The devil in the Covid-19 detail

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As deaths stack up and steeply inclined graphs of casualties reflect our new dystopian normality, the story contained within Mark Shannon tweets of how he lost his fight against coronavirus disease 2019 (Covid-19) is sobering to read. He was a young IT professional in UK, working from home and diligently looking after his 5-month-old baby. He seemed very worried about the pandemic and had researched it. He went out of his way to take precautions against it. On 16th April he tweeted proudly about his parenting skills. On April 25th, he died from Covid-19 after a short but brief period in hospital. Mark Channon could have been any of us. Mark Channon could be any of us.

Understanding why someone as careful as Mark Channon could get infected and subsequently die as a result of Covid-19 requires understanding the epidemiological framework called SIR that describes how epidemics unfold. Individuals in a population can be either infected (I) or not infected. The non-infected can either be individuals who have never been infected and are thus susceptible to infection (S) or individuals that have recovered (R) from the diseases and thus are immune to the disease. The infected could pass on the infection to the susceptible through contact. The *reproduction rate* in this framework is the number of people each infected individual infects on the average. If the reproduction rate is less than, the contagion will slowly dwindle away. The necessary condition for an epidemic in any population is that reproduction rate is greater than one.

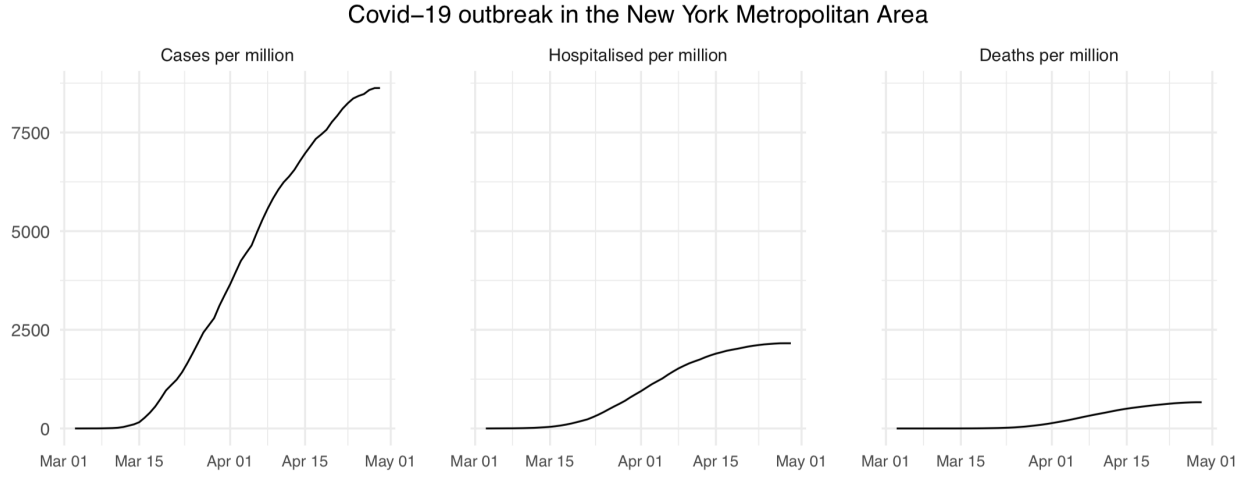

Figure 1: Covid-19 Cases and Deaths in New York City

There are two distinct stages in how a typical epidemic unfolds. The initial stage is where the pool of infected is very small in the population and the probability of a susceptible individual coming in contact with an infected person remains low. The infection grows very slowly in this stage. If the reproduction rate remains unchecked, the pool of infected grows slowly and steadily and the probability of susceptible individuals coming in contact with infected individuals increases with it. As the pool of infected becomes large, the probability of susceptible coming in contact with an infected person becomes high and the infections start growing exponentially. Covid-19 can potentially have an extremely high reproduction rate because it is an

extremely infectious disease and the infection period where the infected individual remains asymptomatic is extremely long, giving them time to infect the people they have proximal contact with.

In Figure 1, we can discern the two distinct phases of growth in the Covid-19 outbreak in New York City. The cases per-million increase slowly at first and start growing exponentially once a sufficiently large proportion of New Yorkers were infected.

The South Korean were able to stop the epidemic by taking decisive action early on. On 8 March 2020, the authorities in South Korea were notified of a confirmed case of Covid-19 in a person working on 11th floor of a 19 storey building in the busiest part of Seoul. S. Park et al. (2020) reports how the authorities immediately closed down the building and tested 1,143 individuals who either worked or lived in the building. 97 individuals of those people tested positive for Covid-19 were quarantined immediately. This implies 8.5% of people in the building had got infected. Off the people working on the 11th floor, 43% had got infected. This case illustrates a number of key points that need to inform the policy response to Covid-19.

The urban spaces that have been the location of Covid-19 clusters across the world. It turns out that population density is one of the key determinants of Covid-19 reproduction rate.

