Localising COVID-19 models to bring young people to the table

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... with Brahmni Nutakki, Quinn Kennedy, Harshita Magroria and Farrah Farnejad
Our overall aims ...

COVID-19 out-breaks are *local* ... so too are the health-systems to deal with them

It is helpful for citizens to *understand* about the outbreak

... so give everyone a tool they can use that gives *actionable* insight!
Young people can be effective advocates in this crisis.

Modelling targeted to help young people (and anyone else) understand how Covid 19 spreads and how policies may differ in each local area to get a better outcome.

- Covid 19 Mythology
- Out of the loop
- ‘Model mystery’
- Why comply?
Elements of the program ...

- A standard but accessible SEIR model
- Easy learning
- Real-world case support
- Real-world publicity
1. A standard but accessible SEIR model

Local population and other data

Local counter-measures

**WHAT THE MODEL SAYS IS “REALLY” HAPPENING .. only some of these cases are reported, and not all of the deaths**

With no counter-measures, numbers will be VERY large. Values may be displayed as ‘K’ (thousands) or ‘M’ (millions).

- **Susceptible**
- **Infected**
- **Resistant**
- **Deaths**

*Confirmed cases* are a small fraction of the total infected population - few mild cases get confirmed and there is a *very* large fraction with almost no symptoms.

*Active cases* are those currently being cared for - so total confirmed cases to date minus those who recovered or died. NOTE - real-world reported Active-Cases data are meaningless, since there is no way to track all Recovered.

Click here to learn what the model is doing. A Glossary of terms is here. COVID can move from “no problem” to “major crisis” VERY fast, so coverage and timing of reported data is problematic. more here.

Local prospects and policy recommendations

The Covid 19 Localisation Modelling Group
2. Easy learning

Course 1: Modelling how a disease spreads - the basics!
- 9 Lessons
- Free

Course 2: Setting up the Localised COVID-19 model for your chosen area
- 16 Lessons
- Free

<1 hour: basics of disease dynamics

1-2 hour: The COVID-19 model

See ... sdl.re/COVIDcourse

The Covid 19 Localisation Modelling Group
3. Real-world case support

webinar-demos [recordings available]

... plus direct team support

The Covid 19 Localisation Modelling Group

See ... localcovid19model.org/
Some of the extended team ... 

Harshita Magroria, student at University of Mumbai - led a 5-person team on the outbreak in L-Ward and discovered the big differences in out-breaks and policy between slum and non-slum areas

Brahmani Nutakki, student at University of Hyderabad - winner of a hackathon on automating predictive models of Covid 19 – her Delhi study accurately predicted current surge in infections back in September 2020

Farrah Farnejad, student at Queen Mary University, London - won our Covid 19 Youth Modelling Competition modelled the borough of Westminster and impact of the new mutation

Quinn Kennedy, a high School Student at Fordham Prep in the Bronx - New York boroughs analysis and estimated likelihood of herd - helped develop our course
The chronological order of the students' work ...

New York / Bronx (*Quinn*)
Mumbai slums and city / Delhi (*Harshita and Brahmani*)
London / Westminster (*Farrah*)

See ... [localcovid19model.org/](localcovid19model.org/)
COVID-19 in Bronx Count: Herd immunity or not?
I chose to model the Bronx because it is where my school is located, and when my dad told me I would probably be unable to return to school in September, I didn't believe him. I predicted that the worst is over after looking at the case totals and seeing the pandemic cooling off in mid June from the first wave. I figured even if a second wave occurred, it would not be nearly as devastating. To say I was wrong is an understatement!
Early predictions ...

I concluded that I should investigate herd immunity because of what our model was predicting with parameters I believed to be reasonable.

No significant spike in cases from BLM protests, and we had other anecdotal evidence that case-rates were not increasing from an NYC doctor.

I stress tested the model by altering 14 of the most important variables to see how the model reacted. Each of the model predictions is represented by a unique color line in the second graph. Only with drastic changes to the % of the population with very low symptoms parameter did the model notably change (brown Line).
What we were uncertain about ...

Our predictions were too good to be true; Bronx Case totals doubled to date compared to August 31.

In hindsight, we should have considered seroprevalence data of 22% from plasma samples of 10,000 New Yorkers up to July 5.

Takeaway: Always ask: What am I assuming? How can this possibly be wrong?

