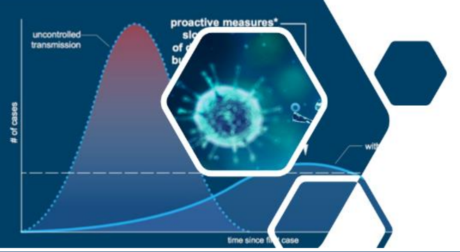


EVIDENCE ON MODELLING FOR COVID-19

N.7: September 22, 2020

The evidence profiled below was selected from credible academic and grey literature sources and based on potential applicability to the Ontario Modelling Consensus Table.

COMPARATIVE MODELLING

Projected effects of non-pharmaceutical public health interventions to prevent resurgence of SARS-CoV-2 transmission in Canada. *CMAJ. Sep 14, 2020.*

This study estimated the projected impact of non-pharmaceutical interventions on SARS-CoV-2 transmission in Canada from May 11, 2020 to January 7, 2022. The authors developed an age-structured agent-based model of the Canadian population. They looked at four interventions (i.e., case detection and isolation, contact tracing and quarantine, physical distancing, and community closures) individually and together. The results suggested that without any interventions, 64.6% of Canadians will be infected with SARS-CoV-2 (i.e., total attack rate) and 3.6% of the infected and symptomatic will die. If case detection and contact tracing are implemented without physical distancing and community closures, the total attack rate will decrease to 56.1%. The total attack rate would drop to 0.4% with enhanced case detection and contact tracing (i.e., case detection and isolation of 50% of all cases and contact tracing to capture and quarantine all contacts of these cases). Enhanced case detection and contact tracing with physical distancing reduced the total attack rate to 0.2%. This was the only scenario that kept hospital and ICU bed use within capacity. The authors found minimal impact with school closures, but closures of workplaces and mixed-age venues markedly reduced attack rates. The authors maintain that enhanced community and individual-level interventions are needed to control SARS-CoV-2 in Canada. *Read.*

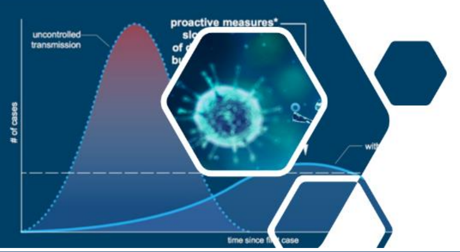
COVID-19 transmission dynamics and effectiveness of public health interventions in New York City during the 2020 spring pandemic wave. *medRxiv*. *Sep 9, 2020.*

This preprint study used a model-inference system to re-construct the underlying transmission dynamics of SARS-COV-2 in New York City from March 1 to June 6, 2020. The system assimilates three sources of data: 1) confirmed COVID-19 case data, 2) COVID-19 associated death data, and 3) neighbourhood-level mobility data. The authors used this system to estimate overall infection rate, key transmission characteristics (i.e., reproduction number), and effectiveness of public health interventions such as social distancing and face covering. The authors estimated that the overall effective reproduction number was 2.99 at the beginning of the pandemic wave and was reduced to 0.93 one week after the stay-at-home mandate. Interventions reducing contact rates (e.g., school closures and stay-at-home mandates) were associated with a 70.7% reduction of transmission overall and greater than 50% for all age groups during the pandemic. Face covering was associated with a 6.6% reduction of transmission overall and up to 20% for 65+ year old individuals during the first month of implementation. The study found that universal masking could reduce transmission by 28-32% when lockdown-measures are lifted. All estimates were verified by comparing estimated projections from models and independent observations. *Read.*

Modelling the impact of reducing control measures on the COVID-19 pandemic in a low transmission setting. *The Medical Journal of Australia. Sep 2, 2020.*
This preprint study reported an agent-based model, Covasim, which was used to simulate network-based transmission risks of COVID-19 in households, schools, workplaces, and a variety of community spaces (e.g., public transport, parks, bars, cafes/restaurants) and activities (e.g., community or professional sports, large events). The model was calibrated to the COVID-19 epidemiological and policy environment in Victoria, Australia, between March and May 2020, at a time when there was low community transmission. From May 2020, policy changes to ease restrictions were simulated (e.g., opening/closing businesses) in the context of interventions that included testing, contact tracing (including via a smartphone app), and quarantine. The results suggested that policy changes leading to the gathering of large, unstructured groups with unknown individuals (e.g., bars opening, increased public transport use) posed the greatest risk of epidemic rebound, while policy changes leading to smaller, structured gatherings with known individuals (e.g., small social gatherings) posed least risk of epidemic rebound. In the model, epidemic rebound following some policy changes took more than two months to occur. Model outcomes support continuation of working from home policies to reduce public transport use, and risk mitigation strategies in the context of social venues opening. The authors suggested that care should be taken to avoid lifting sequential COVID-19 policy restrictions within short time periods, as it could take more than two months to detect the consequences of any changes. *Read*.

