Executive summary

Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) is spreading across the world at a rapid rate. There is no consensus model to predict the spread of SARS-CoV-2, either globally or locally. Furthermore, there are no pharmaceutical interventions currently available to prevent or treat Covid-19, the variably severe clinical syndrome that is caused by the virus. Countries choosing to mitigate or suppress viral spread must rely on non-pharmaceutical interventions (NPIs), which fall into various categories of behaviour change, such as self-isolation for symptomatic individuals, increased personal protection habits, physical distancing in social settings, working from home where possible, and school closures. All countries, regardless of NPI implementation status, may benefit from mathematical modelling of viral spread and resultant clinical disease in light of national health care treatment capacity.

The Covid-19 International Modelling Consortium (CoMo Consortium) comprises several working groups. Each working group plays a specific role in formulating a mathematical modelling response to help guide policymaking responses to the Covid-19 pandemic. These responses can be tailored to the specific Covid-19 context at a national or sub-national level.

The working groups and their roles are as follows:

- **Policy support.** Facilitating a direct link between the experts involved in developing the models and interpreting their outputs, the local in-country experts, and the policymakers in each country.
- **Model development.** Writing, coding, debugging and updating the primary model structure.
- **Interface development.** Creation of a web-based interface that enables non-modellers to run the models, based on their local parameters.
- **Economic modelling.** Conducting modelling to assess the economic costs and impacts arising from an intervention or a suite of interventions.
- **Evidence synthesis.** Combining scientific evidence relating to the Covid-19 pandemic with model projections, economics and financing to create evidence-based policy briefs.
- **Outreach and communications.** Engaging both in-country experts and policymakers who are seeking additional modelling support to deal with their specific Covid-19 situation.
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New members

We welcome groups or individuals who require or are working on policy-facing modelling to support regional, national or sub-national public health responses to the Covid-19 pandemic. Also, we are seeking volunteers to assist in the following areas:

- **Project coordination.** Assistance required with coordinating the CoMo Consortium’s work at the international, national and sub-national levels.
- **Updating parameter estimates.** The parameter estimates must be updated frequently, otherwise there is a risk of using obsolete or out of date information.
- **Testing the model.** The model must be continually tested against historical case studies and other known scenarios. The model must also be compared with other models. It is essential that the model’s performance is regularly checked. This is increasingly important as the model becomes used more and more widely.

Background

The Covid-19 pandemic continues to infect large numbers of people across the world at an alarming rate. As of 26 April 2020, the pandemic has affected at least 185 countries/regions, with more than 2.9 million confirmed cases and in excess of 200,000 deaths globally [1]. The pandemic presents myriad challenges for health care systems around the world, including pressures on health care staff, general hospital beds, intensive care beds and intensive care units, equipment (particularly ventilators), and carers involved in specialist care or treatment for comorbidities.

There is currently no treatment or vaccine available for Covid-19, although enormous efforts are underway to develop both, with at least 70 vaccines in development, three of which are undergoing clinical trials [2]. Human clinical testing of the first Covid-19 vaccine candidate was initiated with unprecedented speed on 16 March 2020 [3]; the trial of one potential vaccine have also begun at the University of Oxford [4]. Passive immunization using direct administration of monoclonal antibodies may be another promising avenue of investigation [5]. Therapeutic options under consideration include molecules that bind to the virus itself or inhibitors that target enzymes involved in viral replication [5]. Currently, therefore, countries that aim to interrupt viral transmission must rely on non-pharmaceutical interventions (NPIs) to slow the spread of Covid-19. These NPIs involve a hierarchy of measures, ranging from those that involve minor inconvenience but are of limited effectiveness, to measures that incur major inconvenience but possess a greater degree of effectiveness. This hierarchy includes handwashing; facial coverings; self-isolation by individuals who suspect they have Covid-19; case detection and self-isolation of people who have tested positive for Covid-19; contact tracing; cocooning of individuals in high-risk groups; physical distancing (also referred to as social distancing)
e.g. maintaining a distance of at least two metres between individuals in social settings; school closures; travel bans; and ‘lockdowns’ of entire cities or countries.

Different countries have adopted a variety of strategies to meet the challenge posed by Covid-19. The first efforts to tackle Covid-19 in a number of countries were directed towards epidemic suppression, where the objective is to prevent invasion of the disease, stunt any community transmission, and maintain a disease-free status. However, once onward transmission has taken off within a country (i.e. new, locally acquired cases with untraceable contacts), many models have predicted that a large epidemic is inevitable. In such cases, countries may choose to deploy mitigation strategies involving some or all of the NPIs outlined above. These NPIs are intended to reduce viral transmission sufficiently to delay the timing of the peak number of Covid-19 cases and reduce the height of the epidemic curve, thus reducing the daily demand on local and national resources for hospital care, vital equipment such as ventilators, and health care staff.

Here, we outline the development and composition of an international consortium comprising mathematical modellers, software developers, health economists, public health experts and policymakers. The Covid-19 Modelling (CoMo) Consortium consists of a number of working groups, all of whom are working together to facilitate direct links between the experts involved in developing the models and interpreting their outputs, local in-country experts, and policymakers in each country. We have developed transparent model structures and a web-based application [6] to investigate the various NPIs and their relative impacts on the spread of Covid-19. By changing the input data and parameter values, the models can be adjusted to represent a given national or subnational context. Full details about the CoMo Consortium, the CoMo model, and its associated web interface are provided in this report.

**Participating countries**

**Afghanistan**

In early March 2020, a group of Afghan epidemiologists approached Weill Cornell Medicine (Cornell University) and Oxford University for support with modelling Covid-19 in Afghanistan. Cornell initially provided support in estimating cases and deaths using the Cornell COVID Caseload Calculator with Capacity and Ventilators (C5V) [7]. Since then, colleagues from Afghanistan, including from the Ministry of Public Health (MoPH) and from the World Health Organization (WHO) country and regional offices have been collaborating with the CoMo Consortium to model various Covid-19 scenarios in Afghanistan.

The questions we will seek to answer include:
• What will be the likely numbers of cases and deaths?
• For resource allocation purposes, how many ICUs, beds and ventilators will be needed?
• How long should we continue non-pharmaceutical interventions, such as handwashing, social distancing, school closures, working from home, and home quarantine, to understand their effectiveness for flattening the curve of Covid-19 cases and deaths? (This is extremely important for Afghanistan because 42% of the population is living below the poverty line and these interventions could have huge economic impacts.)

Brazil

The Observatório Covid-19 BR [8] is an independent initiative. It is the result of a collaboration between researchers who are aiming to contribute to the dissemination of reliable information that is based on detailed data and scientifically grounded analysis. We created a website using open-source code; this allows us to monitor the current state of the Covid-19 epidemic in Brazil, perform statistical analyses, and make careful predictions. We have several groups working in parallel on data collection, statistical modelling, mathematical modelling and nowcasting. In particular, we have been working on adapting the CoMo Consortium model specifically for the Brazilian environment and current data availability.

Cameroon

Our team includes Akindeh Nji, Dr Sheetal Silal, Prof Mbacham, Prof Mbanya, Prof Sobngwi, Prof Ongolo, Prof Nwaga, Prof Penlap, Prof Boudjeko and Prof Bigoga.

The questions we will seek to answer are:
• How many cases are we likely to have in a given period of time?
• When will we see the peak of the epidemic in Cameroon?
• When would our health system become overwhelmed?
• What are the comparative benefits of combinations of different non-pharmaceutical interventions?
• When can we relax some of the non-pharmaceutical interventions that are in place, such as social distancing, school closures, and border closures?

Principally, we intend to use the CoMo Consortium model to answer the questions outlined above. We would also like to take advantage of economic modelling to inform policy based on the costs and benefits of the different measures that have been put in place in our country. To do this, we intend to adapt the current CoMo Consortium model to the Cameroonian situation. We also envisage adapting the CoMo Consortium model code to answer other questions that might arise via feedback from policymakers and the Covid-19 task force.
Haiti

Nathaniel Hupert has assisted Dr Jean Pape and Dr Daniel Fitzgerald in making estimates for both baseline and non-pharmaceutical intervention scenarios at the national level for Haiti.

Indonesia

North Sumatera Province

The North Sumatera Covid-19 research group is led by Dr Inke Lubis; other members include Dr Ivana Alona from Universitas Sumatera Utara and Dr Alwi Hasibuan from the North Sumatera Provincial Health Office. Our team has been using the CoMo Consortium model to predict numbers of cases and deaths using the currently implemented interventions (self-isolation, school closures, working from home, handwashing and social distancing). We also have been exploring other combined interventions, including lockdown, that might be appropriate for the North Sumatran context. North Sumatera has a population of 14,703,400, of whom 66.1% have Islam as a religion. Therefore, with the holy Ramadhan month starting by the end of April, interventions such as social distancing and self-isolation will be disrupted.

We would therefore like to answer the following questions:

• What will be the size of the expected epidemic using the current interventions?
• What are the best interventions to be applied in the setting of North Sumatera during the month of Ramadhan?
• What are the best alternative intervention options (other than lockdown) to reduce deaths in a community with a high level of poverty?
• What is the number of tests needed to ensure adequate numbers of self-isolation in order to limit transmission?
• What is the most cost-effective strategy?
• What are the numbers of health care workers, hospital beds and critical care management teams needed during the epidemic?
• How long should the interventions (school closures, social distancing, working from home) be put in place?
• When should we expect the second wave of cases to arise once the interventions have been ended?
• What will be the economic impacts of the various intervention strategies?

Iran

Our team includes six technical staff: Hamid Sharifi, Professor in Epidemiology, Yunes Jahani, Associate Professor in Biostatistics, Ali Mirzazadeh, Assistant Professor in Epidemiology (based at UCSF), Sana Eybpoosh, Assistant Professor in Epidemiology, Mehran Nakhai, a PhD student studying Biostatistics,
and Milad Ahmadi Gohari, MSc in Biostatistics. The group works under the supervision of Dr Ali Akbar Haghdoost, from the Iranian Ministry of Health (MOH), who is the MOH Deputy Head of Education and the Head of the Covid-19 Epidemiology Group. Our work with the CoMo Consortium would allow us to compare (or cross-validate) our model outputs with the CoMo model results.

Our specific questions are:

- What combinations of interventions (shelter in-place, self-quarantine, etc.) and timings would be most effective?
- Which different intervention combinations would be most feasible for the country, and what would their impact be on the epidemic?
- Do we need to consider sub-national strategies and, if so, what should they be?
- What are the best ways to relax prevention restrictions (e.g. staggered back-to-work schedules)?
- How many resources (e.g. beds, ICU beds, ventilators, temporary isolation units) would be needed, particularly at the peak of the epidemic?
- What is the cost-effectiveness of different combinations of interventions?

