The Global Dimensions of Pandemic Modelling

Dr. Giorgos Galanis (Goldsmiths, University of London) and Dr. Adam Hanieh (SOAS, University of London)

Dear Editor,

In the recent editorial "Modelling the pandemic" [1] Devi Sridhar and Maimuna Majumder raised a number of issued related to the use of mathematical models in guiding the policy response(s) to the current pandemic. We agree both with the fact that the models have key limitations based on their necessary simplifying assumptions and also with the necessity of using models as a policy tool. In this response we want to argue that the predictive power of epidemiological models – and their utility as a policy tool – could be significantly improved through a more robust consideration of global socio-economic inequalities.

Much of the global debate on the contagion dynamics of COVID-19 relies upon projections developed through the use of compartmental epidemiological models. This approach divides a given population into relevant compartments – one common sub-division is between Susceptible, Infected, Recovered, and Deceased – and then models the probability of individuals moving between these compartments. Within this, an important policy focus has been the effectiveness of different combinations of non-pharmaceutical interventions (NPIs) in reducing the transition probability from Susceptible to Infected. A rapidly growing literature utilises compartmental models to analyse various factors influencing COVID-19's transmission and fatality rates – this includes research into the impact of individual compliance with physical distancing measures, the timing and character of other NPIs, and the reliability and homogeneity of government data [2, 3, 4].

It is our contention, however, that global socio-economic inequalities, should be incorporated to these models. Socio-economic conditions determine the capacities of states to implement NPIs as well as the ability of populations to comply with them – they thus have a considerable effect on the transmission and fatality rates of COVID-19. This is particularly important for low-income countries, where poverty and inequality present significant obstacles to standard containment and mitigation measures derived from compartmental modelling.

One example of such socio-economic factors is the nature of work and employment. According to the OECD, around 70% of all employment in developing and emerging countries takes place in the informal sector, where labour is unregulated, intermittent, and poorly remunerated [5]. In these conditions, it is very difficult to enforce longer periods of lockdown and social isolation because the majority of the population depends upon immediate daily wages for survival and lack prior savings. Indeed, as part of their COVID-19 strategy for developing countries, the International Labour Organization has acknowledged that 'physical distancing measures' are an 'impossible choice for informal economy workers' [6].

A further example is the provision and quality of housing. An estimated one-quarter of the world's urban population currently live in slums and other types of informal housing [7]. For some cities in the developing world, the proportion of people living in slums can reach up to

80% of the total population [8]. As with conditions of labour, such living arrangements present severe obstacles for those attempting to quarantine or self-isolate. Informal housing typically consists of multiple families sharing single dwellings, and intergenerational family units that can bring vulnerable populations into close contact with potential sources of infection. Shared infrastructures – including water, sewage and sanitation – present further potential vectors of infection, a problem exacerbated by high population densities and the poor quality of this infrastructure.

To be clear, this is not a criticism of modelling *per se* but a call for a more socially grounded and globally inclusive approach to these techniques. Socio-economic conditions such as those noted above bear directly on how many people get infected, how quickly these infections take place, the likelihood of dying, and the efficacy (and available choices) of NPIs. From the perspective of a compartmental epidemiological model, these social conditions shape the 'transition rates' between compartments, and it would be a relatively straightforward proposition to build an expanded model that incorporates these factors. Moreover, while our discussion has largely focused on differences between poorer and richer countries, the same approach could also be used to model the impact of socio-economic differentiation within individual countries.

There are numerous other socio-economic conditions that could (and should) be considered in developing such an expanded model – quality of health systems, gender inequalities, educational disparities, the prevalence of diseases associated with poverty, levels of government expenditure on social services, and so forth. Data on all of these indicators are widely available from government statistical agencies and multilateral development institutions, and could be deployed in model simulations. Incorporating these factors into epidemiological models further strengthens the argument that poverty is an issue of public health and must be treated as such. It also echoes the recent call by *Lancet Global Health* editors for a decolonised approach towards COVID-19 [9]. In the face of a pandemic that has potentially very serious implications for the world's poor, epidemiological models that foreground global inequality could make an important contribution to the immense public health challenges presented by COVID-19.

References

[1] Sridhar, D, Majumder, D. Modelling the pandemic. *BMJ.* 2020: 369:m1567. doi: https://doi.org/10.1136/bmj.m1567

[2] Prem, Kiesha et al. The effect of control strategies to reduce social mixing on outcomes of the COVID-19 epidemic in Wuhan, China: a modelling study. *The Lancet Public Health*, 2020; Volume 5, Issue 5, https://doi.org/10.1016/S2468-2667(20)30073-6

[3] Verity, Robert et al (2020) Estimates of the severity of coronavirus disease: a model-based analysis, *The Lancet Infectious Diseases*. 2020; Volume 20, Issue 6, 669 – 677 https://doi.org/10.1016/S1473-3099(20)30243-7

[4] Baskozos, G., Di Guilmi, C. and Galanis, G. Social distancing and contagion in a discrete choice model of COVID-19, University of Warwick, Centre for Research in Economic Theory and its Applications, Discussion Papers Series, 2020

[5] OECD/ILO (2019), Tackling Vulnerability in the Informal Economy, Development Centre Studies, OECD Publishing, Paris, https://doi.org/10.1787/939b7bcd-en.

[6] International Labour Organization (ILO). Rapid assessment of the impact of COVID-19 on enterprises and workers in the informal economy in developing and emerging countries. https://www.ilo.org/global/topics/employment-promotion/informal-economy/publications/WCMS_743032/lang--en/index.htm

[7] Habitat for Humanity. The World's Largest Slums. 2020; https://www.habitatforhumanity.org.uk/blog/2017/12/the-worlds-largest-slums-dharavi-kibera-khayelitsha-neza/

[8] WHO. Health and Sustainable Development: Slum Upgrading. 2020; https://www.who.int/sustainable-development/cities/strategies/slum-upgrading/en/

[9] The Lancet Global Health. Decolonising COVID-19. *The Lancet Global Health*. 2020; volume 8, Issue 5. https://doi.org/10.1016/S2214-109X(20)30134-0