RESPONDING TO COVID-19 IN URBAN SETTINGS: EMERGING EVIDENCE, LESSONS AND A LOOK AHEAD

DISCUSSION PAPER

January 2021

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WORLD BANK GROUP
Health, Nutrition & Population

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Health, Nutrition, and Population (HNP) Discussion Paper

Responding to COVID-19 in Urban Settings:
Emerging Evidence, Lessons, and a Look Ahead

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Abstract: Metropolitan areas drive economies, yet the same elements that contribute to economic growth—such as industrialization accompanied by migrant influx—result in overcrowding and poor housing and sanitation. These factors, coupled with intensive international connectivity, make cities extremely vulnerable to pandemics. Experiences from New York and São Paulo show that complex administrative structures; conflicting messages from federal, state, and city governments; human resource shortages; supply chain mismanagement; weak coordination between hospitals and public health systems; and poor linkages with the private sector are all limiting factors of a comprehensive pandemic response. COVID-19 has seriously impacted the delivery of essential health services, especially in cities, where the private sector and public hospitals deliver a significant share of primary care. COVID-19 also presents a major public mental health challenge both for health professionals and the general public.

This paper brings together various local and global lessons, best practices, and emerging innovations to contain the COVID-19 pandemic in large urban areas. This paper aims to provide aid/guidance to municipal and national authorities, policy makers, and agencies leading COVID-19 responses across India and globally. Because COVID-19 is a relatively new disease, and evidence on effectiveness and impact of interventions and innovations is patchy, anecdotal, and still evolving, findings from this note must be interpreted with caution.

This paper does not address broader urban health systems challenges, but rather: (i) outlines factors that make Mumbai vulnerable to pandemics and describes the city's COVID-19 response; (ii) summarizes evolving global lessons from cities and urbanized countries in response to COVID-19; (iii) highlights initiatives and innovations of pandemic response with a focus on India; (iv) emphasizes what Mumbai has done well and what more needs to be done; and (v) presents medium- and long-term actions for integrated development of cities to prepare for future pandemics.

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PART I – KEY MESSAGES

COVID-19 has exposed the vulnerability of urban metropolitan areas to the devastating public health, human, and economic impacts of pandemics. Historically, urban areas have been overlooked by policy makers in planning and investments to strengthen preparedness for pandemics and other infectious disease outbreaks, and the devastating spread of COVID-19 has been a result of this error.

Effective preparedness for pandemics in urban settings enables a more efficient and swift response to COVID-19, as seen in Singapore, Taiwan, the Republic of Korea, and Japan. Investments to strengthen pandemic preparedness, administrative coordination, risk communication, and disease surveillance in urban settings can help offset the devastating costs of pandemic response.

As demonstrated by the impact of COVID-19 on Mumbai's Dharavi slum, the pandemic has both spotlighted and exacerbated social and economic inequities. Before and during pandemics, urgent attention must be paid to the most vulnerable populations, including poor communities, slum residents, indigenous communities, and elderly populations with comorbidities. Addressing multisector social and economic disparities is a matter of national health security.

Human resources for health (HRH) are the backbone of a successful pandemic response. Lessons from Mumbai, New York, and other urban metropolitan areas confirm the importance of supporting the health care workforce during pandemics with appropriately designed incentives, emotional support, and peer guidance coupled with training.

Full partnership with the private sector is essential to an effective pandemic response in urban areas, as demonstrated by the scale-up of diagnostic services in Mumbai and broadly across India.

PART II – EXECUTIVE SUMMARY

Metropolitan areas drive economies. Yet the same elements that contribute to economic growth, such as industrialization accompanied by migrant influx, result in overcrowding and poor housing and sanitation. These factors, coupled with intensive international connectivity, make cities extremely vulnerable to pandemics.

Experiences from New York and São Paulo show that complex administrative structures; conflicting messages from federal, state, and city governments; human resource shortages; supply chain mismanagement; weak coordination between hospitals and public health systems; and poor linkages with the private sector are all limiting factors for a comprehensive pandemic response.

Previous pandemics helped prepare cities and highly urbanized countries in East Asia to quickly contain the spread of COVID-19; identify and target clusters of infection; and comply with safety protocols in public places.

Pandemic responses should be dynamic and informed by science and evolving implementation challenges. Examples include ward-level war rooms to ensure swifter response and strengthened local accountability; active case finding in slums; and timely and comprehensive information sharing in the public domain on the evolving COVID-19 situation.

Socioeconomic vulnerabilities need priority attention, especially for slum residents, migrants, and elderly people with comorbidities, as social distancing is not always an option for vulnerable groups. Innovations in Dharavi include active case finding by trusted local volunteers and private practitioners, and institutional quarantine for most vulnerable groups. These approaches have demonstrated success in containing outbreaks.

Containment and quarantine compliance in cities with large migrant populations require decentralized decision making and partnership with citizens, not just policing. For example, Mumbai devolved authority to 24 wards to make decisions, as well as enhanced accountability to citizens. Effective risk communication by trusted community leaders and experts builds people's confidence in this expertise, which needs to be complemented by a sustained supply of essential commodities, precooked meals, and life-saving medicines.

Sudden surges in demand for intensive care can be addressed through innovations such as the "Tele-ICU" support for hospitals in Mumbai, Bangalore, and Karnataka (in partnership with leading private sector hospitals). Communities can play an essential role by providing home-based intensive care, as seen in Johannesburg, South Africa.

Cities with severely constrained hospital resources should explore home-based care models for less severe cases, such as those rolled out by Resident Welfare Associations in many cities in India; they can also establish private hospitals using nearby hotels.

Sudden surges of COVID-19 cases that lead to severe human resource demands in cities can be addressed through longer duration contracts with additional financial incentives; staff rotation from rural areas to cities; posting medical students and postgraduates; and using e-learning to upskill health care workers on COVID-19 management, as was done in Bangalore and Mumbai.

COVID-19 has seriously impacted the delivery of essential health services, especially in cities, where the private sector and public hospitals deliver a significant share of primary care. Geographic segregation of COVID patients in hospitals and staff rosters to ensure dedicated staff for delivery of essential services (as done by UK National Health Service) could help. Strengthening urban primary care remains a medium-term priority.

COVID-19 presents a major public mental health challenge both for health professionals and the general public. While promoting holistic mental health—as in Mumbai's quarantine facilities and COVID-19 Care Centers (CCCs) through meditation, yoga, and counseling—it is important to provide targeted support for groups at high risk, such as frontline workers and people with poor mental health.

Cities are hubs for private sector health care, which caters for a significant share of curative care. This situation changed rapidly with COVID-19, and the public sector ended up taking on the largest burden of COVID case management. Proactively and meaningfully involving the private sector—as most cities have done when scaling up laboratory services—in the development of pandemic preparedness plans and response will maximize the efficiency and effectiveness of a city's pandemic response.

An important route for the introduction of infections in cities are their wholesale and retail markets. Limiting such risks requires a One Health approach, with critical interfacing between animal and human health. City-level One Health coordination structures need to be created to provide early alerts on zoonotic diseases.

PART III – INTRODUCTION

COVID-19 has exposed the extreme vulnerability of large metropolitan communities to the devastation of pandemics. Cities worldwide are dealing with the consequences of changing population demographics and policies that have failed to effectively manage socioeconomic inequalities, mobility, and population health. Metropolitan areas in the United States, China, and India are predicted to see increases of populations by 33 percent, 38 percent, and 96 percent, respectively (United Nations Department of Economic and Social Affairs 2014). In India, cities are confronted with challenges that render the country's response to the pandemic especially complex. These factors include high population density, overcrowded slums with poorly ventilated housing, limited access to safe water and sanitation, weak linkages between public health and hospitals (both public and private), and complicated and poorly coordinated administrative structures that hinder access to essential services.

This just-in-time Technical Note responds to a Municipal Corporation of Greater Mumbai (MCGM) request to the World Bank's India COVID-19 Health Emergency Response Team to share local and global lessons, best practices, and emerging innovations to contain the COVID-19 pandemic in large urban areas. While Mumbai City health officials are the primary audience for this note, the findings and recommendations within can aid municipal and national authorities, policy makers, and agencies leading COVID-19 responses across India and globally. COVID-19 is a relatively new disease, and so evidence on effectiveness and impact of interventions and innovations is patchy, anecdotal, and still evolving. Thus, findings of this note need to be interpreted through that lens. Additionally, broader urban challenges receive limited attention here, given the MCGM's request to focus on health systems.

This note is organized into five parts. The first part outlines factors that make Mumbai vulnerable to pandemics and describes its COVID-19 response. The second part summarizes evolving global lessons from cities and urbanized countries in responding to COVID-19. The third part highlights initiatives and innovations to optimize the immediate pandemic response with a focus on India, while the fourth part highlights what Mumbai has done well and what more needs to be done. The final part presents medium- and long-term actions for integrated development of cities to prepare them for future pandemics.