We also have two technical advisors from WHO, Dr Christoph Hamelmann and Shadrokh Sirous, who provide technical support and share expertise and relevant data from both the Regional Office and also the Headquarters. They also participate in strategic discussions guiding the national Covid-19 campaign, based on the models’ outputs.

**Kyrgyzstan**

Our group includes Ainura Moldokmatova, Aizhan Dooronbekova, Chynar Jumalieva, Aibek Mukambetov, Shamil Ibragimov, and Aisuluu Kubatova. The group is working on modelling the projected course of Covid-19 epidemic scenarios in Kyrgyzstan. This work is being carried out in close collaboration with the Ministry of Health of the Kyrgyz Republic, the Department of Disease Prevention and Surveillance under the Ministry of Health, the Scientific Production Association ‘Preventive Medicine’, Soros Foundation in the Kyrgyz Republic, and the Public Fund ‘Institution of Social Development’.

We are planning to use the Covid-19 mathematical model framework and its associated user-friendly application, which was developed by the Oxford Modelling Group for Global Health (OMGH) and is owned by the CoMo Consortium, to answer the following policy questions:

- What would the scale of the Covid-19 epidemic be without implementation of the current lockdown?
- When can we relax the lockdown?
• Which other non-pharmaceutical interventions and in what combination(s) would have a greater effect on improving the course of the epidemic?
• Which intervention or combination of interventions would be most cost-effective?

Lao PDR

The Lao PDR Covid-19 national modelling team is led by Professor Mayfong Mayxay, the Vice-President of the University of Health Sciences under the Ministry of Health (MoH). Our group members include Phetsavanh Chanthavilay, Yu Nandar Aung and Sai Thein Than Tun. The modelling aims to provide scientific evidence to assist policymakers in anticipating the possible pattern of the epidemic and designing a mix of interventions tailored to the country’s needs and situation. The modelling is intended to answer questions that might be relevant to Laos’ context, as follows:

• What is the probability of a Covid-19 epidemic and its potential size in Laos with or without the current interventions? What are the possible factors that may make the epidemic worse and how can we avoid them?
• How can the current interventions be customized and what will be their effect on the epidemic?
• How long should the country’s lockdown continue if the current interventions are effective?
• What about the use of medical resources? How can the model outputs be used to determine the need for medical equipment, including PPE such as face masks, testing, etc?
• What will be the national and health economic impact of the current outbreak and any potential interventions?

Phetsavanh and Yu will validate the source data needed for the model and will use the latest data as they become available. Phetsavanh and Sai will perform any further customization of the model as per the country’s context and needs. Prof. Mayfong will reach out to the MoH to schedule the briefings about the model and its application. The entire team will regularly test and review the model parameters, outputs and any necessary improvements to suit the country’s context and needs. The team holds a regular meeting every Thursday. The CoMo Consortium model will be used for comparison, adapting the shared model code, and using the shared model through the interface. The team will also collaborate with local partners to continually improve the model.

Myanmar

The Myanmar national modelling team using the CoMo Consortium model currently consists of three people: Sai Thein Than Tun, Shwe Sin Kyaw and Yu Nandar Aung. Sai is a mathematical modeller and PhD student at the University of Oxford; Shwe Sin is a research physician and economic modeller; and Yu is a public health and financing specialist, completing her master’s in health economics, health financing and policy at the London School of Economics.
The country team analyses the CoMo model inputs, outputs and its relevance to Myanmar context, including generation of policy advocacy materials and the ways the model can be customized to fit Myanmar’s specific situation and/or the policymakers’ needs. The country team’s further plans envision partnering with Myanmar’s policymakers to assist them in the decision-making process for Covid-19 epidemic control measures that are informed by outputs of the CoMo model.

The policy questions we will seek to answer are:

- How long will the epidemic last without any intervention?
- How would different packages of interventions influence the progress and control of the epidemic?
- Given uncertainties in the duration of virus shedding, it is important to determine how long suspected symptomatic people or asymptomatic people with travel/contact history should stay in isolation and how different durations of isolation influence the epidemic’s pattern.
- What is the impact of the Covid-19 epidemic on hospital uptake capacity?
- What are the costs of treating hospitalized Covid-19 patients with different severities of disease?
- Which non-pharmaceutical intervention/intervention package is most cost-effective for flattening the epidemic curve?
- What is the cost-effectiveness of different testing strategies?
- What is the cost-effectiveness of screening/non-screening of asymptomatic contacts?

Nepal

We plan to adapt the CoMo Consortium model and make it appropriate for the Nepalese context. We will provide technical and policy support to the national and sub-national governments of Nepal for Covid-19 preparedness and responses. The questions we will seek to answer that are relevant to the Nepalese context are as follows:

- What would be the scale of epidemic without the implementation of interventions?
- What will be the magnitude of the expected epidemic using the current interventions?
- How can the current interventions be strengthened to scale back the epidemic?
- When and how can the current lockdown interventions be relaxed?
- What number of health care providers will be needed?
- How much health care infrastructure and diagnostic capacity will be needed, and what quantities of medical equipment and supplies are required?
- What will be the economic impact of the epidemic and the different intervention scenarios?

Nigeria

The Nigerian national team consists of three professionals led by Dr Emmanuel Bakare, who is a mathematical modeller, Dr Biniam Getachew, who is an epidemiologist, Dr Semeeh Omoleke, who is a
medical doctor and public health professional, Sandra Adele, who is currently studying International Health and Tropical Medicine at the University of Oxford, and Dr Ibrahim Mamadu, who works with the WHO country office in Abuja. The team are actively working on the CoMo Consortium model to fit it to the Nigerian context; they will provide technical and policy support for Covid-19 response preparation and readiness at both national and sub-national levels. Hence, the team would like to answer the following questions at different levels:

- What are the expected numbers of cases arising from the inflow of travelers?
- What are the long-term effects of increased/decreased contact rates?
- How will the various non-pharmaceutical interventions impact Covid-19 transmission in different states in Nigeria?
- What are the seasonal drivers of Covid-19 transmission in different states within Nigeria? (This will help to know how to allocate resources.)
- What is the transmission rate of Covid-19 in the Nigerian context?
- What are the number of healthcare providers required?
- What number of health care providers is needed?
- What are the quantities of medical supplies and equipment needed, including for critical care management?

Philippines

Our group members are Chris Mercado and Robert Medina. The questions we will seek to answer are:

- How can the CoMo Consortium model inform preparations for a post-lockdown scenario?
- What combination of interventions could work best in the Philippines?

The national team will compare the CoMo Consortium model against other, locally developed models. This will support the development of a local model that better reflects the dynamic local situation and appropriate responses to the Covid-19 epidemic in the country. Other models being used are the official FASSSTER COVID-19 module [9] and the UP COVID-19 Pandemic Response Team model [10].

South Africa

The Modelling and Simulation Hub, Africa (MASHA) is a research group led by Dr Sheetal Silal and based at the University of Cape Town. MASHA’s research focus is the development and application of mathematical modelling and computer simulation to predict the dynamics and control of infectious diseases to evaluate the impact of policies aimed at reducing morbidity and mortality.

MASHA is a member of the South African Modelling Consortium for Covid-19, a technical group comprising experts in modelling, health economics, policy support, clinical planning and virology. We
are providing support to the South African government at both national and provincial levels to predict numbers of Covid-19 cases over the short- and medium-term, estimate resource requirements and inform scenario planning. We have built a novel model (the MASHA-COVID model) and tailored it to the South African context, taking into consideration unique vulnerabilities, age distribution and spatial dynamics.

**Thailand**

The Thailand group members include Associate Professor Wirichada Pan-Ngum, Dr Ricardo Águas, Dr Sompob Saralamba, Dr Nantasit Luangasanatip, Dr Aronrag Cooper Meeyai and Dr Sai Thein Than Tun. In response to the Covid-19 pandemic situation, members of the Mathematical And Economic Modelling group (MAEMOD), based in Bangkok, and others, joined the CoMo Consortium. Our team has been using the CoMo Consortium model to explore different interventions, including self-isolation (for Thailand this mainly involves isolation in hospital), working from home, social distancing, hand hygiene, and the wearing of face masks. The government believes that finding and isolating cases will help to control the number of new cases per day. However, testing large numbers of people is costly and thus who to test was also an important question. The questions we will therefore seek to answer are:

- How can we find and isolate active cases of Covid-19?
- Who should be tested?
- When can some of the rules on social distancing be relaxed, for example letting some businesses reopen?

The Thai government is looking for ways to boost the economy while making sure case numbers are not increasing. There are still many uncertainties about the government’s plan on how to proceed, although the number of cases has been monitored closely and in real time. There are worries about schools re-opening in July as well as concerns about the economy, and tourism in particular, which is the main source of income in many large cities.

The Thai modelling working group meets regularly to share and discuss the results of their models and write weekly recommendation reports for the Ministry of Public Health.

We will assist the CoMo Consortium by:

- Helping with the development of the model and associated web-tools to serve all CoMo Consortium members
- Providing feedback and sharing experiences on the use of the model to help guide policy related to decision making for controlling the spread of Covid-19
• Assisting and mentoring other members who have less experience in modelling or who lack modelling resources in their setting, to help them drive the use of the model in their work on their country’s specific questions

United States

New York State and City
Beginning in February 2020, Nathaniel Hupert worked with Lisa White to develop the first non-UK application of the initial CoMo model for New York State. During February and March 2020, in collaboration with engineering colleagues based in Singapore (Peter L. Jackson), Ithaca, NY (John A. Muckstadt), and California (Michael G. Klein), Nathaniel created a stand-alone Excel-based tool: the Cornell COVID Caseload Calculator with Capacity and Ventilators (C5V) [7]. This C5V model used a hypothetical Covid-19 epidemic curve to make basic forecasts of health care resource requirements; it then formed the basis for the health care components of the CoMo Consortium model. In developing these models, Nathaniel collaborated with a wide number of modelling, public health and medical care delivery professionals. Special thanks go to Babak Pourbohloul, Alex Washburne, Justin Silverman, Monika Safford, Art Evans, the entire hospitalist team at Weill Cornell and NYPH Lower Manhattan Hospital (including especially Maya Hogg, Anand Singh, Elijah Douglass, David Scales, and Sidney Katz), Carter Mecher, James Lawler, Robert Mathes from the NYC DOHMH Syndromic Surveillance Office, and the Office of NYS Governor Cuomo (Michael Schmidt).

