The nature of cities and the Covid-19 pandemic ☆

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The virtual issue will only include the main essay.

Commentary

Cities and population health are intrinsically interlinked [1,2]. Historically cities have systematically metamorphosed in response to threats posed to health and other kinds of security. The 18th century bubonic plague contributed to the emergence of Renaissance cities in Europe; the last three of the seven Cholera epidemics of the 19th century inspired a global sanitary movement in colonial cities; while the 20th century Spanish flu enlightened us of the value of non-pharmacological interventions as a mitigation strategy for controlling epidemics and a pandemic in urban environments [3]. The emergence of novel SARS-COV-2 coronavirus in Wuhan, China late December 2019 and the ongoing COVID-19 pandemic has to-date afflicted 26.65 million people with 875 371 deaths in 188 countries[1] and poses a major global threat to population health in centuries. Taking cues from history, in addition to clinical interventions for prophylaxis and treatment, the value of non-pharmacological interventions related to the design and planning of urban built environments has a primal role to play in the prevention and management of epidemics and pandemics.

Key attributes of urban built environment; the type and quality of housing, physical morphology (density, land use heterogeneity, configuration and design, locations of destinations and accessibility) as well as the quality of infrastructures (public transport, parks, sidewalks and boulevards) and level of services supported (recreational facilities, healthcare, food outlets/pubs and restaurants, supermarkets and groceries, places of worship etc) govern the relative locations of housing, jobs and services, and shapes population-level mobility, mixing and social networks. Cities are self-organizing clusters of humans, coming together to transact in pursuit of wealth and welfare. Living and working close to others is intrinsic to economic specialization and growth. The transport networks and neighbourhood configurations that accommodate human interactions have the potential to lessen/exacerbate infection transmission rates and influencing their frequency and severity. Urban built environment configuration has a major role to play before (prevention), during (containment and mitigation via segregation) and after (contingency planning and counter

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[1] https://coronavirus.jhu.edu/map.html.

measures for offsetting future risks) epidemics [4,5]. Emerging evidence points to the links between urban attribute-related individual activities and risks of infections [6]. While pathogens are spread by mobile vectors, a city's architecture shapes their flows.

A city's carrying capacity to support population and communities can be measured by its density and form. High density cities are synonymous with low per-capita living space and overcrowding. Although high density can mean spatial compactness, the highest density cities tend also to be larger and therefore have longer commute times. They have a higher propensity of social contact and transmission due to crowded indoor and outdoor living and through closely packed public transport systems. This is the case of cities such as New York, London and Mumbai, especially their inner neighbourhoods. Isolation and social distancing constitute key pillars in the fight against COVID-19, and density defines the intrinsic capacity of a city to implement preventive physical segregation policies in public transport, public spaces as well as shared services and facilities [7,8]. Urban density and residents' personal attributes configure the inherent characteristics of the underlying social networks in a city, which in turn is the key to effective post-lockdown social distancing [9]. Contingency post-pandemic urban planning might need to consider guidelines for density-specific social distances in mass transport systems, pedestrian sidewalks, parks, bars and restaurants and workspaces. Phased movement of people via optimization of frequency of transport and other services can be considered to minimize intersection of personalized activity niches. But in many developed cities, scheduling (of buses, trains) approaches maximal capacity for the existing design of stations, interchanges and tracks. Aversion to crowded public transport is likely to push more journeys onto private road-based transport, with attendant issues for road congestion. The only real scope of adjustment is in rescheduling working hours, which many cities have done in the Pandemic. Even cities running at near capacity on their road networks have some cyclical peaks, meaning that more private transport commuting can be accommodated by spreading home-work journeys. Something similar may be said for social infrastructure such as schools. School buildings are generally very inefficiently used, being unused at weekends and evenings. This gives scope for lower-density classes by spreading across time. But making more efficient use of educational space in cities, unlike road space, requires more labour input, and this is not generally, therefore a realistic option.

High density informal settlements of Lower and Middle Income Countries pose a different set of challenges [10,11]. Social distancing in settlements such as the *favelas* in Rio or the slums of Dharavi, Mumbai and Cape Town has thus far been difficult to implement as a result of overcrowding and resulting reduced capacity to

social distancing measures, hence focus has needed to be on personalized protection. Activity-friendly environments and travel can play a significant role in the fight against COVID-19 given the established links between physical activity, improved immune defense and reduced vulnerability to COVID-19 infections [12,13]. At the same time, personalized protection in parks, public spaces and while biking is necessary to reduce the risks of clusters developing when outside crowding replaces inside crowding [14]. The size of public green spaces in cities clearly influences this risk [15]. Planning standards for green space, which typically focus on pro rata provision (square meters pp) may need to be revisited to emphasis accessibility to large spaces. At a micro-level, housing attributes such as sanitation and ventilation system play an important role in infection transmission as has been evidenced in the public housing estates of Hong Kong [16]. Modular self-contained design has an in-built capacity to segregate and shield against risk of infection. Future housing must also focus on the creation of a multi-functional design with inherent abilities to couple living with working to enable work-from-home routines that can not only facilitate performance efficiency but also individual's wellbeing. This requires innovative design solutions in low-space settings, such as devising modular furniture. The spatial configuration and design of indoor public spaces (shopping malls, underground mass transit stops, indoor walkaways) requires specific focus, especially the need for flexible design with intrinsic ability to restrict encounters, overcrowding and mixing in diverse pandemic scenarios [17]. Mall design is, in any case, focused on spreading footfall throughout the building (for example by express lifts and escalators to higher floors), a criterion that is in keeping with social distancing if you abstract from the other criterion of maximizing people entering the building. Control measures to limit total volume and remote sensing and messaging to smooth congestion over shopping hours is a likely development.