MODELLING UNKNOWN PARAMETERS

Estimating unobserved SARS-CoV-2 infections in the United States (US). *Proceedings of the National Academy of Sciences of the United States of America. Sep 8,2020.*
Using a stochastic transmission model, this study estimated the number of unobserved infections in the US during early 2020. The study is based on data that are commonly available shortly after the emergence of a new infectious disease (i.e., number of imported cases and deaths from line list data compiled by the Models of Infectious Disease Agent Spread (MIDAS) Network). The logic of the approach is that there are bounds on the amount of exponential growth of new infections that can occur during the first few weeks after imported cases start appearing. Applying that logic to data on imported cases and local deaths in the US through March 12, 2020, the study estimated that 108,689 (95% posterior predictive interval [95% PPI]: 1,023 to 14,182,310) infections occurred in the US by this date. By comparing the model's predictions of symptomatic infections with local cases reported over time, the study obtained daily estimates of the proportion of symptomatic infections detected by surveillance. The results mean that many more thousands of people were infected than were reported as cases by the time a national emergency was declared and that fewer than 10% of locally acquired, symptomatic infections in the US may have been detected over a period of a month. The results also suggested that detection of symptomatic infections decreased throughout February as exponential growth of infections outpaced increases in testing. Between February 24 and March 12, the study estimated an increase in detection of symptomatic infections, which was strongly correlated with increases in testing (Pearson's correlation, median: 0.98; 95% PPI: 0.66 to 0.98).



These results suggested that testing was a major limiting factor in assessing the extent of SARS-CoV-2 transmission during its initial invasion of the US. [Read](#).

MODELLING TECHNIQUES

On the reliability of predictions on COVID-19 dynamics: a systematic and critical review of modelling techniques. *medRxiv. Sep 11, 2020.*
This preprint study conducted a global systematic literature review to summarize trends in the modelling techniques used for Covid-19 from January 12020 to June 30, 2020. The reliability and correctness of predictions were further examined by comparing predicted and observed values for cumulative cases and deaths. From an initial 2,170 peer-reviewed articles and preprints the study found with defined keywords, 148 articles were fully analyzed. The review found that most studies on the modelling of COVID-19 were from Asia (52.70%) and Europe (25%). Most of them used compartmental models (i.e., SIR and SEIR) (57%) and statistical models (i.e., growth models and time series) (28%) while few used artificial intelligence (5%) and/or a Bayesian approach (3%). For cumulative cases, the ratio predicted/observed values and the ratio of the amplitude of confidence interval (CI) or credibility interval (CrI) of predictions and the central value were on average larger than 1 (4.49-9.98 and 1.10-1.94, respectively) indicating cases of incorrect predictions, large uncertainty on predictions, and large variation across studies. There was no clear difference among models used for these two ratios. However, the ratio predicted/observed values was relatively smaller for SIR models than for SEIR models, indicating that more complex models might not be more accurate for predictions. Furthermore, the values of both ratios decreased with the number of days covered by studies, indicating that the wider the time covered by the data, the higher the correctness and accuracy of predictions. In 21.62% of studies, observed values fall within the CI or CrI of the cumulative cases predicted by studies. Only six of the 148 selected studies (4.05%) predicted the number of deaths. For 33.3% of these predictions, the ratio of predicted to actual number of deaths was close to 1. The review also found that the Bayesian model made predictions closer to reality than the compartmental and the statistical models, although these differences are only suggestive due to the small size of the dataset. The findings suggest that while predictions made by the different models are useful to understand the pandemic course and guide policy-making, they should be used with cautions. [Read](#).

A global-scale ecological niche model to predict SARS-CoV-2 coronavirus infection rate. *Ecological Modelling. Sep 1, 2020.*
In this paper, infection rate of COVID-19 is modelled globally at a 0.5° resolution, using a Maximum Entropy-based Ecological Niche Model that identifies geographical areas potentially subject to a high infection rate. The model identifies locations that could favour infection rate due to their particular geophysical (i.e., surface air temperature, precipitation, and elevation) and human-related characteristics (i.e., CO^2 and population density). The model was trained by facilitating data from Italian provinces that have reported a high infection rate and subsequently tested using datasets from countries' reports. Based on this model, a risk index was calculated to identify the potential countries and regions that have a high

risk of disease increment. The distribution outputs foresee a high infection rate in many locations where real-world disease outbreaks have occurred (e.g., the Hubei province in China) and reports a high risk of disease increment in most countries that have reported significant outbreaks (e.g., Western US). Overall, the results of this study suggest that a complex combination of the selected parameters might be of integral importance to understanding the spread of COVID-19 among human populations, particularly in Europe. As a future extension, the model will be enhanced by increasing the projection resolution to 0.1◦ on specific areas to produce regional-scale distributions. The corresponding cloud computing service will be used to: 1) explore a more extensive set of parameters taken from open-access repositories, 2) understand the importance of climatic factors with respect to human-related factors in COVID-19 infection rate, and 3) detect seasonal trends. *Read*.