Southern California
For Orange County, California, Daniel M. Parker is using the CoMo Consortium model to make comparisons with other models and to answer questions that other models do not answer. This work is being carried out in collaboration with other researchers at the University of California, Irvine and with local health officials at the Orange County Health Care Agency.

Some of the questions we seek to answer are:
• When will we experience a surge in cases, at or above the level our hospitals can handle?
• When can we relax some of the public health interventions (such as physical distancing in social settings) that are in place?
• What happens as these physical distancing practices wane over time (as people tire of staying indoors)?

We are also coordinating and collaborating with Nathaniel Hupert and others in the CoMo Consortium with regard to model architecture and the collation of statistical metrics for use in parameterization.
WHO Eastern Mediterranean countries

The WHO-EMRO modelling support group is part of the Information Management pillar of the Covid-19 Incident Management Support Team (IMST) that was established by the World Health Organization Regional Office for the Eastern Mediterranean (WHO-EMRO) to respond to specific modelling inquiries in relation to Covid-19 from the 22 countries in the region. The group has undertaken a mapping and appraisal exercise of existing models and explored the possibility of adapting identified models to country-specific parameters and assumptions.

The group is providing technical support on modelling to WHO, national governments and partners. It works in close collaboration with similar groups in WHO Headquarters and other regional offices for the development of a set of tools including epidemiological models and health workforce and essential supplies forecasting tools. Collaborations with academia have also been established.

WHO-EMRO modelling support group leader: Lubna Al-Ariqi
CoMo Consortium member/EMRO focal point: Keyrellous Adib

Some of the questions we will seek to answer are:

- What are the estimated numbers of infections, deaths, hospitalisations, admissions to ICUs, and ventilators required?
- What are the effects of various non-pharmaceutical interventions according to different scenarios?
- How many healthcare workers will be needed?
- What quantities of supplies and equipment will be needed?
- What will be the economic impact?

WHO-EMRO use case for the CoMo Consortium:

- Support the Eastern Mediterranean countries in adapting the CoMo Consortium model and other models, interpret the outputs from different scenarios and convey the models’ caveats
- Answer policy-makers’ inquiries about the models used, support the identification of data sources and country-specific model inputs
- Support the drafting of policy briefs for data-guided decision making and resource forecasting
- Review and appraise models developed by organisations and/or academic institutions at the national level, and provide guidance on interpreting outputs from these models and potential ways to improve the situation
- Support the process documentation and strengthen regional and national focal points’ capacity by providing relevant training online or performing demonstrations of the CoMo model and other tools
• Support the validation of the assumptions of the models and adapt the CoMo model R code to country-specific contexts and/or emerging evidence

Model Development

The model is continually being updated and refined based on feedback from members of the CoMo Consortium and to accommodate changing analytical needs. We have incorporated as much complexity as possible within a relatively simple framework, thus ensuring that the app’s functionality remains uncompromised. The app will be updated using the most parsimonious version of the model that we believe will be most suitable for all users. We intend to keep updates to a minimum and will in due course document all updates to the model in any upcoming releases. Any discordance in expected model behaviour between two model versions will be thoroughly investigated and critically presented to users.

We expect that some countries will have more specific analyses they wish to perform and might therefore prefer to operate offline. In such instances, the app’s underlying model structure itself can be tailored to suit each country, depending on any idiosyncrasies in how data are being reported, and what testing and treatment algorithms and containment interventions are in place. Similarly, the hospitalization sub-model can be customized to meet different requirements according to how hospital resources are being managed and what treatment protocols have been implemented.

Interface development

Overview

An interactive web application (CoMo app) was developed to allow easy access to and use of a mathematical model of Covid-19 transmission (the CoMo model).

The App is deployed online via a server made available by Oxford Research Support Services and can be accessed at https://comomodel.net. The underlying code and App are continually being updated as the CoMo model is being developed, new features are added and corrections to the existing code are made. The CoMo App was written in the R language and uses Shiny, an R package that makes it easy to build interactive web applications.

The App comprises three panels:

• Welcome panel, with general information on the App, including a disclaimer.
• Visual Calibration, to allow the user to upload data or select pre-existing data, decide on parameter values that are adapted to the context of their study, and create a baseline reflecting the current planned interventions.
• **Model Predictions**, to visualise the impact of any changes in the interventions (modification of existing interventions or adding/removing interventions).

User Instructions

• Open [https://comomodel.net](https://comomodel.net)
• [Welcome] Read and acknowledge the disclaimer and the different sources of data.
• (optional) [Visual Calibration] Using the link, download an Excel template and edit the following sheets:
  o [Cases]: daily cases and deaths
  o [Severity/Mortality]: severity and infection fatality rates per age category
  o [Population]: population, births and deaths rates per age category
  o [Country/Area Parameters]: a subset of parameters accessible in the App by clicking the Country button. (Doesn’t include Social Contacts).
  o [Virus Parameters]: all parameters accessible in the App by clicking the Virus button.
  o [Hospital Parameters]: all parameters accessible in the App by clicking the Hospital button.
  o [Interventions]: all parameters of the Interventions.
• (optional) [Visual Calibration] Upload a modified Excel template.
• [Visual Calibration] Choose all parameters to reflect with the current situation.
• [Visual Calibration] Click on Run Baseline.
• [Visual Calibration] Adjust the parameters and rerun the baseline as required until observed cases/deaths loosely fit the predicted reported cases/deaths.
• [Visual Calibration] Click on Validate Baseline

![Figure 1: Visual Calibration](image)

• [Model Predictions] Edit the Interventions as required.
• [Model Predictions] Click on Run Interventions,
- [Model Predictions] Compare the two columns to explore the model predictions and see the predicted impact of the interventions surge.
- [Visual Calibration] (optional) Download a csv file with results.

The interface was developed after consultation with several members of the CoMo Consortium. It possesses all the features and functionalities necessary to successfully perform a model fit to the available data and investigate the potential impact of several non-pharmaceutical interventions (NPIs). It has undergone several updates and will continue to do so based on user inputs and needs. All changes to the user interface are appropriately documented and shared across the CoMo Consortium.

**Policy support**

Mathematical modelling has played an important role in informing policymaking with regard to Covid-19, especially in terms of predicting the progression of the epidemic when different combinations of NPIs are deployed. However, published models often remain inaccessible to policymakers in low- to middle-income countries (LMICs) due to the lack of translational capacity in many of these countries. Therefore, with the CoMo Consortium we adopted a participatory approach. Participatory simulation modelling provides policymakers with both timely and dynamic support, enabling the modelling process to be built around the co-production of knowledge between modellers and policymakers [11].

**Economic modelling**

Led by Rima Shretta, the economic modelling group of the CoMo Consortium is working on linking the outputs of the epidemiological model with an economic model to estimate the economic impact of Covid-19 at both global and national levels. The indirect costs of the pandemic are expected to outstrip the direct costs of diagnosing and treating suspected cases [12]. Economic, poverty and finance modelling will be used to estimate the spillover effects, in terms of supply and demand shocks on the
economy, arising from NPIs that are either government- or self-imposed to avoid exposure to the virus. Unemployment, business closures and the erosion of assets are likely to continue once the pandemic is over, and poverty alleviation measures will carry a public financial cost. In turn, depressed government revenues are expected due to the decrease in economic activity, and this will have further knock-on effects. These estimations of the various economic impacts will be used to guide decision-makers and inform the most cost-effective strategies for ending lockdown in each situation. In addition, a cost component is being added to the CSV hospitalisation model [7] to enable countries to estimate the cost of essential supplies as well as the cost of inpatient care for hospitalised patients.

Several members of the CoMo Consortium participate in this work group, including Nantasit, Farshad, Shwe Sin, Siyu, Biniam, Yu, Keyrellous, Phetsavanh, Sayed, and economists from Oxford Policy Management.

**Evidence synthesis**

The evidence synthesis working group of the CoMo Consortium is concerned with synthesizing the rapidly emerging scientific and social evidence relating to the Covid-19 pandemic and associated interventions. This evidence will then help to inform the model parameters, elaborate the impact of economic analyses and inform financing mechanisms to create evidence-based policy briefs. We will also identify gaps in the evidence and elaborate the breadth of (unintended) impacts resulting from both the pandemic and the interventions designed to curtail it. We will do this in consultation with in-country colleagues working across various sectors. This group will include alumni of the MSc in International Health and Tropical Medicine (IHTM), University of Oxford, directed by Dr Proochista Ariana.

**Refugees/internationally displaced populations**

Members of the refugees/internationally displaced populations working group include Proochista Ariana, Sophie Janet, Manar Marzouk, Rimu Byadya and Priya T Balasubramaniam. This group will be considering parameters relevant to refugee and internally displaced populations and contexts. We will adapt the models and apply them in an effort to inform decisions around which combinations of viable and sustainable interventions would be most suitable for such complex contexts. We will engage relevant actors in the consideration of these parameters and their use in models to help inform locally relevant decisions.
Outreach and communications

Policy communication guidance for modellers: DOs and DON’Ts

**DO:** Ask the policymakers what they would like to know and what they are considering, including their overall objectives and their priorities: containment, flatten the curve, cost effective interventions, low disruption, reduce deaths at any cost, etc.

**DO:** Make it very clear at the beginning that this model as well as all the others are based on incomplete information about the disease and recommendations should and will change as you learn more about the speed of spread and impact of interventions.

**DO:** State that the model is a tool to help think about all the options given the uncertainty we are all working with.

**DO:** Point it out if the epidemic is in its early stage in your country, region of interest leading to even more uncertainty.

**DO:** Take the decision-makers through the model structure and choices for key parameters. This should be FAST (not longer than 10 minutes) and in non-technical language.

**DO:** Take the opportunity to ask the policymakers to help you with choosing some scenarios to simulate so that you do not show only one output. For example, slow versus fast spreading and high versus low reporting etc. for the transmission, as well as low versus high coverage and adherence to the NPIs. See if you can agree on some options ideally three to five scenarios and then plan to explore those and provide a report for the next discussion.

**DON’T:** overstate the results of the model. For example, statements like ‘this will happen’ or ‘that will happen’ are NOT SUPPORTED by modelled evidence. Try instead to say things like ‘in this simulation/with these assumptions the model predicts X, Y or Z’.

**DON’T:** Imply or make the decision on strategy but rather keep trying to get the policymakers to help with deciding on realistic scenarios to simulate both for the transmission and the intervention packages.

**DON’T:** Underestimate the importance of context. Engage with policymakers and epidemiologists handling the data in each country to understand how the data are being collected and reported and what nuances are present within the implementation of each intervention (different countries commonly deploy the same interventions in different ways).
Age-structured epidemiological model with health care utilization

An age structured SEIR model with infected compartments stratified by symptoms, severity and treatment seeking and access.