Since cases accumulated much too fast through our model, other error may come from assumptions of:

- 6.5 Contacts/day
- Too severe Lockdown
- 22% Mild Cases Reported

Fractional reduction in normal contact rates during 2020
Mumbai Slums-v-City ... and Delhi

The story of our work:

Understanding the early out-break in the slum district of Mumbai (L-Ward)

Contrast with the very different growth of the out-break in nearby non-slum areas

Comparison with how the out-break developed in Delhi
Co-existence of slums & non-slums in Mumbai

Slum and non-slum districts are very close in Mumbai and other cities - surely the epidemic will behave differently?
Our results were consistent with reported cases (unreliable!)

... and with more reliable seroprevalence and reported deaths, allowing for under-reporting

By December nearly everyone likely to be infected and resistant.

The virus swept through the slums in the initial outbreak of the pandemic due to:
Very high contacts/person per day
Limited protection or healthcare

seroprevalence 57% in July
In September, most people in non-slum districts were still susceptible

... leaving open a big surge in cases and deaths through December-February, if lock-down were to be released.

In non-slum districts infections would likely not peak until January 2021, with many more deaths than in the slum districts

seroprevalence 16% in July
Delhi analysis, September

Following a good explanation of reported cases to date, there was a likely larger 2\textsuperscript{nd} wave of cases, with only a small relaxation of contact rates.

Note the very variable reporting quality - even of \textit{deaths} data - which should be more reliable than it is!
Mumbai / Delhi observations

There is a lack of district-level data for Delhi: Mumbai has ward-wise breakdown of data – but district differences are important!

Delhi has since conducted more tests/million than Mumbai.

Are there irregularities in registering deaths due to the virus in Delhi and Mumbai?

Model-estimates of likely reported deaths-per-capita

Delhi projected death-rate may disguise big differences between Delhi slum/non-slum districts
Recommendations from the Model

**Mumbai**

**Non-slums:** Continue rampant testing through RT-PCR test kits, testing both symptomatic and asymptomatic people.

Conduct seroprevalence survey with large and diverse sample size.

**Slums:** Use modeling to anticipate reinfections – and test, in case.

Involve urban local government leaders to promote hygiene standards.

**Delhi**

Continue extensive testing but shift from Rapid Antigen Tests to RT-PCR Tests.

Continue limiting contacts/person/day, use makeshift quarantine facilities.

**Other Observations:**

Role of the Union Health Ministry and India’s Federal structure.

Assess impact of vaccination program.

Beware B.1.1.7 variant of COVID-19 in India.
Our experiences

Modelling the virus created a beautiful engagement between academic disciplines. It is a tool to anticipate the future and develop strategy to minimise the counter-acting force.

*Localisation* enables us to consider characteristics specific to an area and devise customised policies.

Comparing L-Ward, Mumbai and Delhi showed the similarities and differences in demographic and administrative structures of the cosmopolitans.

Insights from one region can be applied to other with systematic study of the odds.

Helped us analyse different factors and their varying effects on the spread of the virus.

Helped us gauge the actual spread of the virus and compared to the scenario that is being portrayed.

A very powerful tool that can be used without knowledge of System Dynamics modelling.
Westminster: tiny heart of the city, population 253,000
Westminster results: matched to reported data to December

A 3rd surge in cases was very likely if the 2nd lock-down totally ended

**Vaccines alone** could cut future deaths by 30%

... but 70% reduction in deaths was possible, with vaccines and continued vigilance (less than full lock-down)
The invisibles are critical to see highest impact actions

"What we see" reported is often inaccurate and misleading

"What we don't see" – mostly invisible, not reported, but critical to strategy
The mutation triple-whammy: infections surge before vaccines can help; risk of infection doubles; more people sent home

"What we see" reported

"What we don't see" – mostly invisible

data.london.gov.uk/dataset/coronavirus--covid-19--cases and COVID19 Localisation Modeling Group analysis
Overall learning and implications ...

System dynamics models can and should be accessible

Bright young people with no experience can "get it"!

Technical opportunity: mass-customisation with machine-learning

Articles with more detail on the Mumbai and UK work [localcovid19model.medium.com](http://localcovid19model.medium.com/)

Our course with links to additional articles [covid-19-localisation-modelling.thinkific.com](http://covid-19-localisation-modelling.thinkific.com/)

The online course ... [sdl.re/COVIDcourse](http://sdl.re/COVIDcourse)

Any questions to ... [info@localcovid19model.org](mailto:info@localcovid19model.org)