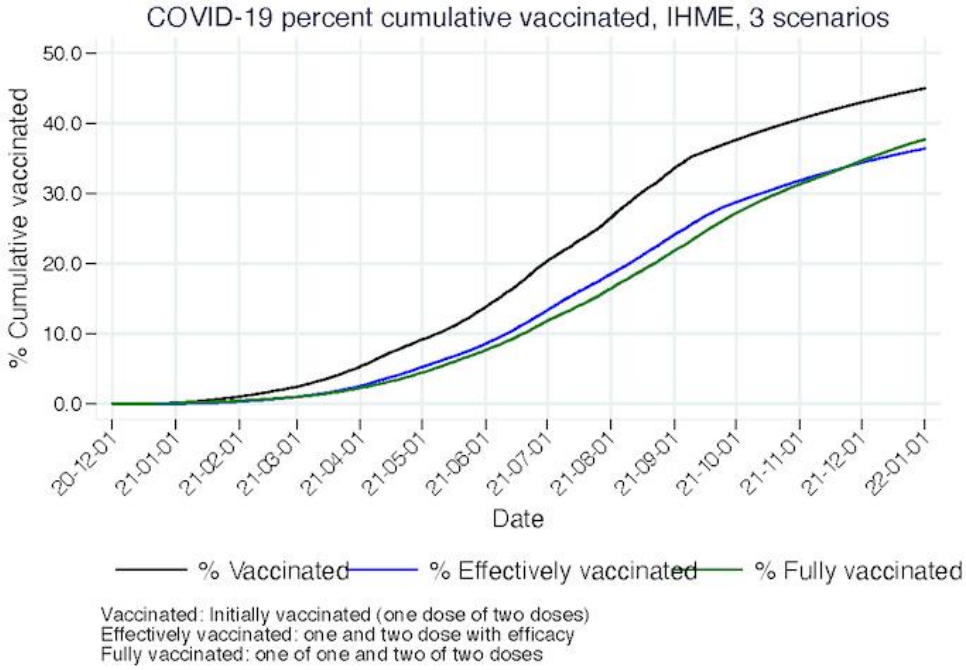
(11) [Daily Infection outcomes ratios, global 3 scenarios, all time, IHME]



(12) [Daily mobility, global, 3 scenarios, all time, IHME]



(13) Daily mask_use, global, 3 scenarios, IHME



(14) Percent cumulative vaccinated, IHME