Figure 3: A diagram of the baseline model structure representing the unmitigated epidemic spread scenario

The model uses publicly available country-specific data to define the population structure [13] as a model input. The model interface uses publicly available country-specific data on cases and mortality [14] for visual calibration of model parameters to user selected baseline scenarios. More elaborate calibration methods are under consideration but are not a priority since the system is unidentifiable and therefore calibration will be entirely dependent on user-selected baseline scenarios.

The model interface can be found here: https://comomodel.net/. The equations for the basic model structure follow (Equation 1).
\[
\frac{dS}{dt} = -S \odot \Lambda + \omega R + A \cdot S - \mu \cdot S + bP \\
\frac{dE}{dt} = S \odot \Lambda - \gamma E + A \cdot E - \mu \cdot E \\
\frac{dl}{dt} = \gamma (1 - p_{\text{clin}})(1 - p_{\text{thr}}) \cdot E - \nu l + A \cdot l - \mu \cdot l \\
\frac{dC}{dt} = \gamma p_{\text{clin}}(1 - p_{\text{thr}}) \cdot E - \nu l C + A \cdot C - \mu \cdot C \\
\frac{dR}{dt} = \nu(I + C) + A \cdot R - \omega R - \mu \cdot R + (1 - \delta_H p_{hfr})\nu_H \cdot H \\
&& + (1 - \delta_H p_{hfr})\nu_H \cdot H_c + (1 - \delta_U p_{hfr})\nu_U \cdot U \\
&& + (1 - \delta_u p_{hfr})\nu_U \cdot U_c + (1 - \delta_V p_{hfr})\nu_v \cdot U_{cv} \\
&& + (1 - \delta_V p_{hfr})\nu_v \cdot V + (1 - \delta_V p_{hfr})\nu_v \cdot V_c \\
\frac{dH}{dt} = p_{\text{thr}} (1 - p_{U})(1 - p_{K_H})\gamma E - \nu_H H + A \cdot H - \mu \cdot H \\
\frac{dH_c}{dt} = p_{\text{thr}} (1 - p_{U}) p_{K_H} \gamma E - \nu_H H_c + A \cdot H_c - \mu \cdot H_c \\
\frac{dU}{dt} = p_{\text{thr}} p_U (1 - p_{K_U})(1 - p_{V})\gamma E - \nu_U U + A \cdot U - \mu \cdot U \\
\frac{dU_c}{dt} = p_{\text{thr}} p_U p_{K_U} (1 - p_{v}) \gamma E - \nu_U U_c + A \cdot U_c - \mu \cdot U_c \\
\frac{dU_{cv}}{dt} = p_{\text{thr}} p_U p_{K_U} p_{V \gamma} E - \nu_U U_{cv} + A \cdot U_{cv} - \mu \cdot U_{cv} \\
\frac{dV}{dt} = p_{\text{thr}} p_U (1 - p_{K_U})(1 - p_{K_V}) \gamma E - \nu_V V + A \cdot V - \mu \cdot V \\
\frac{dV_c}{dt} = p_{\text{thr}} p_U (1 - p_{K_U}) p_{K_V} p_V \gamma E - \nu_V V_c + A \cdot V_c - \mu \cdot V_c \\
P = (S + E + I + C + R + H + H_c + U + U_c + U_{cv} + V + V_c) \\
s = 1 + a \cos \left(2\pi \left(\frac{t - \left(365.25\phi \right)}{365.25} + t_m \right)\right) \\
W = W_{\text{home}} + W_{\text{work}} + W_{\text{school}} + W_{\text{other}} \\
\Lambda = p s W \cdot \left(\frac{p E + I + C + p s \ast (H + H_c + U + U_c + U_{cv} + V + V_c)}{p}\right) \\
A = \begin{pmatrix}
\begin{array}{cccc}
\alpha & 0 & \cdots & 0 \\
0 & -\alpha & \cdots & 0 \\
\alpha & 0 & \cdots & 0 \\
0 & \cdots & \alpha & 0
\end{array}
\end{pmatrix}
\begin{cases}
p_{K_H} = \begin{cases}
0 & \text{for } H < K_H \\
1 & \text{for } H \geq K_H
\end{cases} \\
p_{K_U} = \begin{cases}
0 & \text{for } U < K_U \\
1 & \text{for } U \geq K_U
\end{cases} \\
p_{K_V} = \begin{cases}
0 & \text{for } V < K_V \\
1 & \text{for } V \geq K_V
\end{cases}
\end{cases} \\
Equation 1
Non-pharmaceutical interventions

A series of non-pharmaceutical interventions were included in the model which can be switched on for specific periods of time, thus building a bespoke intervention package.

Self-Isolation if Symptomatic
This is the practice of individuals with either a confirmed case of Covid-19 or with Covid-19 symptoms isolating themselves at home for a period of 7 days. The parameters governing this intervention are:

- Start Date: the start date of the protocol
- Duration: the duration of the protocol
- Coverage: the percentage of the population who will be able to self-isolate if they have symptoms or are a confirmed case
- Adherence: the percentage of the designated isolation period that self-isolated individuals adhere to the intervention

Screening
This is a form of contact-tracing. Given enough testing capacity, it reflects how suspected contacts of confirmed cases are tested with a virological test. All individuals who test positive are then requested to self-isolate

- Start Date: the start date of additional screening
- Test Sensitivity: Probability that an infected person will test positive when screened.
- Suspected Contacts: number of people screened per reported case.
- Overdispersion: informs the probability of finding an infected person that is a known contact of a reported case, relative to random sampling (overdispersion = 1).
- Duration: duration of this additional protocol

Social Distancing
Also known as physical distancing, this refers to the measures taken to prevent the spread of a contagious disease by maintaining a specific physical distance between individuals and reducing the number of times individuals come into close contact with each other. The parameters governing this intervention are:

- Start Date: the start date of the protocol
- Duration: the duration of the protocol
- Coverage: the percentage of the population who reduce their societal contacts (excluding those at home, work and school)
- Adherence: the percentage of the time that those practicing social distancing adhere to social distancing measures
Handwashing
This indicates improvements in personal hygiene and reduction in risk behaviours (touching the face, nose or mouth), including the adoption of Personal Protection Equipment such as masks. The parameters governing this intervention are:
- Start Date: the start date of the protocol
- Duration: the duration of the protocol
- Efficacy: the effectiveness of personal hygiene measures in reducing the risk of infection per contact

Working at Home
This indicates the effect of having workers working from home. The parameters governing this intervention are:
- Start Date: the start date of the protocol
- Duration: the duration of the protocol
- Efficacy: the reduction in work related contacts
- Home contacts inflation: increased numbers of home contacts due to increased number of hours spent at home

School Closures
This indicates school closures and assumes that all schools in a country close at the same time. The parameters governing this intervention are:
- Start Date: the start date of the protocol
- Duration: the duration of the protocol
- Efficacy: defined as the reduction in contacts between school children when schools are closed
- Home contacts inflation: increased numbers of home contacts due to increased numbers of hours spent at home

Shielding the Elderly
This intervention is designed to isolate a proportion of the elderly population and reduce their overall contacts. The parameters governing this intervention are:
- Start Date: the start date of the protocol
- Duration: the duration of the protocol
- Coverage: the percentage of the elderly population who are shielded
- Efficacy: defined as the reduction in overall contacts of the shielded elderly population
- Minimum age for elderly cocoon: the minimum age cut-off defining which people should protect themselves
Travel Ban
This refers to a ban on international travel. The parameters governing this intervention are:

- Start Date: the start date of the protocol
- Duration: the duration of the protocol
- Efficacy: the reduction in imported cases per day (as a percentage)

Voluntary home quarantine
This indicates how many people will voluntarily quarantine themselves at home for a specified number of days if a person they live with tests positive for Covid-19. The parameters governing this intervention are:

- Start Date: the start date of the protocol
- Duration: the duration of the protocol
- Days in quarantine for an average person
- Coverage: The percentage of people voluntarily quarantining themselves given they live with a known infectious case.
- Rate: Speed at which people decide to quarantine themselves if they live with a known infectious case.
- Decrease in the number of other contacts when voluntarily quarantining: refers to decreased mean numbers of contacts outside of the home while quarantining.
- Increase in the number of contacts at home when voluntarily quarantining: refers to increased numbers of home contacts due to increased time spent at home while quarantining.

Lockdown
This refers to an emergency protocol that is categorized into three levels based on the efficacy or coverage of the various non-pharmaceutical interventions. The parameters governing this intervention are:

- Low-level lockdown (self-isolation 50%, social distancing 25%, cocoon 95%, hand-hygiene 5%)
  - Start Date: the start date of low-level lockdown protocols
  - Duration: the duration of low-level lockdown protocols

- Mid-level lockdown (self-isolation 50%, social distancing 95%, school closure 85%, travel ban 95%, voluntary home quarantine 5%, working from home 50%, cocoon 95%, hand-hygiene 5%)
  - Start Date: the start date of mid-level lockdown protocols
  - Duration: the duration of mid-level lockdown protocols

- High-level lockdown (self-isolation 95%, social distancing 35%, school closure 85%, voluntary home quarantine 90%, working from home 75%, cocoon 95%, hand-hygiene 7.5%)
  - Start Date: the start date of high-level lockdown protocols
  - Duration: the duration of high-level lockdown protocols
### Table of variables

The model variables are defined in Table 1 below.