The built environment configures the social environment and the two govern the extent of environmental and social disparity and relation to health inequity [18]. Vulnerable communities comprise population subgroups of low SES, specific ethnic minority, age group (for example, outbreaks in care homes for elderly in UK [19]) and those with underlying chronic conditions (diabetes, CVD, chronic lung disease kidney disease etc) [20,21]. For example, older adults with underlying conditions have higher risk of COVID-19-related complications and mortality [22]. People from black and Asian minority with lower SES [23,24] are also at higher risk. Also, low resource settings also act as proxies for poorer access to personal protective equipment, healthcare facilities and equipment (such as ventilators, negative air- pressure isolation rooms). Localized COVID-19 outbreaks among poorly housed migrant worker

communities emerged in Singapore [25] as well as among internal migrant workers of India [26]. Planning regulations governing high density migrant worker dormitories in rich countries are likely to change. Countries and ethnic communities where inter-generational habitation and socialization is common, experienced faster earlier transmission rates (Italy, for example [27]). Future research should focus on the interior design of residential micro-environments (where space is not a constraint) and fine-grained design of public spaces with a view to optimize mixing between age-groups with different levels of vulnerabilities to minimize transmissions in times of pandemic.

Surveillance and contact tracing are key to fighting COVID-19 pandemic. Smart-city tech is available for continuous surveillance and rapid response by individuals and building and space managers. Application of technologies is currently limited by privacy concerns, but these are being addressed rapidly, for example, with Google-Apple's contact-tracing platform that is hard-wired into the operating system of smart-phones. How governments make use of such tech along with other big data, AI and sensor technologies to identify source, trace transmission networks and target associated vulnerable populations with reasonable degree of accuracy will unravel in the next few years [28,29]. Workable smart apps for population-wide electronic surveillance are already operational in China[2], Singapore[3] and Germany[4] and there is a need for closer collaboration between hospitals, public health department, urban planning, transport, social services and other related departments with adequate ethical protocols for rapid mitigation measures.

The epidemic growth curve of COVID-19, as with other infectious diseases, is characterized by an initial establishment phase with high random effects; exponential growth phase during which the susceptibles get infected; a peak; and subsequent die-down phase as the susceptibles get exhausted. Urban health policy responses aimed at flattening the curve have involved stay-at-home orders, lock downs, school closures, thresholds on number of people purposefully gather and social distancing [30,31]. As populations are restricted indoors, into limited per-capita space, the role of neighbourhood built environment becomes ever more important; its restorative potential in maintaining emotional resilience and mental wellbeing as well as enabling adequate levels of physical activity, more so among the elderly to maintain cognitive and physical functional capacities [32,33]. The onslaught of multiple waves of COVID-19 epidemic requires a careful waxing and waning of policies to restrict population movement and mixing; following the *hammer and dance* approach [34] for the twin objectives of long-term public health and economic sustainability. An effective strategy will entail a degree of urban planning and design reorienting to make the built environment more resilient to pandemics and repeat epidemics; and a degree of re-organization of use of that environment, adjusting time-synchronization of working, shopping and recreation. Cities have taken shape over tens and hundreds of years around a simple diurnal pattern based around working in the day and sleeping at night. As a result, much urban space is underused and can be de-crowded by smoothing usage over daily and weekly cycles. The idea of planning, designing and managing cities for greater segregation and lower concentrations of people is a complete reversal of both the intrinsic dynamic of clustering that creates cities and the urban planning doctrines of the 20th century and longer. But it may be, if pandemic risk remains with us, that we are on the cusp of a new wave of de-densification, suburbanization, decentralisation. If so, then the electrified private transport and people carrying drone tech have arrived just in time.

The COVID-19 pandemic has opened up a crucial time-window of opportunity for urban scientists, planners and designers by unravelling before us the largest natural experiment [35] in multiple aspects of urban activities and population mobility, with half of the globe forced in to *lock-down mode*. The opportunity has come at a time when urban performance data is rapidly changing from aggregate to individual and from expensive periodic surveys to real-time remotely sourced. When John Snow employed a primitive GIS technique with point-based cholera epidemic data, the science of healthy cities changed and so did the built environmental response [36,37]. A new science of healthy cities is rapidly emerging as a result of large spatialized, gene-environment data platforms [38–40]. The emphasis in the past decade has been on sedentary disease. Now we have an old-fashioned infectious urban pandemic and the science of urban infectious health will respond accordingly. We are much better equipped than Snow and his colleagues, to employ data science to plan and design the built environment to create *healthy and resilient cities of tomorrow* with in-built abilities imprinted to address challenges posed by present and future pandemics.

Declaration of Competing Interest

The authors report no declarations of interest.

Acknowledgements

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[2] https://www.bbc.com/news/technology-51439401.
[3] https://www.tracetogether.gov.sg/.
[4] https://www.bundesregierung.de/breg-de/themen/corona-warn-app/unterstuetzt-uns-im-kampf-gegen-corona-1754756.

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