PART IV – COVID-19 IN MUMBAI: VULNERABILITY AND RESPONSE

A National and Global Hub

Mumbai—the capital city of the state of Maharashtra on India's southwestern coast—is divided into two main districts: Mumbai City and Mumbai Suburban, both of which are governed by the MCGM. Beyond being India's financial, commercial, and entertainment capital, Mumbai is among the world's top ten centers of commerce in terms of global financial flow (Mahajan 2014). Mumbai's 603.4 square kilometer (km) area is home to the highest population density in India, at 20,634 persons per km (Census of India 2011).

Rapid Urbanization and Informal Settlements

Like other fast-growing cities, Mumbai faces disparities in housing and basic amenities. As per the 2011 census, Mumbai has the largest slum population among India's metro cities (including Dharavi, Asia's second-largest slum), with more than half of its 12.5 million people living in overcrowded informal settlements. There is increasing evidence of enhanced risk of COVID-19 spread through aerosols, similar to other respiratory infections like tuberculosis (TB) and pneumonia. Access to adequate water is a major challenge in these slums, given the lack of infrastructure and depletion of water resources. Quality of water is another central concern. In one study, 50 percent of the water samples collected during the monsoon season and 76 percent of stored water during the rest of the year showed microbial contamination (Safe Water Network 2016). Lack of sanitation and access to toilets threaten basic health, hygiene, and safety, with more than three-fourths of community toilets lacking a water supply, half without electricity, several without proper doors, and many lacking separate facilities for women (Koppikar 2017).

Large Migrant Population

More than half of Mumbai's residents are migrants, an increase from 43 percent of the population in 2001 to 54 percent in 2011 (Devulapalli 2019). The movement of people to and from Mumbai contributes to the city's social and economic fabric, but challenges the delivery of public health interventions, especially during pandemics.

Public Transportation and International Connectivity

About 12 million Mumbai residents use its extensive local railway system and its BEST (Brihanmumbai Electric Supply and Transport) bus network daily, more people than in any other city in India. The railway and bus systems are further supported by metro and monorail services, metered taxis, and auto-rickshaws. These transportation modes are also extensively used by daily commuters from the nearby townships of Thane and Navi Mumbai, resulting in overcrowding during peak hours. Every year, nearly 14 million travelers from 47 international destinations pass through Mumbai's international airport, which is among the busiest airports in the world. The airport caters to 25 percent of India's domestic and 38 percent of international passenger traffic, and 26 percent of domestic and 40 percent of international cargo.

Economic Impact

Because of their very nature, cities have been hardest hit by the COVID-19 crisis. They are densely populated and bustling with activity, with economies dominated by retail and hospitality services, whose workers are among the most vulnerable. The lockdown of the nation's financial capital comes at a huge economic cost. Nearly 70 percent of Mumbai's economic output is service sector–oriented. Hotels, restaurants, and real estate make up the largest segments of the city's services sector and are the main contributors to the economy and the employment it provides. All three have taken a hard knock. Micro, small, and medium enterprises (MSMEs) and construction sectors are also badly affected, and the exodus of migrant labor makes an economic rebound unlikely in the near future. COVID's economic impact can be observed in Maharashtra's revenue figures. Mumbai represents two-thirds of Maharashtra's GDP. Revenue collection in March 2019 was Rs 42,000 crore (about US$5,707 million), but in March 2020 this fell to just Rs 17,000 crore (about US$2,310 million)—a 60 percent drop—as a result of lockdown. This decline will constrain the government's ability to respond to the pandemic in various ways moving forward, including strengthening the public health system and providing a safety net to vulnerable households and MSMEs.

Mumbai's Health System

Organization

Mumbai's health system consists of hospitals and dispensaries run by the MCGM, the Maharashtra state government, a large private sector, and autonomous bodies.

- Public sector: The MCGM has a network of five medical college hospitals, one dental college hospital, 16 municipal general hospitals, five specialty hospitals, 28 maternity homes, 186 municipal dispensaries, and 211 urban primary health posts. The Maharashtra state government has one medical college hospital; three general hospitals; and two health units in Mumbai. Apart from these public health facilities, several priority national public health programs, including those addressing TB, human immunodeficiency virus (HIV), and noncommunicable diseases (NCDs), along with the Integrated Disease Surveillance Program (IDSP), are implemented in the city. In addition, Police, Railways, Port Trust, Navy, and the Employee State Insurance Corporation run dedicated health services for their employees and families.
- Private sector: The large private health care sector is mostly organized as clinics, small nursing homes, hospitals, informal providers, laboratories and diagnostic centers, and large corporate hospitals; however, a validated count of these private facilities is not readily available.
- Nongovernmental organizations (NGOs): A large number of NGOs work in the city in the areas of health, water, sanitation, and human rights, among many others. Many of these NGOs cater specifically to slums to meet their health care needs.

HUMAN RESOURCES FOR HEALTH

Though India's health worker density is about 30 per 10,000 (above the World Health Organization [WHO]-recommended minimum threshold of 22.8), the country suffers from a continuing shortage of staff in public hospitals and dispensaries (Karan et al. 2019). The COVID-19 pandemic has overburdened and burned out medical staff because of the severe and sudden physical and psychological stress of working on the COVID-19 response, especially given staff shortages before the pandemic.

As many as 43 percent of medical staff, 33 percent of paramedical staff, and 13 percent of nursing staff positions in municipal hospitals were vacant heading into the pandemic, according to the Praja report (Praja 2019). In the public sector, shortages of healthcare staff reflect an unwillingness of newly qualified health professionals to join government service because of the high costs of private medical education, lower government salaries, irregular payments in government hospitals, and the lack of opportunity for career growth.

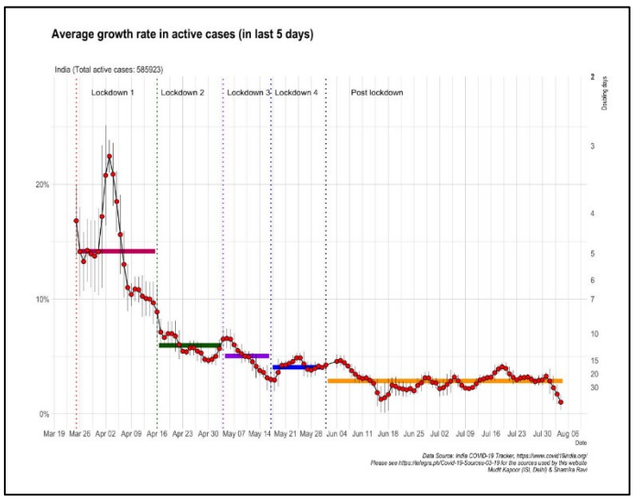
During the months of April and May 2020, when the pandemic was rapidly spreading, large numbers of nurses, mostly from the private sector, fled Mumbai. These nurses were fearful of the risk of COVID-19 infection (approximately 300 nurses from several private hospitals tested positive for COVID-19) as well as the great difficulty they faced in finding accommodation for quarantine due to work-related stigma. Several nurses from Kerala, in particular, returned home. Mumbai's nursing shortage has weakened an important pillar for case management during the pandemic (Mishra 2020). A recent study underscores that lack of availability of nurses has had a significant impact on COVID-19 mortality (Chaudhry et al. 2020).

INDIA'S RESPONSE TO COVID-19

India's first reported case of COVID-19 on January 30, 2020 was traced to a group of students who had traveled from Wuhan to Kerala. As of September 15, 2020, India has reported 4.53 million cases. Recovery rates have reached approximately 80 percent and case fatality in India is 1.64 percent. The Government of India (GOI) has taken several measures to contain COVID-19, including stopping all international passenger flights (effective March 22, 2020), implementing a 40-day strict nationwide lockdown (from March 25, 2020)—which was extended by eight more weeks with some relaxation—taking steps toward boosting health infrastructure, and rolling out a mass media campaign on the importance of social distancing, mask-wearing, hand washing, and sanitation measures (Acharya and Porwal 2020). The Indian Council of Medical Research (ICMR) played a pivotal role in supporting India's effort to ramp up laboratory capacity for testing.