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>S</td>
<td>Susceptible</td>
</tr>
<tr>
<td>E</td>
<td>Infected and incubating</td>
</tr>
<tr>
<td>I</td>
<td>Infectious and asymptomatic following incubation</td>
</tr>
<tr>
<td>C</td>
<td>Infectious and mildly symptomatic following incubation</td>
</tr>
<tr>
<td>R</td>
<td>Recovered and immune</td>
</tr>
<tr>
<td>H</td>
<td>Severe infection: hospitalized</td>
</tr>
<tr>
<td>H_c</td>
<td>Severe infection: not hospitalized due to lack of capacity</td>
</tr>
<tr>
<td>U</td>
<td>Severe infection: hospitalized in ICU</td>
</tr>
<tr>
<td>U_c</td>
<td>Severe infection: hospitalized and requiring ICU but placed in surge ward</td>
</tr>
<tr>
<td>U_c_v</td>
<td>Severe infection: hospitalized and requiring ventilator but placed in surge ward</td>
</tr>
<tr>
<td>V</td>
<td>Severe infection: hospitalized in ICU and on a ventilator</td>
</tr>
<tr>
<td>V_c</td>
<td>Severe infection: hospitalized in ICU requiring a ventilator but not on one</td>
</tr>
</tbody>
</table>

*Table 1: A list of model variables and their definitions.*

### Table of parameters

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Definition</th>
<th>Value</th>
<th>Unit</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>Demographic</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>W_{home}</td>
<td>Country-specific age-dependent contact matrix describing the number of potentially infectious contacts at home per person per day</td>
<td>†</td>
<td>day⁻¹</td>
<td>[15]</td>
</tr>
<tr>
<td>W_{work}</td>
<td>Country-specific age-dependent contact matrix describing the number of potentially infectious contacts at work per person per day</td>
<td>†</td>
<td>day⁻¹</td>
<td>[15]</td>
</tr>
<tr>
<td>W_{school}</td>
<td>Country-specific age-dependent contact matrix describing the number of potentially infectious contacts at school per person per day</td>
<td>†</td>
<td>day⁻¹</td>
<td>[15]</td>
</tr>
<tr>
<td>W_{other}</td>
<td>Country-specific age-dependent contact matrix describing the number of potentially infectious societal contacts per person per day</td>
<td>†</td>
<td>day⁻¹</td>
<td>[15]</td>
</tr>
<tr>
<td>μ</td>
<td>1/Age-dependent non-covid related death rate</td>
<td>†</td>
<td>day⁻¹</td>
<td>[13]</td>
</tr>
<tr>
<td>b</td>
<td>1/Age-dependent fertility rate</td>
<td>†</td>
<td>day⁻¹</td>
<td>[13]</td>
</tr>
<tr>
<td>α</td>
<td>1/duration in each age category</td>
<td>1/5</td>
<td>yr⁻¹</td>
<td>[13]</td>
</tr>
<tr>
<td></td>
<td><strong>Natural history of infection</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>p</td>
<td>Probability of infection given a single contact</td>
<td>†</td>
<td>NA</td>
<td>[16]</td>
</tr>
<tr>
<td>γ</td>
<td>1/duration of incubation period</td>
<td>1/3.5</td>
<td>day⁻¹</td>
<td>[17-20]</td>
</tr>
<tr>
<td>ρ</td>
<td>Relative infectiousness of incubating phase</td>
<td>0.1</td>
<td>NA</td>
<td>‡</td>
</tr>
<tr>
<td>Parameter</td>
<td>Description</td>
<td>Value</td>
<td>Reference</td>
<td></td>
</tr>
<tr>
<td>------------------</td>
<td>-----------------------------------------------------------------------------</td>
<td>---------</td>
<td>-----------------</td>
<td></td>
</tr>
<tr>
<td>$p_{\text{clin}}$</td>
<td>Proportion of all infections that ever develop symptoms</td>
<td>0.55</td>
<td>[21-23]</td>
<td></td>
</tr>
<tr>
<td>$v_I$</td>
<td>1/duration of infectious phase post incubation</td>
<td>1/4.5</td>
<td>[17]</td>
<td></td>
</tr>
<tr>
<td>$\rho_s$</td>
<td>Relative proportion of contacts for hospitalized patients</td>
<td>0.15</td>
<td>±</td>
<td></td>
</tr>
<tr>
<td>$\omega$</td>
<td>1/duration of immunity</td>
<td>1/150</td>
<td>‡</td>
<td></td>
</tr>
</tbody>
</table>

**Seasonality**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
<th>Value</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\alpha$</td>
<td>Relative variation in viral transmissibility throughout the year (+- a proportion)</td>
<td>†</td>
<td>NA</td>
</tr>
<tr>
<td>$\phi$</td>
<td>Month of peak in transmissibility</td>
<td>†</td>
<td>NA</td>
</tr>
</tbody>
</table>

**Patient outcomes**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
<th>Value</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>$p_{\text{ih}}$</td>
<td>Probability of an infection being severe (requiring hospitalization) by age</td>
<td>NA</td>
<td>[13, 24-27]</td>
</tr>
<tr>
<td>$p_{hfr}$</td>
<td>Probability of a severe/hospitalized infection being fatal by age</td>
<td>NA</td>
<td>[13, 24, 25, 27, 28]</td>
</tr>
<tr>
<td>$v_H$</td>
<td>1/Duration of hospitalized infection</td>
<td>1/24</td>
<td>[29]</td>
</tr>
<tr>
<td>$v_U$</td>
<td>1/Duration of ICU infection</td>
<td>1/24</td>
<td>[30]</td>
</tr>
<tr>
<td>$v_V$</td>
<td>1/Duration of ventilated infection</td>
<td>1/24</td>
<td>[17, 18, 28]</td>
</tr>
<tr>
<td>$\delta_H$</td>
<td>Maximum death probability for a hospitalized infection</td>
<td>0.35</td>
<td>[13, 29]</td>
</tr>
<tr>
<td>$\delta_{Hc}$</td>
<td>Maximum death probability for an infection requiring hospitalization that did not receive appropriate treatment</td>
<td>0.45</td>
<td>[31]</td>
</tr>
<tr>
<td>$\delta_U$</td>
<td>Maximum death probability for a hospitalized infection requiring ICU admission</td>
<td>0.55</td>
<td>[31, 32]</td>
</tr>
<tr>
<td>$\delta_{Uc}$</td>
<td>Maximum death probability for a hospitalized infection that would require ICU admission but was not admitted to the ICU</td>
<td>0.8</td>
<td>[31]</td>
</tr>
<tr>
<td>$\delta_V$</td>
<td>Maximum death probability for a hospitalized infection requiring a ventilator</td>
<td>0.8</td>
<td>[31]</td>
</tr>
<tr>
<td>$\delta_{Vc}$</td>
<td>Maximum death probability for a hospitalized infection that would require a ventilator but did not get one</td>
<td>0.95</td>
<td>[33]</td>
</tr>
<tr>
<td>$p_U$</td>
<td>Probability of an infected patient needing ICU</td>
<td>0.5</td>
<td>[26, 33]</td>
</tr>
<tr>
<td>$p_V$</td>
<td>Probability of an infected patient needing ICU and a ventilator</td>
<td>0.75</td>
<td>NA</td>
</tr>
<tr>
<td>$K_H$</td>
<td>Standard hospital bed capacity</td>
<td>†</td>
<td>NA</td>
</tr>
<tr>
<td>$K_U$</td>
<td>ICU bed capacity</td>
<td>†</td>
<td>NA</td>
</tr>
<tr>
<td>$K_V$</td>
<td>Ventilator capacity</td>
<td>†</td>
<td>NA</td>
</tr>
</tbody>
</table>

Table 2: A list of the default parameter values of the model. These are subject to change when the model is applied to a new setting and/or with new information about Covid-19. We have provided references to demonstrate that the default values lie within plausible ranges. † Country-specific value; ‡ Assumed value (no reference found)
CoMo Consortium Members

Prof Lisa J White

Big Data Institute, Li Ka Shing Centre for Health Information and Discovery, Nuffield Department of Medicine, University of Oxford

Lisa is a mathematical modeller with a focus on global health and policymaking. Her work combines within- and between-host infection models with multi-strain/species modelling to consider the characterisation, emergence and spread of antimicrobial drug resistance and its containment. Her modelling work is participatory, with models for malaria and other diseases being developed in close collaboration with national control programs, international decision-makers, funders and donors.

Lisa initiated and leads the CoMo Consortium, develops the model and supports the national teams.

Dr Nathaniel Hupert MD MPH FACP

Weill Cornell Medicine, Cornell University, New York, NY
New York-Presbyterian Hospital, New York, NY
Cornell Institute for Disease and Disaster Preparedness.

Nathaniel is a physician/researcher focused on public health emergency response logistics and health care operations research. He served 10 years as Senior Medical Advisor to the US Centers for Disease Control and Prevention (CDC) Division of Preparedness and Emerging Infections. He was also Medical Advisor for the US Hospital Preparedness Program and served on the Scientific Advisory Board of the National Institute of Health’s Modeling of Infectious Disease Agent Study (MIDAS). Nathaniel trained at Harvard Medical School and School of Public Health and the University of Pittsburgh Medical Center; he now practises as a hospitalist in Lower Manhattan, NYC.

Nathaniel has worked with Lisa White since early March 2020 to customize the first version of the R-based CoMo model for use in the United States, specifically for New York State and City. He has continued to support the development of the application and has provided particular assistance with the hospital-based components of the model.
Dr Ricardo Águas
University of Oxford
Mahidol Oxford Research Unit, MORU

Ricardo is a mathematical modeller of infectious diseases and currently leads the Analytical Tools for Malaria Elimination (AToME) group at the University of Oxford. The group is currently entirely dedicated to the Enhanced modelling for NMCP Decision-making to Accelerate Malaria Elimination (ENDGAME) project, funded by the Bill and Melinda Gates Foundation. Engaging with National Malaria Control Programs (NMCP) in the Greater Mekong Sub-Region (GMS), ENDGAME calibrates malaria transmission models using epidemiological data and records from previous intervention deployments to predict the impact and cost efficiency of different elimination-driven strategies. Ricardo has previously developed genotype to phenotype mapping tools to identify host-species transition events for diseases such as MERS and SARS and has vast experience in modelling epidemic and pandemic outbreaks.

*Ricardo helped develop the CoMo Consortium model and provides user support.*

Olivier Celhay
Independent Consultant, https://oliviercelhay.com

As a Data Scientist with 15 years’ experience, Olivier have designed and led the implementation of large-scale surveys, leveraged new technologies for surveillance systems in resource-constrained settings, and used both standard and cutting-edge data analysis methods to support decision making in public health, with a focus on malaria. Recently, Olivier have focused on designing and developing interactive applications to bridge the gap between research and policymaking.

*Olivier designed and developed the CoMo Consortium app.*
Dr Proochista Ariana

University of Oxford, Nuffield Department of Medicine, Centre for Tropical Medicine and Global Health

Proochista Ariana directs the MSc in International Health and Tropical Medicine (IHTM) at the University of Oxford. She holds a Master’s in International Health from Harvard and a Doctorate in International Development from Oxford University. Her research examines the intersection between international development and health.

As a member of the CoMo Consortium, Proochista will be supporting evidence synthesis and advising on evaluation methods as well as helping with the translation of evidence for communication with policy colleagues. Proochista will also facilitate the extension of the consortium to the IHTM alumni network.

Dr Rima Shretta

Big Data Institute, Li Ka Shing Centre for Health Information and Discovery, Nuffield Department of Medicine, University of Oxford

Rima Shretta is an experienced global health expert, with more than 20 years’ experience in developing effective health system strategies to improve access to essential public health services. She has extensive experience in measuring the efficiency and cost-effectiveness of service delivery platforms and using real-world epidemiological, economic and financial evidence to support integrated strategies for multiple diseases to strengthen health systems, optimize efficiency and inform policy.