Urban areas have enclosed focal points for dense human interaction, which makes them more vulnerable to Covid-19 outbreaks. These focal points are markets, places of work and transport networks. Qian et al. (2020) study 318 outbreaks involving 1245 confirmed cases in 120 prefectural cities across China and find that all but one case of infection occurred in an indoor environment with 34% cases occurring in a transport setting. This may explain why the spread of Covid-19 hitherto has been correlated with urbanisation. At this stage, the available data shows the Covid-19 cases and deaths per million in a country is positively correlated with the extent to which it is urbanised.

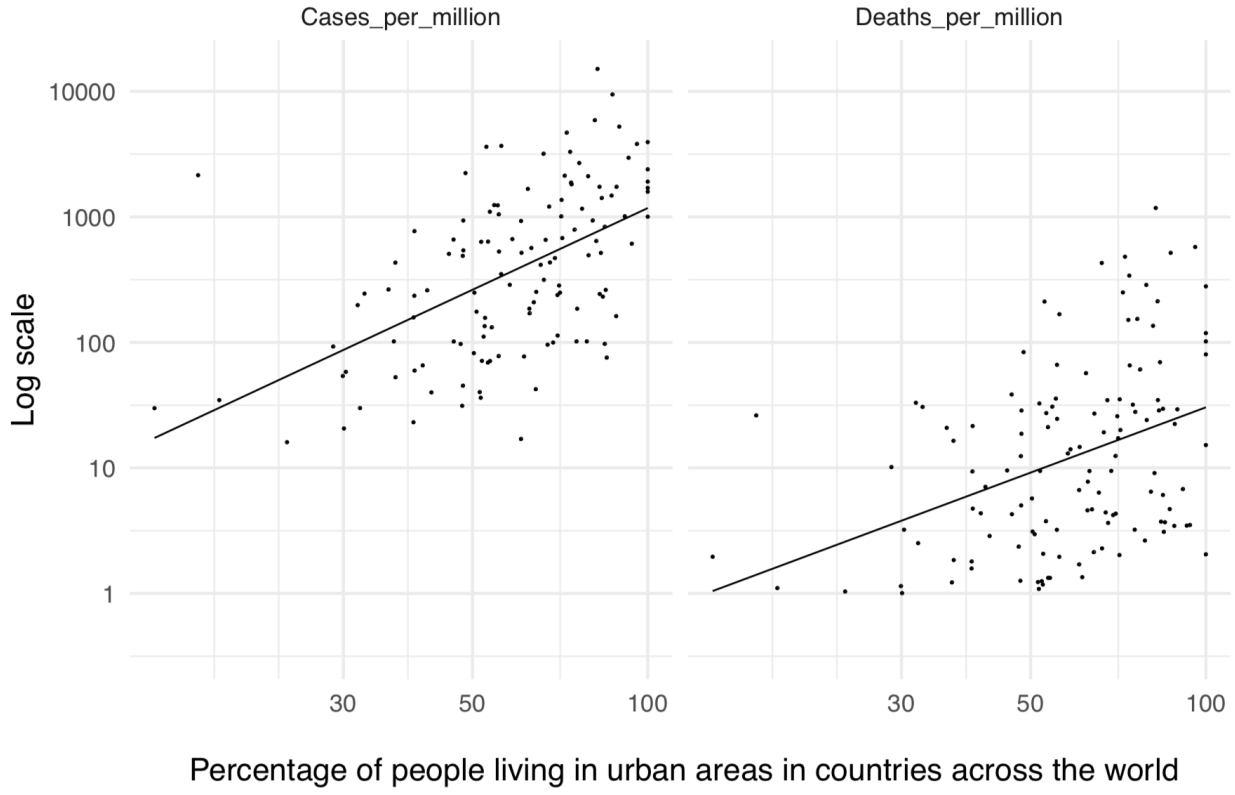

Figure 2: Figure 2

In India, approximately 34% of people live in urban agglomerations. This means only one-third of the country

is in a high-risk Covid-19 environment. Conversely, the population density in urban areas is extremely high. Mumbai's population density at 83,660 people per square kilometre is comparable to Manhattan's density of 71,340 people per square kilometre. There are densely populated high-risk areas all across India.

The detail of on-going research can help India avoid the devastation experienced by cities like Milan, New York and London. Several recent papers have shown the flow of air plays a critical role in preventing transmission in a confined environment. In an article published in Emerging Infectious Diseases, Lu et al. (2020) carefully study the transmission of Covid-19 in a Chinese restaurant in early February where an infected person passed on the infection to people sitting on three tables in one row but not to the rest of the people in the restaurant. What is surprising was that the infection pattern was consistent with the airflow pattern created by the air-conditioning.