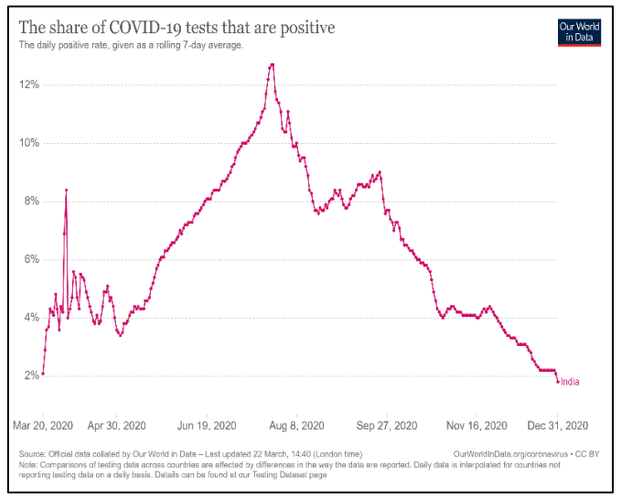
Despite increases in numbers of new cases reported daily, the growth of active cases in India is steadily decreasing due to increased recovery rates (Figure 1). With the ramped-up capacity, as of September 2020, India is testing more than 800 individuals per million each day; test positivity ranges between 8 and 9 percent (Figure 2).

Figure 1: Average Growth Rate in Active Cases (Five days)



Source: Karan et al. 2019.

Figure 2: Test Positivity Rate



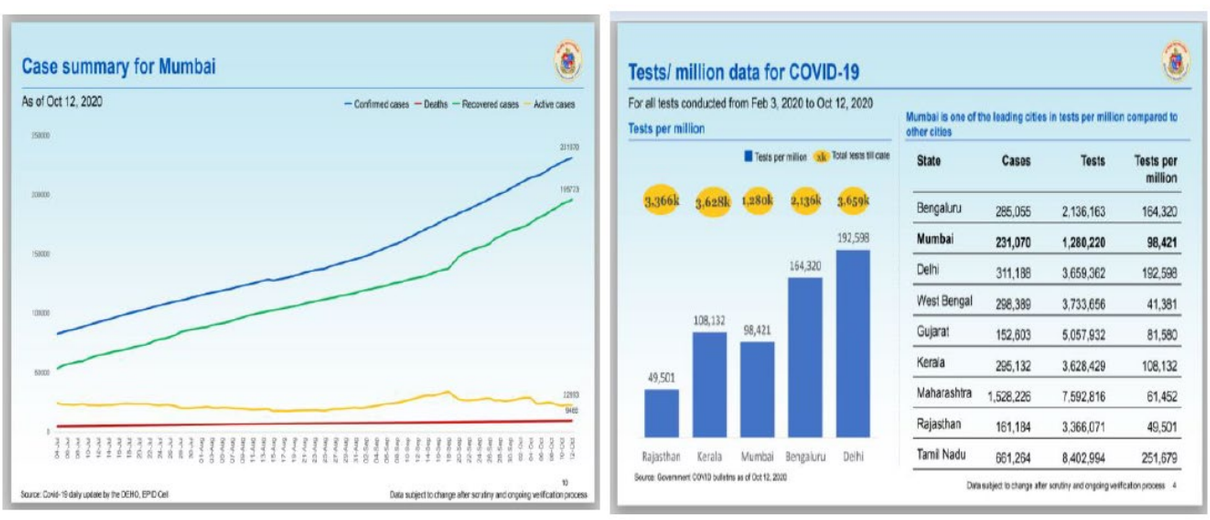
Source: https://ourworldindata.org.

India still faces a threat of serious COVID-19 spread due to its large population and rampant poverty, challenges in practicing social distancing, densely populated urban areas, lack of universal access to water and sanitation, and large numbers of migrant workers moving from state to state for livelihoods. In addition, the threats of new COVID-19 variants that spread faster and seriously affect younger populations are of major concern.

UNFOLDING OF THE COVID-19 PANDEMIC IN MUMBAI

The first case of COVID-19 in Maharashtra was confirmed on March 9, 2020. Over the next couple of weeks, the number of cases increased rapidly, from all over the state, and especially in Mumbai. By October 12, 2020, Mumbai had reported 231,070 COVID-19 cases and conducted 1,280,220 tests (Figure 3) with a positivity rate of 18.04 percent. For the same period, the recovery rate (discharge) of 80 percent was higher than the national average, while the death rate was 4 percent.

Figure 3: Unfolding of Pandemic in Mumbai



State	Cases	Tests	Tests per million
Bengaluru	285,055	2,136,163	164,320
Mumbai	**231,070**	**1,280,220**	**98,421**
Delhi	311,188	3,659,362	192,598
West Bengal	298,389	3,733,656	41,381
Gujarat	152,603	5,057,932	81,580
Kerala	295,132	3,628,429	108,132
Maharashtra	1,528,226	7,592,816	61,452
Rajasthan	161,184	3,366,071	49,501
Tamil Nadu	661,264	8,402,994	251,679

Source: https://stopcoronavirus.mcgm.gov.in/key-updates-trends.

MUNICIPAL CORPORATION OF GREATER MUMBAI'S RESPONSE

To tackle the rapidly growing pandemic in greater Mumbai, the MCGM executed several measures, including the following:

- Constituting a COVID-19 Task Force comprising leading medical and health care practitioners to advise on measures to contain the outbreak in districts hit hard by the virus.
- Enforcing strict lockdown, and Mumbai Police using more than 5,000 CCTV cameras and drones, as of April 1, 2020, to monitor compliance through aerial surveillance and to relay audio messages and warnings.
- Scaling up testing with 23 (6 public, 17 private) laboratories approved by the ICMR for COVID-19 testing in the MCGM area, which enhanced testing capacity from 100 samples a day initially to

around 13,000 per day by October 2020. The MCGM outsourced testing through private laboratories to enhance testing capacity (Pavithra 2020; MOHFW 2020).

- Adopting a "chase the virus policy" in densely populated urban slums. This involves shifting high-risk contacts (elderly and those with comorbidities) to institutional quarantine and effectively tracking contacts to break the chain of transmission.[1]
- Engaging local private practitioners and dispensaries that are trusted by local communities in active and passive surveillance; and using bed capacity in the private sector in a phased manner.
- Making face masks mandatory in public places on April 8, 2020. Mumbai was the first city in India to mandate face masks.
- Demarcating the containment zones and restricting movement of people in and around containment zones (in May 2020) and issuing guidelines for sealing residential buildings.
- Issuing detailed guidelines for offices, which include mandatory thermal screening, use of sanitizers, and social distancing on May 31, 2020.
- Establishing a dashboard to track bed availability and show the combined availability of COVID beds in public and private facilities in real time and decentralized management of beds at the ward level. An online platform for dialysis facilities was also established.

Ramping up health infrastructure for responding to COVID-19: Between March 2020, as COVID-19 cases increased through the city, and May 2020, the MCGM increased the number of hospital beds from 29,000 to 85,000 across all facilities, expanded ambulance services from 100 to 700, and improved access to medicines and ventilators using emergency procurement procedures (Box 1). There are four levels of COVID facilities. The first includes stadiums, hostels, schools, and lodges, called COVID-19 Care Centers (CCCs); CCCs provide institutional quarantine for high-risk and suspected cases The second level caters for mild positive cases; the next two levels include hospitals with oxygen support, ventilators, and intensive care unit (ICU) facilities. (Raghavan et al. 2020). The city also established jumbo facilities (Table 1) for COVID-19 care by July 7, which helped to gradually reduce the demand for beds (as shown in Figures 4 and 5).

Box 1: Handling Sudden Surges in Demand for Hospital Beds

The National Sample Survey Office (NSSO) 75th round (2017–18) reported that more than three-fourths of people who were hospitalized during the past one year used the private sector in urban Maharashtra. However, during the COVID-19 pandemic, this trend reversed and more than two-thirds (71 percent) of people hospitalized for treatment of COVID-19 primarily used public facilities.

Factors contributing to such a shift need more in-depth analysis. However, potential reasons for the surge in demand at public sector hospitals include the following:

1. Higher costs of private sector care may have limited health care access of poor and slum residents. According to the NSSO survey, the average hospitalization expenditure in a private hospital was six times higher than in a public sector hospital (Rs. 42,540 vs. Rs. 7,189, equivalent of US$578 vs. US$98).
2. The need to segregate infectious disease cases to avoid infection among other patients and staff caused many small and medium-size private hospitals to shut down their services.
3. Providing adequate support staff and personal protective equipment (PPE) further increases costs for the patient.