Rima holds a PhD in epidemiology and public health and a Masters in Public Health in Developing Countries from the London School of Hygiene and Tropical Medicine. She is currently an Honorary Visiting Research Fellow collaborating closely with the Oxford Modelling for Global Health group based at the Big Data Big Data Institute, Li Ka Shing Centre for Health Information and Discovery at the University of Oxford.

Rima’s current work in the CoMo Consortium focusses on the cost of the various interventions as the economic impact of the pandemic.
Daniel M. Parker, PhD

University of California, Irvine

Daniel works on infectious disease epidemiology, spatial epidemiology and spatial demography. His research group considers spatial and temporal heterogeneities in infectious diseases. They incorporate geographic information science, molecular approaches, statistics, demography and anthropology in their work. Much of his group’s work focuses on the ways that humans navigate their environment, how this leads to increased risk of infection for some people, how it influences access to healthcare, and how this information can be used to disrupt disease transmission.

Daniel is advising on public health and epidemiological features of the CoMo Consortium model and its applications.

Ainura Moldokmatova

Big Data Institute, Li Ka Shing Centre for Health Information and Discovery, Nuffield Department of Medicine, University of Oxford

Ainura works as a research assistant and mathematical modeller with the Oxford Modelling Group for Global Health (OMGH). She holds a Masters in International Health and Tropical Medicine from the University of Oxford and a Masters in Social Research from the University of Edinburgh. Her research interests focus on behavioural studies, mathematical modelling and health policy.

In the CoMo Consortium, Ainura is coordinating the communication for the consortium and supporting the modelling for Kyrgyzstan.
Michael G. Klein, PhD
San José State University

Dr Michael G. Klein’s research focuses on the application of operations research for healthcare management and humanitarian logistics. His work includes the development of Emergency Department (ED) patient flow simulation models. He has worked with Internal Medicine specialists to model their workflow decisions in managing ED consultation requests and inpatient ward care. For patients with chronic conditions, he has developed optimization models to help identify the best network of dialysis facilities from an access to care perspective. He teaches Business Analytics courses in Managerial Decision Analysis, Simulation Modeling & Analysis, and Supply Chain Logistics. Dr Klein received his PhD in Operations Management from McGill University.

Michael is currently working on the Cornell COVID Caseload Calculator with Capacity and Ventilators (C5V) with Nathaniel Hupert, Peter L. Jackson and John A. Muckstadt. He is also developing a web version to facilitate use and integration with the CoMo International Model.

Dr Penelope Hancock

Big Data Institute, Li Ka Shing Centre for Health Information and Discovery, Nuffield Department of Medicine, University of Oxford

Penny is a mathematical modeller with interests in geospatial models, population dynamics and epidemiology. She is currently a postdoctoral researcher in the Malaria Atlas Project (MAP) group at Oxford University, working on spatial models of the spread of insecticide resistance in African mosquito vectors of malaria. She has previously also worked on the population dynamics of mosquito-borne diseases such as the dengue and Zika viruses, investigating novel mosquito control strategies.

Penny joined the CoMo Consortium to work with Keyrellous Adib and Lisa White to support epidemiological model development with members of the WHO-EMRO Covid-19 Modelling Support Group.
Dr Rashid Zaman is a medical epidemiologist with 17 years’ experience in social, epidemiological and clinical research, surveillance, monitoring and evaluation, providing technical assistance, and managing large and complex projects in more than 20 low and middle-income countries. He is a Senior Consultant at Oxford Policy Management (OPM) and is currently working on several projects around Covid-19. He previously worked in a large DFID programme on epidemic prevention and control, mainly focusing on Ebola and implemented by WHO Africa Regional Office, called Tackling Deadly Diseases in Africa (TDDAP). Prior to joining OPM in 2010, he worked in US-CDC’s International Emerging Infections Programme (IEIP) in Bangladesh, where he led the design and implementation of the country’s first national respiratory virus surveillance system, involving public and private sector health facilities across the country. He has also led several outbreak investigations and played a major role in the national response to the 2009 H1N1 influenza pandemic. Rashid has authored more than 50 publications, many of them published in highly reputed international peer reviewed journals including Bulletin of the World Health Organization, Journal of Infectious Diseases, American Journal of Tropical Medicine and Hygiene, Human Resource for Health, Cochrane Database of Systematic Reviews etc. Through OPM, Rashid works closely with the government, donors and development partners in many low and middle-income countries. He will be liaising with various governments, donors, and other development partners to bring in commissioned work for modelling to the CoMo Consortium. He will also support the implementation of this work by providing technical inputs as an epidemiologist and coordinator.
Dr Nicholas Letchford

Oxford Policy Management

Nicholas works at the Cross-Cutting Team under the Chief Economist’s Office at Oxford Policy Management (OPM). He works on projects across a variety of sectors, mostly in health, nutrition, poverty and social protection. He holds a Bachelor of Science in Mathematics (Hons) and a Bachelor of Mechanical Engineering (Hons) from the University of Tasmania, an MSc in Health Technology Assessment from the University of Glasgow and a DPhil (PhD) in Mathematics from the University of Oxford, where he used mathematical modelling techniques to investigate the processes of cavitation in lubricant films. Prior to joining OPM, Nicholas worked as a post-doctoral researcher with the Vaccine Impact Modelling Consortium, Imperial College, London, on developing vaccine impact and disease burden estimates for a range of diseases in various countries across the world.

Nicholas will be working on mathematical modelling with the CoMo Consortium, helping to generate models using various scenarios for countries where OPM have been asked to provide support.

Keyrellous Adib

World Health Organization
Regional Office for the Eastern Mediterranean


Keyrellous’ roles in the CoMo Consortium include model testing and adaptation to WHO-EMRO countries, economic modelling and policy support.
Sudhir is a Senior Consultant in Statistics at IQVIA. Much of Sudhir’s work involves applying frequentist statistical approaches to problems in medicine and, more broadly, the life sciences. Prior to joining IQVIA, Sudhir spent 7 years working at the WHO Collaborating Centre for Pandemic Influenza, University of Nottingham. In addition, Sudhir completed a brief secondment at the Health Economics and Modelling Unit (HEMU) of the US CDC where he undertook a health economic evaluation of community-based antiviral treatment for pandemic influenza. Sudhir holds an MPH and a PhD from the University of Nottingham. Sudhir’s PhD research involved the development of agent-based computational models to investigate pandemic influenza treatment strategies. **Sudhir will be helping to test and adapt the CoMo Consortium model and assisting with economic modeling (supporting WHO EMRO).**

Akindeh is a senior lecturer of Biostatistics in the Department of Biochemistry at the University of Yaoundé I, Cameroon. He is also Head of the Clinical and Laboratory Data Management Unit at the Biotechnology Center of the University of Yaoundé I. In the past, Akindeh has played a major role in designing and running clinical trials, mainly researching anti-malarial drugs and tuberculosis treatments. He is a member of the Society of Epidemiology Cameroon (CaSE) and also the Tropical Diseases Modelling Network (TDMod.Net). His research interest is studying relationships between diseases and populations in terms of their control. He is currently modeling malaria control in Cameroon as a Marcad PostDoc Fellow. **Akindeh will be leading the Covid-19 modelling for Cameroon in the CoMo Consortium, with the support of several members of this consortium.**
Biniam Getachew MPH, PhD
Stop Transmission of Polio (STOP) program
World Health Organization, Nigeria

Biniam is an experienced public health consultant with a demonstrated history of working in the Ministry of Health (Ethiopia), local NGOs and INGOs. He is skilled in public health, epidemiology, infectious disease, reproductive health and vaccination. Biniam also has strong professional research skills and a PhD that focused on epidemiology.

**Biniam actively participates in policy support and economic modelling in the CoMo Consortium and is a member of the Nigerian country team.**

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Dr Emmanuel Bakare

Co-ordinator, Laboratory of Modelling in Infectious Diseases and Applied Sciences (LOMIDAS), Federal University Oye-Ekiti, Ekiti State, Nigeria

Regular Associate, Abdus Salam International Centre for Theoretical Physics (ICTP), Trieste, Italy

Emmanuel Bakare is a mathematical modeller who focusses on infectious diseases in Nigeria and other sub-Saharan African countries. His research interests primarily lie in the area of applied nonlinear dynamics and differential equations with applications to epidemiology, ecology and immunology. He has a strong interest in understanding infectious disease transmission based on the analysis of incidence and/or surveillance data from surveillance systems, and uses a number of techniques for data visualization and time series analysis in order to characterize meaningful signals to identify seasonal patterns in data using R software. His topics of interest include deterministic and stochastic modelling of population dynamics of infectious diseases; statistical analysis of population-level infectious disease data; describing and modelling human behavioural decisions in relation to infectious diseases; using mathematical models to predict control and eradication strategies for endemic infections; prevention and response strategies for emerging and re-emerging infections; and social and policy implications. In recent years, he has been involved in country-specific modelling, especially since
the time he spent working with the Swiss Tropical and Public Health Institute, Associated Institute of the University of Basel, Switzerland, for his postdoctoral studies. He is in close contact with the National Malaria Control Program (NMCP) in Nigeria and the Nigeria Centre for Disease Control (NCDC), Abuja, Nigeria.

Emmanuel is participating in the COMO Consortium to provide mathematical modelling support for the Nigeria country team.

Dr Semeeh Omoleke

World Health Organization, Nigeria

Dr Semeeh Omoleke is a medical doctor by training and holds a master’s degree in public health (MPH). He also has a postgraduate diploma in public administration. Dr Semeeh currently works as a Surveillance Officer and coordinates WHO activities in Kebbi State, a Northwestern State in Nigeria. He has been practising public health in developing countries for more than a decade and has immense experience in epidemiological surveillance for diseases, immunization programs and health systems. He has secured Fellowships to attend international short courses on immunization and epidemiology at the Centre for Global Health, Les Pensieres/University of Geneva and Imperial College of Science, Technology and Medicine. Dr Semeeh has published many academic papers in reputable journals such as Bulletin of World Health Organization, Vaccine, BMJ Global Health, BMC Public Health, BMC Pregnancy and Childbirth and Pan African Medical Journal.