In a paper published in the scientific journal Nature on 27 April 2020, Y. Liu et al. (2020) examine the aerosol concentration of Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2) RNA concentration within two Wuhan hospitals. They found that the aerosol concentration of SARS-CoV-2 RNA was low in well-ventilated areas like the isolation wards but much higher in low ventilated areas like the patient's toilets and staff areas. Louise Walsh from Cambridge University[1] shows that replacing the standard mixing ventilation in hospitals with partial cross-ventilation reduces the risk of Covid-19 infection between patients in hospitals.

What matters is not whether an interaction between the infected and the susceptible occurs, what matters is where it occurs. The reproduction rate is higher indoors. Further, the pattern of ventilation and airflow in confined spaces is one of the key determinants of the reproduction rate. Morawska & Cao (2020) is emphatic in arguing that recognising the risk of transmission in confined spaces is key to fighting the Covid-19 epidemic.

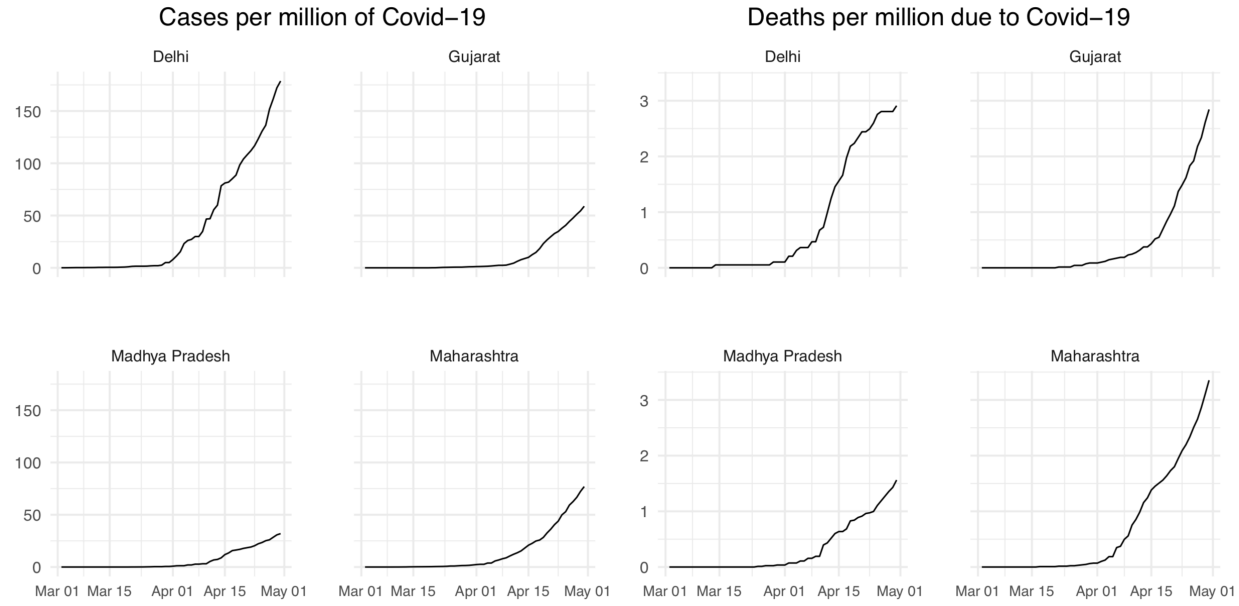

Figure 3: Covid-19 Cases and Deaths in Delhi, Gujarat, Madhya Pradesh and Maharashtra

The approach to Covid-19 till now has been a uniform policy of social distancing. Imposing perfect lockdown across India is a gargantuan task with obvious social and economic costs. The figure below shows that despite lockdown in India there has been an uptick in Covid-19 related deaths in four states. According to the currently available data, the death rate is about 3 per million in these states. The concern is that there seems an almost imperceptible, yet discernible pattern of exponential growth that indicates an increasing pool of infected in these states.

[1] https://www.cam.ac.uk/stories/emergency-hospitals

Covid-19 clusters have their own endogenous pattern that do not respect administrative boundaries. Aggregated data can often create a misleading picture and obscure the devil in the detail. With Covid-19 it is the detailed understanding of the spatial clustering of Covid-19 infection. Fighting the Covid-19 epidemic requires real time-mapping and data-driven approach like the one used by the army and scientists in the ultra-orthodox community in Bnei Brak[2] or South Korea.

Each Covid-19 cluster creates a pattern of death and destruction in its own unique way. Each Covid-19 cluster offers lessons in how future deaths can be prevented. South Korea's ability to contain the outbreak stemmed from the lessons they had learnt from the experience of dealing with previous outbreaks of SARS and MERS. How India deals with Covid-19 depends on whether it learns lessons from its early clusters and use the information to redesign its urban spaces to reduce the risk of transmission. It can be done. It just requires parsing the devil in the detail.

Reference

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[2]Ultra-Orthodox Enclave in Israel Opens to Outsiders to Fight a Virus, New York Times, 15 April 2020. Link