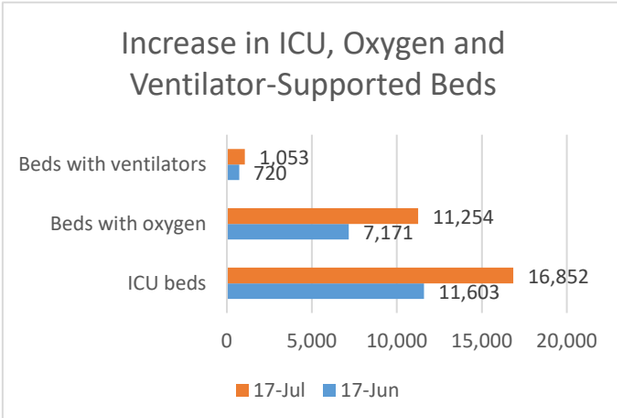
Public hospitals entered the pandemic with their own challenges, including limited resources—especially human resources and intensive care unit (ICU) beds. Despite these challenges, initiatives taken by the Municipal Corporation of Greater Mumbai (MCGM), such as converting public facilities like stadiums and convention centers into temporary hospitals, helped to rapidly scale up ICU beds (by nearly 45 percent), beds supported by oxygen (by 57 percent), and ventilators (by 46 percent). These initiatives, together with a dashboard for real-time management of beds in public and private sectors and treating milder cases that do not have the option of home-based care at COVID-19 Care Centers, slowly reduced the demand for hospital beds.

Learning from COVID-19, cities must take a whole-systems approach to preparing for future pandemics, including actively involving the private sector in development of pandemic preparedness plans and response, rather than making these shifts in the midst of a pandemic.

Source: NSSO 75th Round (2017–18).

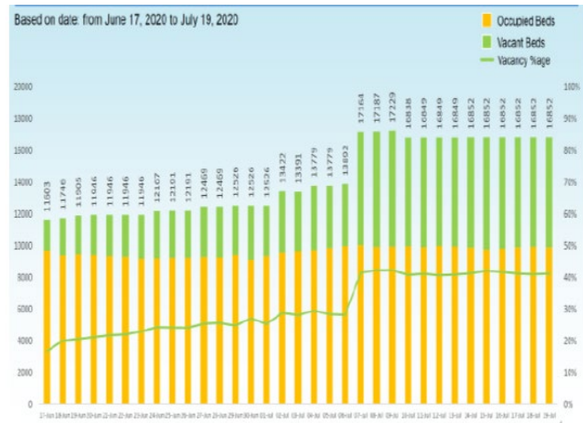
[1] According to administrative data, Mumbai was able to trace up to 15 contacts per each case tested positive in slums.

Figure 5: Increase in Bed Capacity



Source: https://stopcoronavirus.mcgm.gov.in/key-updates-trends.

Figure 4: Trends in Occupancy of COVID beds



Source: Authors analysis from data reported during June 17 to July 17, 2020, https://stopcoronavirus.mcgm.gov.in.

Table 1: Jumbo Facilities

NESCO (Formerly New Standard Engineering Company)	3,000 beds
Bandra Kurla Complex	2,000 beds
Race Course	1,400 beds
Dahisar Naka	1,000 beds
Mulund Naka	1,000 beds
Dome	600 beds
Richardson and Krudas	600 beds

Source: https://stopcoronavirus.mcgm.gov.in/key-updates-trends (data as of July 7, 2020).

ENHANCING COORDINATION BETWEEN ADMINISTRATIVE STRUCTURES

The urban area of Mumbai is governed by the MCGM; however, it is part of the larger Mumbai Metropolitan Region (MMR), covering 4,355 square kilometers and including parts of Thane, Palghar, and Raigad Districts. The MMR is governed by seven Municipal Corporations in total. To enable a more effective and prompter COVID-19 response, the MCGM set up an emergency response mechanism with a main war room, and devolved responsibility to 24 ward-level war rooms. Each ward-level war room is managed by public health professionals, data analytic experts, paramedicals, teachers, and staff from other concerned departments. Coordination and management are carried out at the ward level. Every morning, the war room at each ward receives the list of confirmed positive cases during the past 24 hours, and then carries out contact tracing and testing, coupled with quarantine and isolation. These ward-level war rooms helped in the management of beds and to streamline vertical streams of data from multiple sources and ensure responsibility and accountability for action.

Undertaking sero-surveillance of COVID-19: Mumbai's sero-surveillance in July 2020 covering three civic wards with a sample of 6,396 estimated that more than half (57 percent) of slum residents and about a fifth (16 percent) of nonslum residents in Mumbai had COVID-19 antibodies. An earlier study conducted by the ICMR in May 2020 estimated seroprevalence of 15–30 percent in hotspot areas, although Mumbai-specific details are not yet available. Information from different sources available in the public domain on sero-surveillance presented in Annex 1 suggests a range of 7.75 percent (Indore) to 65.4 percent (Pune).

Data tracking and transparency: Mumbai has adopted a data-driven approach and is sharing the data in the public domain, with daily bulletins offering granular data from its dashboard. The Mumbai dashboard at www.stopcoronavirus.mcgm.gov.in/key-updates-trends provides data covering several verticals: number of high-risk, symptomatic, asymptomatic, and critical patients in each of the city's 24 wards; total active cases, deaths, and rates of positivity; ICU beds available in hospitals; contact tracing done in the last 24 hours (the number of contacts traced and if they have tested positive, as well as how many of them are in home or institutional quarantine); tests conducted; laboratory reports pending; containment zones declared; and building/areas sealed. Thus, compared to other Indian cities, Mumbai's dashboard made available the most information on the COVID-19 situation in the public domain.

To ensure compliance with government guidelines on fee and bed allocation for moderate and severe COVID-19 cases by the private hospitals, a systematic monitoring mechanism was put in place that included zonal auditors and Indian Administrative Service (IAS) officers making random visits to private facilities. Through a partnership with the private sector, the MCGM contracted an agency to support home-based monitoring of mild COVID-19 cases, including presymptomatic and asymptomatic cases using standardized protocols. Approximately 10,000 patients are currently enrolled in this initiative, which has demonstrated benefits of proactive engagement with the private sector in delivering effective low-cost models for managing mild cases of COVID-19.

PART V – EVOLVING LESSONS AND INNOVATIONS FROM CITIES AND URBANIZED COUNTRIES

Global trends point to high vulnerability of densely populated and well-connected cities to COVID-19, with India following this pattern. Box 2 provides a summary of key evolving lessons from handling the COVID-19 pandemic by metropolitan cities and urban areas across the globe.

Box 2: Evolving Global Lessons from COVID-19 Pandemic Containment in Urban Areas: The Eight Ps

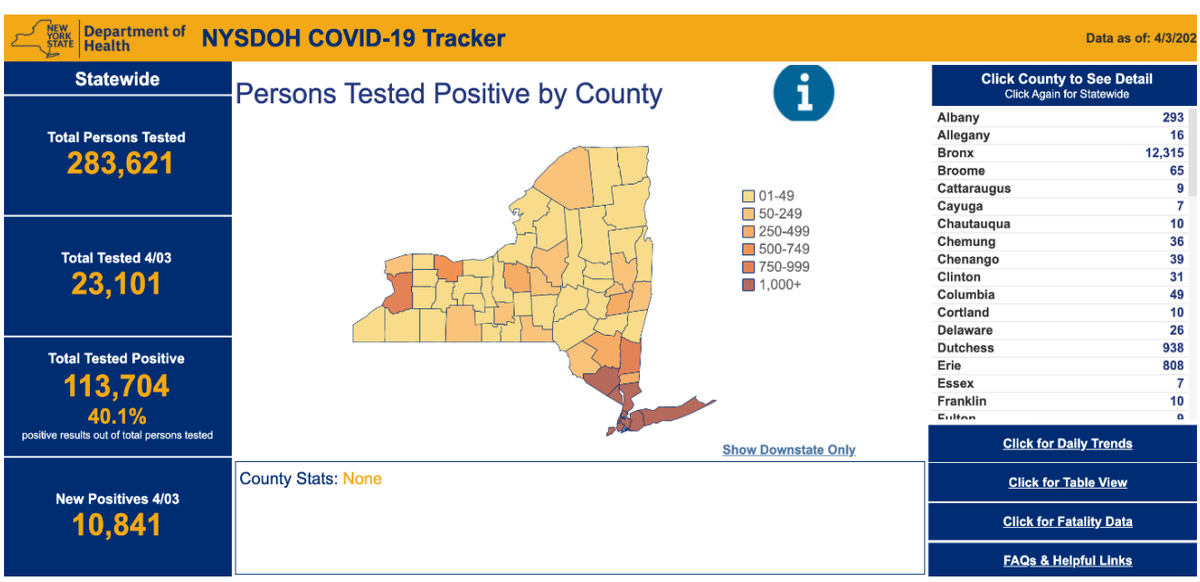
1. Prioritize vulnerable groups living in overcrowded slums and poor neighborhoods using "group averages" for target testing, communication, and financial support.
2. Prepare cities for disasters to ensure standardized protocols and stockpiles, building on experiences of prior pandemics such as Severe Acute Respiratory Syndrome (SARS).
3. Promote public health and health service delivery linkages in cities to optimize effective response and minimize overload on hospitals during public health emergencies and outbreaks.
4. Protect providers—the most precious resource—by addressing their needs comprehensively.
5. Promptly update data accessible to public on availability of COVID hospital beds, especially during surges.
6. Provide holistic support to citizens, especially slum residents, with enhanced attention to mental health and physical activity.
7. Partner with the private sector early on to complement the preparedness of cities for pandemics and to optimize the overall response.
8. Proactively use technology to identify super-spreading clusters and for contact tracing, as done by Tokyo and Seoul.