Within the CoMo Consortium, Dr Semeeh is a member of the Nigerian team that will be modelling the Covid-19 Outbreak in Nigeria. He will be supporting Drs Emmanuel Bakare and Biniam Getachew, who are mathematical modeller and epidemiologist, respectively. He will also serve as an interface between the modelling team and the government at the State level. He will support the team with the development of policy briefs that can be shared with or used for advocacy with the government and their subsequent application for controlling the epidemic.
Fatima Arifi is a Fulbright scholar from Afghanistan, currently in her last semester of studying for an MPH in Epidemiology at Florida International University. Before coming to the US, she worked in International Health Regulations/Global Health Security with the Ministry of Public Health and the WHO country office in Afghanistan. Her research focus is on infectious disease and surveillance. Fatima’s role with the CoMo Consortium is supporting Covid-19 modelling for Afghanistan. She is also helping with economic modelling, evidence synthesis and volunteering with project coordination.

Dr Mohammad Nadir Sahak is an Infectious Disease Epidemiologist at the Focal Point of Infectious Hazard Preparedness Unit of the WHO country office in Afghanistan. He has an MSc in Epidemiology and Biostatistics from the Aga Khan University. He has more than 15 years’ experience in public health in Afghanistan. His research area is mostly focused on infectious diseases, including influenza, Crimean-Congo haemorrhagic fever, brucellosis, Q fever, leishmaniasis, malaria, and other emerging and re-emerging diseases.

In the CoMo Consortium, Nadir helps with the model’s development for Afghanistan and provides policy support to communicate findings with policymakers within the MoPH and WHO in Afghanistan.
Dr Sayed Ataullah Saeedzai is the Director General of Monitoring Evaluation and Health Information (M&E-HIS) in the Ministry of Public Health, Afghanistan. Dr Saeedzai obtained his MD from Kabul Medical University in 2003 and he received his MSc in Epidemiology and Biostatistics in 2008. Dr Saeedzai has provided technical support for national surveys and has worked in key positions focusing on research, monitoring and evaluation with NGOs such as the Leadership, Management and Governance Project and the Management Sciences for Health (Afghanistan), the Aga Khan Health Services, Afghanistan, the Aga Khan University, the Johns Hopkins Bloomberg School of Public Health, and BRAC Afghanistan (a development organization dedicated to alleviating poverty by empowering the poor). He has worked as consultant with KPMG, a Local Fund Agent for the Global Fund and has considerable expertise in the Immunization and Surveillance technical areas of the International Health Regulations (IHR). Dr Saeedzai has worked as a volunteer at Kabul Medical University as a lecturer of Biostatistics for Public Health Faculty Students.

In the CoMo Consortium, Dr Saeedzai is supporting the model’s development for Afghanistan and communicating the results with policy decision makers in Afghanistan.

Hamid Sharifi, DVM, PhD in Epidemiology, is Professor in the Department of Epidemiology & Biostatistics, School of Public Health, Kerman University of Medical Sciences, Kerman, Iran and the director of the HIV/STI Surveillance Research Center and WHO Collaborating Center for HIV Surveillance, Institute for Futures Studies in Health, Kerman University of Medical Sciences, Kerman, Iran. He also a member of the Modeling in Health Research Center, Institute for Futures Studies in Health, Kerman University of Medical Sciences, Kerman, Iran. His training and expertise are in
epidemiology (basic and advanced), research methods, epidemiology of infectious diseases, especially HIV, hepatitis and influenza.

**Hamid will help the CoMo Consortium as an epidemiologist, and he is the leader of the country team. Using Vensim software, Iran developed a compartmental model to estimate the number of infections, deaths, and hospitalizations based on several scenarios to find the best and most practical scenario. We will use the CoMo Consortium model to develop and compare with our national model and see how we might improve our domestic model.**

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**Yunes Jahani**

Modeling in Health Research Center, Institute for Futures Studies in Health, Kerman University of Medical Sciences, Kerman, Iran

Department Biostatistics and Epidemiology, School of Public Health, Kerman University of Medical Sciences, Kerman, Iran

Yunes Jahani, PhD in Biostatistics, is Associate Professor in the Department of Epidemiology & Biostatistics, School of Public Health, Kerman University of Medical Sciences, Kerman, Iran and the Head of Modeling in Health Research Center, Institute for Futures Studies in Health, Kerman University of Medical Sciences, Kerman, Iran. His training and expertise is in biostatistics (categorical data analysis, longitudinal data analysis and survival data analysis).

**Yunes will help the CoMo Consortium with data analysis.**

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**Mehran Nakhaeizadeh**

Modeling in Health Research Center, Institute for Futures Studies in Health, Kerman University of Medical Sciences

Mehran Nakhaeizadeh is a PhD student in Biostatistics at Kerman University of Medical Sciences, Iran. He has studied mathematical modelling for one year. His thesis title is ‘Uncertainty analysis in a mathematical model in respiratory infectious diseases using rule-based fuzzy system’. He is also a member of the Modeling in Health Research Center in the Institute for Futures Studies in Health at Kerman University of Medical Sciences.
Milad Ahmadi

Modeling in Health Research Center, Institute for Futures Studies in Health, Kerman University of Medical Sciences, Kerman, Iran.

Milad Ahmadi, MSc in Biostatistics, is a researcher at the Modeling in Health Research Center, Institute for Futures Studies in Health, Kerman University of Medical Sciences, Kerman, Iran. His research interest is dynamic models in health sciences.

**Milad will help the CoMo Consortium with data analysis.**

Ali Mirzazadeh

Division of Infectious Disease & Global Epidemiology, Institute for Global Health Sciences, University of California San Francisco (UCSF), USA
HIV/STI Surveillance Research Center and WHO Collaborating Center for HIV Surveillance, Institute for Futures Studies in Health, Kerman University of Medical Sciences, Iran

Ali Mirzazadeh, MD, MPH, PhD, is an Assistant Professor of Epidemiology in the Division of Infectious Disease & Global Epidemiology at UCSF Department of Epidemiology & Biostatistics. He has more than 10 years of research experience working on HIV and HCV prevalence and risk, and program evaluations among key populations, including people who inject drugs in Iran, the US, and other countries in Asia and Africa. He is also the Associate Program Director of the PhD in Global Health Sciences at UCSF. His second affiliation, as adjunct assistance professor, education manager and senior research specialist, is with the HIV/STI Surveillance Research Center (a WHO Collaborating Center) in Iran. He is a fellow member of SAPHIR, the Scientific Association for Public Health in Iran.

Dr Mirzazadeh has contributed to the national and global response to the Covid-19 pandemic with the following specific activities:

- Led the data collection, extraction and analyses of secondary data collected for a systematic review to evaluate the epidemiological characteristics of Covid-19 (the manuscript is under peer review with Annals of Internal Medicine)
- Contributed to conceptualizing a compartmental model for Covid-19 and interpreting the results to guide policy and public health interventions to mitigate the epidemic in Iran (the manuscript is drafted and ready for submission to Lancet Global Health)
- Designed a cohort study to investigate the incidence rates and associated factors of novel coronavirus in Iran (the study has been piloted successfully and launched)
• Evaluated strategies to lift or relax the physical distancing interventions in Iran, an experience that can also help other countries to optimize their interventions and strategies (the concept has been discussed and approved, modelling is underway)

Dr Mirzazadeh will provide technical support and contribute to scientific discussions, conceptual development and policy analysis within the CoMo Consortium.

Sana Eybpoosh

Sana Eybpoosh, MSc, PhD is an Assistant Professor of Epidemiology at the Pasteur Institute of Iran. Dr Eybpoosh completed her MSc at Tehran University of Medical Sciences, Iran, in 2010, and received her PhD in Epidemiology from Kerman University of Medical Sciences in 2016. Dr Eybpoosh’s research and teaching interests include the epidemiology of infectious diseases. Specifically, she is interested in molecular epidemiology, dispersal patterns, transmission dynamics and the emergence and reemergence of viral infections, especially RNA viruses. Dr Eybpoosh is the Vice Chancellor of Research at the WHO Collaborating Centre for HIV Surveillance in Iran. She is also an elected member of the Strategic Council of the National Network on Emerging and Reemerging Infectious Diseases in Iran, as well as a member of Iran’s National Committee on Antimicrobial Resistance. She is currently an invited member of the National Committee on Covid-19 Epidemiology in the Ministry of Health and Medical Education of Iran. Dr Eybpoosh has contributed to the national and global response to the Covid-19 pandemic with the following specific activities:

• Led the cross-validation of models based on national-level empirical data related to Covid-19.
• Contributed to the conceptualization of the compartmental model and interpreting its outputs to guide policy and public health interventions to mitigate the epidemic in Iran. (A manuscript has been drafted and is ready for submission to Lancet Global Health.)
• Contributed to designing and implementing a cohort study to investigate the incidence rates and associated factors of novel coronavirus in Iran (the study has been successfully piloted and launched).

Dr Eybpoosh will provide technical support and contribute to scientific discussions, conceptual development and policy analysis within the CoMo Consortium.
Prof Roberto A Kraenkel

Institute of Theoretical Physics, Sao Paulo State University

Roberto is a theoretical physicist presently working on mathematical biology and complex systems, with applications to ecology and epidemiology. He is interested in infectious disease dynamics, with a view to real-world applications. He studies models and compares them with data. Recently, he has been engaged in new frameworks that use recent advances in time-series analysis to seek causal relationships between infectious diseases and environmental/climatic factors.

In the CoMo Consortium, Roberto supports the development of the model and the communication of results to policymakers in Brazil.

Caroline Franco

Institute of Theoretical Physics, Sao Paulo State University

Caroline holds an MSc in Physics and is studying for a PhD in complex systems, focused on mathematical modelling of infectious diseases, especially vector-borne diseases, such as dengue and malaria. Her work combines both data-driven and mathematical modelling approaches.

Caroline is working with the CoMo Consortium on model development for Brazil.

Dr Renato M Coutinho

Center for Mathematics, Computation and Cognition, Federal University of ABC

Renato’s research essentially encompasses mathematical modelling applied to ecology, epidemiology and evolution, often in collaboration with biologists and ecologists. The main motivation is understanding biological systems (such as populations, communities, and the spread of infectious
diseases) through mathematical models, using tools such as differential and difference equations, making frequent use of numerical simulations.  

**Renato is working with the CoMo Consortium on model development for Brazil.**

![Sunil Pokharel, MD](image)

**Sunil Pokharel, MD**  
World Health Organization, Nepal

Sunil Pokharel, MD, MSc is a medical doctor and public health practitioner with a focus on global health, infectious diseases, epidemiology, mathematical modelling, health systems and policy. He is currently serving the World Health Organization in Nepal as a Surveillance Medical Officer. Over the last decade, Sunil has contributed to the fields of clinical medicine, public health, research and policy. Sunil received his academic training from the Institute of Medicine, Nepal and the University of Oxford, UK.  