Source: Author's summary from documented global lessons.

NEW YORK CITY

New York City is a prime example of the devastation of a pandemic on a dense metropolitan area. New York state reported the second-largest number of COVID-19 cases among states in the United States (416,298 as of August 3, 2020) (Johns Hopkins University of Medicine 2020), and at its peak was reporting more than 10,000 cases a day (Figure 6). The state has experienced several disasters over the past few centuries, including yellow fever in the 18th century, cholera in the 19th century, and the September 11 terrorist attacks and Superstorm Sandy in the 20th century. None of these crises prepared New York to handle COVID-19, which transformed the financial capital of the United States into a global epicenter of a pandemic by April 2020. COVID-19 overwhelmed New York's famed hospitals and public health services within a month.

Figure 6: COVID-19 in New York



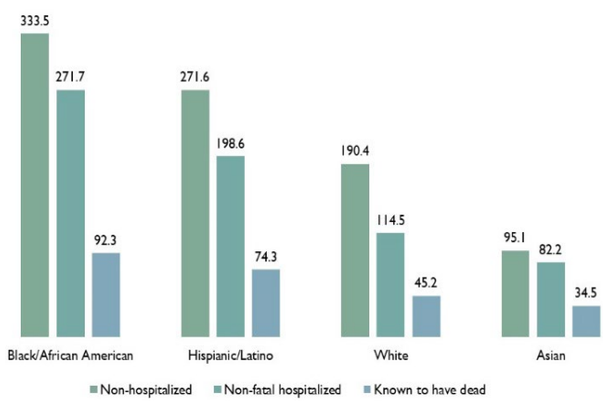
Source: NYSDOH COVID-19 Tracker: Department of Health New York State Department of Health.

New York City's health department is regarded as one of the best municipal health agencies in the world. However, the administration did not consistently take the advice of health department experts, which led to the resignation of the New York City Health Commissioner (Goodman 2020) in the midst of the COVID-19 crisis. Key lessons from New York include:

Pay attention to economic geography: There are close correlations of virus outbreak with population densities, migration linkages, and economic distance from places that are already infected. New York had a population of 8.4 million and a population density of 27,012 people per square mile. In addition to high population density, New York had strong linkages with China, especially air travel to and from Wuhan. This is a clear alert for developing countries like India to focus on densest settlements (cities like Mumbai) and internationally connected states such as Kerala, Karnataka, and Punjab; these states, despite initial success in containment, have experienced case resurgence with residents returning from overseas (Gill 2020).

Prioritize and address socioeconomic vulnerability: New York has a much larger share than the national average of Black (24.3 percent), Hispanic (29.1 percent), and Asian (13.9 percent) populations, and about a fifth of these groups are estimated to be poor. Data from New York City derived from the Bureau of Communicable Disease Surveillance System as of April 16, 2020, show that as of April 2020, age-adjusted rates for lab-confirmed COVID-19 non-hospitalized cases, estimated nonfatal hospitalized cases, and patients known to have died for 100,000 race/ethnicity groups is disproportionately higher among Black/African American and Hispanic/Latino compared to White and Asian populations (Figure 7). Black and Latino residents tend to live in densely populated parts of the city and are poorer. In the United States, people of color have higher rates of chronic disease than their White counterparts. Generations of health disparities have resulted in higher prevalence of preexisting conditions, including asthma, hypertension, and diabetes—all of which heighten the risk of COVID-19 complications.

Figure 7: Age-Adjusted Lab-Confirmed COVID-19 Trends in New York, April 2020



Source: New York City Department of Health 2020.

Multigenerational and crowded housing enhanced susceptibility of all immigrants to COVID-19, as seen in the New York City borough of Queens, which bore the brunt of the first wave of the virus. Historic disparities leading to poverty, tobacco use, poor nutrition, and chronic stress enhance vulnerability, which has been further compounded by lost wages due to lockdowns. An assessment of community-level disparities in COVID-19 infections and deaths in large US metropolitan areas shows that counties with substantially non-White or more diverse populations have had higher than expected cumulative COVID-19 incident infections than counties with substantially White or less diverse populations (Adhikari et.al. 2020).

While individual comorbidities provide most reliable indicators for susceptibility, "herd averages" should be used to target COVID-19 testing, tracing (using trusted people from migrant communities), information programs (using vernacular languages), and medical care. This also highlights the importance of systemic record keeping of chronic diseases among vulnerable and migrant populations in larger cities, including access to social benefits such as food rations. Available evidence suggests that in addition to general vulnerabilities of cities, high-risk groups such as migrant communities and slum dwellers, as well as settings such as homes for the aged, health facilities, and religious congregations, enhance risk of COVID transmission.

Ensure effective linkages between public health and health care delivery: Linkages between public health and health care delivery are important for optimizing response effectiveness. For example, the effectiveness of lockdown and social distancing policies, and the ability to trace contacts of suspected/confirmed cases, impact the number of sick patients reporting at hospital emergency departments and ICUs. Policies on COVID-19 restrictions should carefully consider the unique position of health workers. For example, opening enrichment schools[2] for children of first responders while public schools are closed helps to enhance frontline staff availability and motivation at work (Chokshi 2020).

Sustain health care provider morale: Strategies such as flattening the curve and social distancing sometimes overlook the importance of clinician morale. Sustaining the morale of health care workers is critical for the functioning of health systems. Frontline responders risk their own health and that of their families, and also face the brunt of social stigma. Unlike 9/11 and Superstorm Sandy, COVID-19 requires much longer endurance of medical staff. In the face of such overwhelming challenges, celebrating small victories and appreciating risks being taken by health workers is essential. Strong and repeated acknowledgement from citizens and high-ranking policy makers that their contributions are saving lives will be the strongest possible motivation.

[2] Enrichment schools are schools for children of frontline staff so that the parents are not stressed by having to find childcare while they are at work.

Provide holistic mental support: New York State partnered with Headspace, a global leader in mindfulness and meditation, to offer free meditation and mindfulness content for all New Yorkers as a mental health resource for residents coping with the unprecedented public health crisis. New Yorkers can access a collection of evidence-based guided meditations, along with at-home mindful workouts, sleep support, and child-oriented content to help address rising stress and anxiety. The state also established an emotional support hotline for health staff. Online guides were made available for managing anxiety for all, as well as for specific groups such as individuals receiving mental health services; parents, including those whose children have preexisting anxiety disorders; caregivers of older adults; and mental health providers.

Communicate effectively: Risk communication is key; even a one-week delay during a pandemic can have a devastating impact. The initial delay in making the decision to stay at home as recommended by health officials and the inability to communicate this recommendation as clearly as the state government of California did, for example, had a negative impact on New York. The Severe Acute Respiratory Syndrome (SARS) and Middle East Respiratory Syndrome (MERS) outbreaks helped many countries in East Asia, such as Taiwan and Vietnam, better prepare for such eventualities, including putting in place policies that enabled prompt use of technology for tracking, while addressing concerns about privacy.

Address system bottlenecks: Multiple agencies and administrative roles (federal, state, city, and county) also created operational challenges in mounting a cohesive response (Box 3).

Box 3: Multiple Agencies and Administrative Roles

A recent Comptroller review noted that New York's health centers, eleven public hospitals, and the larger system in which they operated faced an unprecedented situation for which no one was fully prepared. While emphasizing the need to address underlying inequities in access to health care, the Comptroller highlighted key operational deficiencies, including the following:

- Inadequate access to needed supplies and equipment
- Lack of systems and procedures for managing patient loads across hospitals, and insufficient protocols for deploying staff
- Failure to stockpile enough personal protective equipment (PPE) or ventilators by city hospitals, despite several planning exercises, because of limited capacity and funds
- Slow response from the public health system to expand hospital beds and transfer staff as the number of coronavirus patients surged
- Long time taken to centralize procurement and distribution of PPE. While the hospital system eventually streamlined both processes, the federal government complicated the situation with insufficient and conflicting guidance

Source: Stringer 2020.

Supply chain challenges: According to anecdotal information from a supplier with standing New York City contracts, the initial requests for protective gear from the Department of Citywide Administrative Services (DCAS) were bogged down by inefficient bureaucratic delays. It took 72 hours for the agency to place an order when a list of products that can be delivered within 24 to 48 hours was sent. The suppliers were under pressure with very high demand coming from hospitals and the private sector. There were also complaints of delays in payments to suppliers.

Testing bottlenecks: Private corporations responsible for testing had a limited testing capacity. Backlogs for tests increased, sometimes taking weeks to deliver results. Consequently, the US Food and Drug Administration (FDA) approved New York State to authorize the state's 28 public and private labs to begin manual, semi-automated, and automated testing, including high-volume platforms for COVID-19. The approval allowed the state to dramatically increase testing capacity by thousands of tests per day.
Patient tracking: Keeping track of patients requiring hospitalization requires effective triangulation and real-time communication between hospitals. When there is a sudden surge in demand, accurately tracking bed capacity and availability becomes a matter of life and death, as happened in New York. This requires robust intelligence (1) to determine the proportion of people who need hospitalization; (2) to care for people without COVID-19 who are delaying and avoiding treatment; and (3) to continuously update these assumptions based on evolving data to improve the predictability of modeling. Such a learning network should be global to build widespread collaboration and the quick translation of research into policies and decisions to benefit people suffering from COVID-19 (Chokshi 2020).

Hospital overflows. Projections about the spread of the coronavirus sent New York State scrambling to more than double its existing 53,000 bed capacity. By March, hospital lobbies were being converted into extra patient rooms to meet the growing volume of patients and a 68-bed COVID-19 respiratory care unit was set up in Central Park. By the end of March, some hospitals set up sidewalk morgues on city streets to deal with the overflow of corpses from the pandemic. The federal government was called in to convert spaces like the Jacob Javits Center in Manhattan into an overflow hospital, but its capacity hasn't been stretched to its limits due to shutdowns. The floating hospital, Comfort, and its 1,000 hospital beds sailed

into New York in late March, but was sparsely used due to administrative bottlenecks, such as initial confusion over admission criteria (limited to non-COVID cases).

Box 4 summarizes how Seoul and San Francisco operated differently from New York in optimizing system efficiency by establishing a network of testing facilities, introducing a scheduling system to evenly distribute the testing load, and eliminating bottlenecks such as requirement of doctors' referrals. Also, leveraging the large number of tests to be carried out enabled these cities to negotiate a better price with the private sector.

Box 4: What Seoul and San Francisco did differently?

- Establishing a network (grid) of free drive-through and walk-in testing sites open to anyone who works and lives in the city to provide adequate capacity and keep turnaround times low (typically one day)
- Activating a scheduling system that could be accessed online or through the phone to balance testing loads and handle excess demand on the few labs
- Eliminating need for doctors' referrals by issuing standing orders for each site by city public health officers
- Negotiating and paying for most tests by the city

Source: Gawande (2020)

BRAZIL

The first case of COVID-19 was detected in Brazil on February 25, 2020 in São Paulo, the largest city in South America (population 23 million, with six subregions and 39 municipalities). São Paulo also receives the highest proportion of international flights to Brazil. COVID-19 spread first to the most populous cities/municipalities, followed by smaller municipalities. Like India, most cases and deaths are reported in highly populated states of São Paulo, Rio de Janeiro, and Cera, which together account for 49.2 percent of cases and 61.5 percent of deaths. As of August 3, 2020, Brazil had reported 2.74 million cases and 94,104 deaths.

Despite early declaration of a national public health emergency on February 3, 2020, and the presence of a national network of influenza surveillance laboratories, Brazil encountered several challenges in containing the pandemic (de Souza et al. 2020). Chronic underfinancing of the unified public health system was compounded by Constitutional Amendment 95, which reduced Brazil's Ministry of Health budget by 7 billion reais (about US$1.3 billion) in 2016.

Divergence among administrative levels (national, 26 states, one federal district, and 5,500 municipalities) added to this challenge (Silva et al. 2020). Due to weak coordination between the federal administration, states, and municipalities, each administrative level implemented an isolated response to COVID-19, and new beds created to absorb COVID-19 cases were not distributed according to need (Box 5).

Box 5: Lessons from Brazil

- Chronic underfunding coupled with decisions not informed by science led to critical gaps in subnational health systems.
- Divergence between different administrative levels (federal, state, and municipal) resulted in isolated approaches and a poorly coordinated response.
- High vulnerability existed among densely populated cities that were well-connected through air travel. Three cities contributed to nearly half of total COVID-19 cases.
- Inequitable access to prevention, testing, and treatment in poor neighborhoods led to high mortality rates among Black populations.
- Private laboratories became the main source for testing during the initial phase due to inadequate planning, which led to shortages of reagents and instruments in the existing public laboratory network.
- Poor coordination resulted in underutilization of available beds in private hospitals, while public hospitals were overwhelmed with COVID-19 patients.

Source: Extracted from Fernandes, Martinelli, and Castro 2020.

Brazil's poor populations have disproportionately low access to COVID-19 prevention, diagnosis, and treatment. People working in informal jobs (such as street vendors, restaurant workers, manicurists, hairdressers, food sellers, delivery staff, car washers, etc.) have felt the maximum impact of the pandemic, as hygiene essentials are difficult due to water and sanitation shortages and because social isolation is impossible. More importantly, working from home was not an option for informal workers. In April 2020, the federal government announced an emergency fund that provided cash transfers to

informal sector workers ($115) and mothers ($235), which is reported to have benefitted 59 million people.

COVID-19-related deaths occurred at a higher rate in the north and northeast regions of the country, which have a much lower GDP per capita. In São Paulo, more cases were reported from poor neighborhoods of Brasilandia, Sapopemba, and São Mateus, and mortality rates were higher among Black populations. Black people who lacked formal education were four times more likely to die from COVID-19 compared to White people with higher education; among those with similar education, Black people were still 37 percent more likely to die from coronavirus-related illness compared to their White counterparts (Fernandes, Martinelli, and Castro 2020). The virus is now spreading among Brazil's indigenous populations, a historically neglected group. Beyond the loss of life, the pandemic threatens indigenous leadership, knowledge, culture, and history.

The national network of laboratories faced several challenges in coping with demand, especially shortages of reagents and instruments. Economic inequalities also played a major role in limiting access to testing in Metropolitan São Paulo during the initial phase, that is, epidemic weeks 12–21. Incomes of individuals with COVID-19 laboratory confirmation were higher during this period, while increased relative odds for Severe Acute Respiratory Infection (SARI) of unknown etiology were reported from poorer subregions, highlighting inequitable access to testing. Anecdotal information suggests that nearly two-thirds (66.9 percent) of tests until March 25, 2020, in São Paulo and Rio de Janeiro were done by private labs, with each test costing $60–$130.

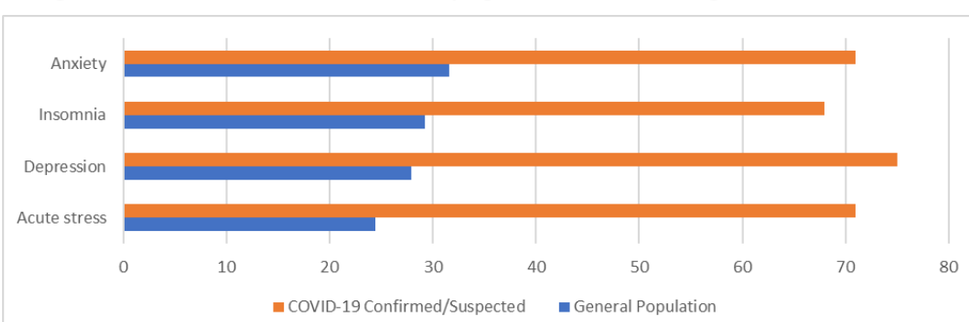
Poor coordination between the public and private sectors resulted in overcrowding of public hospitals, with people dying in hallways, while private hospitals in São Paulo had nearly a third of their beds available. These private hospitals mainly cater to people with private health insurance, covering about half of São Paulo's population and one-fifth of Brazil's total population.

HANDLING MENTAL HEALTH ISSUES

Outbreaks and pandemics are known to have serious impact on mental health. During the SARS outbreak in Singapore, the prevalence of psychiatric morbidities was reported to be 22.9 percent (Sim et al. 2010); similarly, one-third of people exhibited psychological distress during the equine influenza outbreak in Australia (Taylor et al. 2008). Data from previous pandemics show clear mental health effects on frontline health workers, who experience a variety of mental health issues, especially burnout and fear. In a survey undertaken by University College London during the city's COVID lockdown, 18 percent of people reported thoughts of self-harm or suicide. More than one in four reported clinically relevant levels of mental distress in late April 2020, compared to one in five before lockdown. Women, young people, and those living with preschool children were most affected (*The Lancet Public Health* 2020).