**Sunil is working with the CoMo Consortium to customize the model for the country setting of Nepal and working with policymakers for its application.**

![Siyu Chen](image)

**Siyu Chen**  
Nuffield Department of Medicine, University of Oxford

Siyu is a PhD student at the Nuffield Department of Medicine, University of Oxford, under the supervision of Prof Lisa White. Prior that she obtained a BA and an MSc in Statistics. She has experience in statistical modelling. Her research interests focus on global health and policymaking as a mathematical and statistical modeller.  

**Siyu is supporting the COVID-19 modelling for Afghanistan. She is also helping in economic modelling and volunteering to test the model for the consortium.**
Dr Phetsavanh Chanthavilay
University of Health Sciences, Lao PDR

Phetsavanh Chanthavilay, who graduated with a PhD in epidemiology in Canada, is currently working at the University of Health Sciences in Vientiane, Lao PDR, as a lecturer and researcher. His PhD thesis was on economic modelling of HPV vaccination to prevent cervical cancer in women in Lao PDR. His research interests are public health interventions and health economic evaluation. **Phetsavanh is currently appointed to work on Covid-19 modelling for Lao PDR using the CoMo Consortium model in collaboration with other international experts. He is also involved in testing the CoMo model and its interface and providing feedback to the CoMo Consortium.**

Prof Mayfong Mayxay
University of Health Sciences, Ministry of Health, Lao PDR
Lao-Oxford-Mahosot Hospital-Wellcome Trust Research Unit, Mahosot Hospital, Vientiane, Lao PDR

Mayfong Mayxay is a medical doctor specialised in infectious diseases and tropical medicine; he completed his PhD in clinical tropical medicine at Mahidol University, Thailand in 2001. Between 2002 and 2006, he carried out his Wellcome Trust Fellowship training in clinical tropical medicine, which was associated with Mahidol University and the University of Oxford. In 1999, he co-founded a clinical research unit, the Lao-Oxford-Mahosot Hospital-Wellcome Trust Research Unit (LOMWRU), at Mahosot Hospital, Vientiane, Lao PDR. He was the key person involved in establishing the first Lao Ethical Committee in 2002 and the first Lao Medical Journal in 2009. More recently, he co-founded the Unit for Health Evidence and Policy (UHEP) at the Lao University of Health Sciences, Ministry of Health. His research interests include antimalarial drug resistance (AMR), causes of fever, sepsis, dengue, rickettsial infections, melioidosis, leptospirosis, Japanese encephalitis virus infection and infantile beriberi. **Prof Mayfong is currently the Vice-President of the University of Health Sciences (UHS); Chairman, Research Promotion and Management Committee, UHS; President of the Lao Infectious Disease Society (LIDS); Vice-President, Lao National Immunization Technical Advisory Group (NITAG);**
Head of Field Research at LOMWRU; and an Honorary Visiting Research Fellow and a Visiting Professor in Tropical Medicine at the University of Oxford, UK. Prof Mayfong is supervising and supporting the Laos country team for Covid-19 modelling and using the CoMo model for Laos.

Mick Soukavong

University of Health Sciences, Lao PDR

Mick Soukavong has been working in academia since he completed his BS in Mathematics at the National University of Laos (NUOL) in 2009. He was immediately engaged as a Lecturer in the University of Health Sciences, while completing his Master’s degree with the Department of Preventive Medicine, Seoul National University, Korea. His Master’s thesis was on pharmacovigilance data mining for amoxicillin using the Korea Adverse Event Reporting System Database. His research interests are in the areas of public health and pharmacoepidemiology. 

Mick is currently appointed to work on Covid-19 modelling for Lao PDR using the CoMo Consortium model in collaboration with other international experts. He is also involved in testing the CoMo model.

Sai Thein Than Tun, MD

Mahidol-Oxford Tropical Medicine Research Unit
Nuffield Department of Medicine, University of Oxford

Sai is a DPhil candidate at the University of Oxford, focusing his research on the mathematical modelling of malaria elimination in dynamic populations. He is a medical doctor by training and has a master’s degree in demography and health. He is passionate about data science and data-driven health care. 

Sai is participating in the CoMo Consortium to provide mathematical modelling support to the Lao PDR and Myanmar country teams.
Dr Shwe Sin Kyaw

Mahidol-Oxford Tropical Medicine Research Unit

Shwe Sin is an economic modeller currently focusing on costing different malaria interventions to support global malaria elimination. She developed a malaria mass intervention costing model to help policymakers estimate the programme costs of mass malaria interventions using different targeting strategies.

As a member of the CoMo Consortium country team for Myanmar, Shwe Sin is providing support in both epidemic and economic modelling.

Yu Nandar Aung, MD

London School of Economics and Political Science

Yu Nandar Aung is a medical doctor with a public health background. She has worked with various organisations in the South East Asia region, for different health programmes. She is currently working full-time with a UN agency in Lao PDR as a public health specialist and fund manager, providing support to the Ministry of Health and other organisations. She is also completing a part time master’s in health economics, health financing and policy with the London School of Economics and Political Science.

Yu’s support of the CoMo Consortium is mainly through the lens of policy and operation. This involves testing the model, providing feedback on the model outputs, providing advice on tailoring the model structure to an individual country’s context/need, reaching out to policymakers, and generating policy advocacy pieces. Yu is also supporting the economic analysis function of the CoMo Consortium. Currently, Yu is helping with the CoMo country models for Myanmar and Lao PDR.
Dr Sheetal Silal

Modelling and Simulation Hub, Africa (MASHA), University of Cape Town
Nuffield Department of Medicine, University of Oxford

Sheetal is a mathematical modeller and statistician focusing on infectious diseases in South Africa, sub-Saharan Africa and the Asia Pacific region. Her interests are in epidemiological and economic modelling to support intervention planning and policy development. Sheetal is the Director of MASHA and an Honorary Visiting Research Fellow in Tropical Disease Modelling at the University of Oxford.

**Sheetal is providing technical support to national teams in Africa who are participating in the CoMo Consortium.**

Rachel Hounsell

Modelling and Simulation Hub, Africa (MASHA), University of Cape Town
Nuffield Department of Medicine, University of Oxford

Rachel is a health economist and mathematical modeller with an interest in applied research for policymaking. Her modelling focus is on vaccine-preventable diseases, malaria, and epidemic modelling. She has experience in public health, intervention planning, project management, communications and stakeholder engagement. Rachel will be starting her PhD at the University of Oxford later this year.

**Rachel is providing technical support to national teams who are participating in the CoMo Consortium.**
Jared Norman  

Modelling and Simulation Hub, Africa (MASHA), University of Cape Town

Jared is a computer scientist with a background in pure and applied mathematics. His research interests are in agent-based modelling and simulation, GPU computing, and mathematical modelling of infectious diseases. He has experience in the development of user-friendly computer applications designed to allow policymakers to run simple mathematical models and navigate the output of complex models with the aid of interactive graphs.

**Jared is providing technical support to national teams who are participating in the CoMo Consortium.**

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Chris Erwin G Mercado, BSN, MPH, MSc, RN, USRN

Independent Researcher

Chris is a public health professional from the Philippines. He works as a Technical Officer for the Asia Pacific Malaria Elimination Network (APMEN) Secretariat in Singapore. Chris was a postgraduate researcher in Epidemiology at the Mahidol Oxford Tropical Medicine Research Unit (MORU) in Thailand, where he supported the collection, collation, and analysis of datasets on malaria surveillance in multiple countries in the Asia Pacific region, for the development of disease risk maps and mathematical models to support malaria elimination efforts.

**As a member of the Philippines team, Chris is seeking to test and compare the CoMo Consortium model against other local modelling efforts in the Philippines and engage local decision makers in its use. Chris also aims to support evidence synthesis to inform the potential development of a local model and policy brief.**

John Robert C Medina, RMT, MD, MHS  
Department of Epidemiology and Biostatistics, College of Public Health, University of the Philippines Manila

Robert is an Assistant Professor, teaching courses on biostatistics and epidemiology at the College of Public Health of UP Manila. He has obtained his primary medical qualification and a post-graduate degree in global health. His training and experience in the field of public health and global health focus on the epidemiology, prevention, and control of infectious diseases such as dengue, soil-transmitted helminthiases, schistosomiasis, and Zika virus. His research interests include the use of geographic information systems and spatial statistics in public health, application of mixed-methods design, and disease surveillance. He is currently part of a working group composed of public health professionals from UP Manila-CPH and the World Health Organization Country Office that supports the Department of Health in strengthening Covid-19 surveillance in the Philippines.

As a member of the Philippines team, Robert is aiming to test and compare the CoMo Consortium model with existing local models that have previously been developed. By engaging key stakeholders who are involved in decision-making, he will support evidence synthesis to inform the potential development of a local model and policy brief.

Inke Lubis, MD, PhD  
Department of Paediatrics, Faculty of Medicine, Universitas Sumatera Utara, Indonesia  
Tropical Medicine Master Programme, Universitas Sumatera, Indonesia

Inke is a paediatrician and an infectious diseases researcher. She is currently posted as the Course Director of the Tropical Medicine Master Programme at the Faculty of Medicine, Universitas Sumatera Utara, Medan, Indonesia. She holds a PhD in Tropical Medicine from the London School of Hygiene and Tropical Medicine. She is a member of the Indonesian Paediatric Infectious and Tropical Diseases Working Group, a consultant for the Indonesian National Malaria Control Programme, and a Young Representative for Indonesia at the European Society for Paediatric Infectious Diseases.

During the Covid-19 pandemic, Inke is the regional coordinator for paediatricians working in hospitals treating patients with Covid-19. As well as working with the CoMo Consortium, Inke is part
of the Covid-19 task force for the North Sumatran region on public health strategies and their implementation.

Ivana Alona, MD, MPH
Department of Public Health, Faculty of Medicine, Universitas Sumatera Utara, Indonesia
Universitas Sumatera Utara Hospital, Medan, Indonesia

Ivana is a medical doctor and public health professional with a focus on infectious diseases, epidemiology, social behavior and community health interventions. She is a lecturer at the Department of Public Health, Faculty of Medicine, Universitas Sumatera Utara and a medical doctor at Universitas Sumatera Utara Hospital. She obtained her Master’s in Public Health from the University of Adelaide in 2010. She has secured a place on a short course in Public Health research methods provided by Westat, a research company in Maryland, USA. She has more than five years’ experience as the Chief Coordinator of a tuberculosis control programme to empower communities in Indonesia, with the support of USAID. This program contributed to community mobilization, including increased awareness, case finding, contact tracing, access to health care, community psycho-social support, and advocacy to local and provincial governments for sustainable tuberculosis control.

During the Covid-19 pandemic, as well as assisting the CoMo Consortium, Ivana is working with the North Sumatera government on public health strategies to reduce the transmission and burden of this infection.

References