A recent large-scale online study in China (Shi et al. 2020) (Figure 8) shows high prevalence of symptoms of depression, anxiety, insomnia, and acute stress due to COVID-19. These symptoms were two to three times more pronounced among people who were confirmed or suspected of COVID-19 (depression 75 percent, anxiety 71 percent, insomnia 68 percent, and stress 71 percent). This was followed by people who had family or friends with COVID-19; people with occupational exposure risks; and residents of Hubei Province, which was the epicenter of the pandemic in China. While the study did not find significant association of frontline workers with depression or anxiety, evidence suggests that frontline workers tend to report more fatigue, health worries, and fear (Brooks et al. 2018).

Figure 8: Prevalence of Mental Health Symptoms in China during COVID-19 Pandemic



Source: Shi et.al. 2020.

Quarantining impacts the mental health of both children and adults. People may experience fear of infection, as well as frustration and depression during quarantine. These issues are exacerbated by insufficient basic supplies, disruptions in information flows, and rumors. Unfamiliar and crowded environments and the demand on shared utilities in institutional quarantine may act as catalysts for poor

mental health status. This highlights the importance of population-specific mental health interventions specifically targeting such groups.

Despite the existence of evidence-based public mental health interventions in India, experience shows that their implementation was poor. These interventions need to be appropriately targeted to groups at high risk of mental disorders and poor mental well-being. Interventions and group activities to promote holistic mental health introduced in Mumbai at institutional quarantine facilities and COVID-19 Care Centers, such as medication, yoga, and laughing sessions, are therefore critical to minimize adverse mental health conditions. Targeted interventions for frontline workers (as done in New York to reduce stress through professional counseling and peer support) coupled with staff rotation policies (as done by Kerala and UK National Health Service) are important in preserving the most critical resources during a pandemic.

INNOVATIONS BY URBANIZED COUNTRIES

JAPAN

Despite having early outbreaks, ultradense cities, and one of the oldest populations in the world, Japan had about 1,000 COVID-19 deaths in total by July 2020, which is less than the number of deaths reported on a single day in the United States (Tufekci 2020). Hong Kong, similarly dense and subway-dependent, had only 38 deaths. Japan implemented an unconventional response using well-targeted testing, and was able to manage with fewer formal lockdowns.

Japan's primary focus was on addressing "airborne" transmission, specifically focusing on "short-range aerosols and super-spreader events," which did not receive adequate attention until recently. The super-spreader events rely on three V's: Venue (indoors much higher risk); Ventilation (poorly ventilated and direction of air flow); and Vocalization (a lot of people talking, chanting, or singing). Examples of super-spreader venues and events include indoor restaurants, bars, clubs, choir practices, churches, temples, weddings, funerals, cruise ships, call centers, nursing homes, prisons, crowded markets, and meatpacking plants.

Japan masked up early and focused on super-spreader events using a strategy called "Cluster Busting," which involves identifying and shutting down locations where multiple people were infected, and aggressively testing those linked to these clusters (Reynolds and Reidy 2020). The public messaging focused on avoiding the three C's: Closed Spaces, Crowded Spaces, and Close Conversations. Japan's population were advised not to talk on subways, and the government developed guidelines for improving ventilation in different settings where airborne transmission risks are highest, such as bars, restaurants, and gyms.

Nearly half of those infected in Tokyo after the state of emergency was lifted on May 25, 2020, were in their 20s and from nighttime entertainment districts, popularly known as "Yoru No Machi." Tokyo is now conducting more targeted testing focusing on clusters. The city deliberately limited testing based on experiences with the H1N1 (swine flu) outbreak in 2009, when people got infected waiting to be tested in crowded hospital rooms, and initial testing kits revealed low accuracy. Targeted testing yielded more cases and reduced pressure on medical facilities.

SINGAPORE, REPUBLIC OF KOREA, TAIWAN, AND VIETNAM

These four highly urbanized countries invested heavily in information and communications technology (ICT) to protect public health during outbreaks. Evolving evidence is helping to demystify the role of ICT in health and how it can support swift and large-scale responses in situations affecting population health such as pandemics (Aron 2020).

Singapore has heavily invested in developing capacity and infrastructure to deal with outbreaks over the past decade. The city-state also simultaneously increased capacity for intensive care and patient isolation and built expertise in infectious diseases.

With a population comparable to New York City's, Singapore confirmed 52,825 cases and 25 deaths compared to 416,298 cases and 32,719 deaths in New York, as of August 3, 2020. Prompt contact tracing remains the heart of Singapore's response to COVID-19. The tracers use several digital footprints to prepare a complete 14-days prior contact map of each newly diagnosed COVID-19 case. They review video records of businesses and public and private venues visited by a confirmed case and track ATM transactions and credit card activity. Within 24 hours of each new infection being reported, more than 100 contact tracers working round the clock are able to put together a contact map for that person to enable effective contact tracing.

Korea developed capacities to fight potential disasters stemming from the country's sensitive geopolitical location. Based on experiences from SARS, Korea also amended its legal framework for privacy

protections in the use of digital applications in health (i.e., the Personal Information Protection Act). The Korea Centers for Disease Control (KCDC) first piloted drive-through clinics and large-scale distribution of medicines to the public via a research project to prepare for potential terrorist attacks/war. When COVID-19 hit, the country successfully leveraged its preparedness and digital technology by quickly installing drive-through testing and new laws to use mobile applications for tracing contacts and monitoring those in quarantine. Korea also used drones to disinfect large public spaces.

Learning from the SARS epidemic of 2003, Taiwan was in a state of constant readiness to combat epidemics arising from China due to extensive contacts between the two countries, with nearly 3 million visitors each year. After SARS, Taiwan created a Disaster Management and Recovery Center and Central Epidemic Command Center to provide operational command and coordinated response across multiple agencies and regions. Taiwan uses data analytics from different sources—immigrations and customs and national insurance—to quickly identity suspected cases from travel history and clinical visits to provide real-time alerts on possible infection. Box 6 summarizes measures taken by Taiwan documented by the Outbreak Observatory, Johns Hopkins University (Trotochaud 2020).

Box 6: Key Measures Taken by Taiwan to Contain COVID-19

1. Activating Central Epidemic Command Center, keeping the Ministry of Health and Welfare at the forefront
2. Putting in place a multilayered screening and monitoring system at points of entry
3. Complementing medical support with financial support during14-day quarantine/isolation
4. Increasing domestic production of personal protective equipment (PPE) with 73 new factories and 90 production lines
5. Making masks widely available to citizens at low cost
6. Enhancing health system capacity—including isolation rooms and mechanical ventilators
7. Transparent and proactive communication, including twice daily briefings by public health officers and press releases

Source: Trotochaud 2020.

All three countries, Singapore, Korea, and Taiwan, have strict data protection and privacy laws. But they still used information effectively, making a distinction between advancing commercial objectives and protecting the health of citizens in an emergency. They do this by sharing information about the potential spread of infection in their geographic area and monitoring any violations by quarantined people. Singapore has also strategically used social media as a tool in the country's pandemic response; Even Singapore's prime minister has reached out to citizens over Facebook and frequent WhatsApp messages.

Vietnam also had high levels of preparedness, similar to its East Asian counterparts, due to experiences with SARS, MERS, and avian Influenza. Vietnam launched a multisector COVID-19 response involving military, public security, and grassroots organizations, with targeted communication to citizens. The country's existing health systems capacity—built over the years with the help of key partners, especially the US Centers for Disease Control and Prevention (CDC) and GAVI—also helped. Vietnam was able to implement early and aggressive action as soon as cases arose in China, with which Vietnam shares a border. Screening for COVID-19 started at airports on January 11, 2020, and mandatory quarantine was imposed. This was followed first by closure of schools and targeted lockdowns and then a national lockdown in April 2020. One common thread of praise for Vietnam has been the country's emphasis on case finding and isolation. The country's testing capacity was rapidly increased, and testing criteria were expanded to test people who frequent high-risk settings, such as hot spot communities, wholesale markets, and industrial zones. Extensive contact tracing is supported by 63 provincial centers for disease control, 700 district-level centers for disease control, and 11,000 community health centers. Vietnam also promotes two-way risk communication through hotlines actively engaging citizens and clarifying their concerns. However, it should also be noted that Vietnam's one-party government is uniquely suited to make quick unilateral changes that may not suited for other styles of governance. Regardless, the international community should continue to watch Vietnam (Potter 2020).

SOUTH AFRICA

Home-Based Intensive Care: Communities taking the lead in South Africa

With nearly 600,000 COVID-19 cases, South Africa ranks fifth-highest in total number of cases reported in the world. According to the Johns Hopkins University, the number of people who have died due to COVID-19 in South Africa reached more than 15,000 as of September 14, 2020. Even though the government had months to prepare, the health system has wobbled, with a critical shortage of beds, staff, and equipment. As chaos and uncertainty swirled around the official response to the pandemic, a group

of people in a community called Lenasia, south of Johannesburg, developed their own response as thousands of locals fell ill.

Lenasia is a close-knit township, created by the apartheid regime in the 1950s as a place to house Asians. Today, roughly half the population claim Indian and South Asian descent, with Muslim, Hindu, Sikh, and Christian communities living and working in close proximity. By working together, members of this community have created their own parallel health care system in the middle of a raging pandemic. This system can serve as a model for several communities in the developing world.

Aboobaker Sayed, the head of the "Saaberie Chishty" community-run ambulance service, who lost his father and uncle to COVID-19, started this initiative. With the help of partner organizations and Dr. Fatima Lambat, an anesthesiologist, Mr. Sayed secured advanced medical equipment—including scarce oxygen concentrators—to turn ordinary bedrooms into critical care beds. Sayed created 60 critical care rooms in his community to try and “save 60 lives instead of one." This home-based intensive care is an extraordinary concept, but it also requires specialist physicians like Dr. Lambat. She has helped to design Lenasia's mini health care system and spends her out-of-hospital hours, along with her sister Dr. Safiyya Lambat, making it work. (Sparks 2020)

PART VI – INDIAN CITIES' INITIATIVES AND INNOVATIONS TO OPTIMIZE THE PANDEMIC RESPONSE

INITIATIVES TO ADDRESS HUMAN RESOURCES FOR HEALTH CHALLENGES

Sudden surges in COVID-19 cases led to challenges in hiring and retaining health care workers in cities in the pandemic's early days, due to the following: (i) fear of infection, (ii) short duration of contracts (e.g., three months for nurses), (iii) low pay even amidst the pandemic, (iv) poor working environment and work conditions, (v) long work shifts, and (vi) delayed or reduced salary payments.

These challenges have led to nurses, doctors, and other health workers going on strike in many cities, including Mumbai. Interruptions to service delivery were also fueled by many doctors and nurses testing COVID-19-positive and subsequent blame around shortages of PPE, as well as the lack of quarantine and treatment facilities provided to them.

Mumbai used a multipronged strategy to address health worker concerns. These responses included financial assistance, medical aid, provision of protective gear, free lodging and food near the facility in which medical staff are working, insurance coverage of Rs 5 million, and seven days' break after seven days of COVID work. To meet the urgent demand for doctors, the MCGM initially shifted interns and doctors from their medical colleges to COVID hospitals. The interns were given duties such as reporting and maintaining records, as they were not yet qualified to treat patients. Further, fresh medical graduates awaiting their Post Graduate (PG) results were also roped in, and doctors and nurses from other districts (Latur) and states (Kerala) were employed at the Seven Hills Hospital, in Mumbai, where bed strength was increased from 200 to 1,500. However, as medical colleges began to treat COVID patients, they recalled their staff, leading to increased demand for doctors.

To address this issue, the MCGM reached out to the various medical associations, including the homeopathy and Ayurveda doctors' associations, requesting them to join in the fight against COVID. The director of medical education and research, government of Maharashtra, in collaboration with the Maharashtra Medical Council (MMC), issued a circular to all registered doctors based in Mumbai, mandating compulsory services for a minimum of two to four weeks with regular breaks to support pandemic containment. Doctors who were unable to offer their services for personal reasons were excused. A master list including all doctors in Mumbai from the MMC list as well as those who volunteered was prepared, and all doctors received training online.

Good remuneration was offered to all doctors in addition to free food, lodging, PPE kits, and medical insurance coverage. Specialists were placed in COVID hospitals, while homeopathy and Ayurveda doctors were posted to COVID-19 Care Centers (CCCs), where they handled patients with milder symptoms following fixed protocols.

Both Mumbai and Bangalore recruited doctors, nurses, and health assistants on longer-term contracts (i.e., six months) with additional financial incentives. The retention of these staff, however, needs to be studied to better understand if giving additional financial incentives can improve retention of the staff.

Mumbai was the first city to introduce India's "Frontline Health Worker Initiative" in March 2020. These frontline workers consisted of approximately 1,500 accredited social health activist (ASHA) workers and about 4,000 community health volunteers (CHVs) in the MCGM area covering around 211 health posts. These frontline health workers, especially the CHVs, are the backbone of the MCGM fight against COVID-19. CHVs perform screening of people in slums, contact tracing, quarantining the infected and their high-risk contacts, and door-to-door pulse oximeter and temperature surveys (Singh 2020a; Singh 2020b; Gaikwad and Dhupkar 2020).

Several states, including Andhra Pradesh, Uttar Pradesh, Jharkhand, and Tamil Nadu, were using "contracting in" for various support facilities, such as housekeeping and security. Some states also used this approach for laboratory services and human resources. The contracting in for services related to COVID-19 is another option for consideration. However, establishing contract terms and duration, as well as ensuring effective integration with the existing staff, must be carried out with care.

Other strategies to address human resources for health (HRH) challenges include geographically segregating patients with COVID-19 to limit the number of health care personnel exposed and to conserve supplies (Chopra et al. 2020); converting spaces within the hospital, like lobbies or waiting rooms, into patient care venues; and sourcing other non-health care facilities to be COVID care facilities for mild to moderate cases, for instance, function halls, hotels, stadiums, and other large spaces. Networking with hotels, as done by several cities, to ensure better isolation and home-based care for mild cases, also helped to ensure better focus of available staff on critically ill COVID-19 patients (Box 7). However, safety parameters within the hotels must be carefully assessed before such a conversion.

For example, there was a major fire accident in a hotel transformed into a COVID-19 center by a private hospital in Vijayawada, Andhra Pradesh.

Box 7: Home Care Packages

A hospital in Hyderabad has forged a partnership with hotels to provide isolation facilities for patents who test positive for COVID-19 and who have no symptoms or only mild symptoms. This package includes stay in the hotel; meals; a kit for observations (thermometer, pulse oximeter, and some medications); daily online monitoring by a nurse; daily in-person consultation with a doctor; and, if required, an admission and an assured bed in the hospital.

Source: Telangana Today 2020.

Some countries, including India, have used medical students to address health care staff shortages. Aalborg University in Denmark addressed the shortage of health care staff through deploying final year medical students, without interrupting medical education, and providing courses for ventilator therapy/nursing assistance (Rasmussen et al. 2020). The Ministry of Health and Family Welfare (MOHFW) in India also recommended including Doctor of Medicine (MD)/Master of Surgery (MS)/Diplomate of National Board (DNB) students and Bachelor of Medicine and Bachelor of Surgery (MBBS) interns for COVID-19-related care in both public and private facilities. However, this could be better linked with their training.

Strategies Used for Effective Patient Care

Online training to rapidly build capacities: The pandemic has strained the capacities of the health system in terms of knowledge and skills of health care staff handling COVID-19 cases. Early in the pandemic, the MOHFW came up with structured online modules for field surveillance staff, field supervisory staff, laboratory staff, clinical management of COVID-19 cases (for doctors—allopathic, Ayurveda, Yoga and Naturopathy, Unani, Siddha, and Homeopathy [AYUSH], military and paramilitary, interns, and nursing students), and infection prevention and control (IPC). These trainings were delivered through various institutes and state governments using online modalities (virtual platforms). These virtual training methods were used for the first time on a large scale to reach maximum numbers of health care workers in a short time. However, the quality of the trainings and the knowledge and skills imparted must be assessed. Having a structured assessment of the knowledge/skills and the quality of these e-trainings will help inform such approaches in future health emergencies.

Treatment guidelines: Various national-level training resources were first published by the MOHFW on March 30, 2020. All India Institute of Medical Sciences (AIIMS) is conducting COVID-19 grand rounds, with updates on clinical management, and the MOHFW and ICMR are frequently updating treatment guidelines accordingly. Several institutions, like Christian Medical College (CMC), Vellore, Tamil Nadu, also came up with COVID-19 treatment guidelines, which include the ICMR guidelines. However, there has not been a national consolidation of these guidelines, as rapidly evolving evidence on efficacy of various treatments remains a challenge for incorporation and dissemination. Thus, the current treatment guidelines have a lag period for including new evidence. Mumbai, under its “Mission Save Lives,” established an expert task force to regularly update treatment guidelines based on evolving evidence. Some of the strategies under this initiative include video surveillance of ICU cases by senior doctors with regular interaction with junior doctors, audits of all deaths, etc.

Partnering with the private sector for quality ICU services: Tele-ICU partnership (Box 8) initiated in Karnataka used technology for a remote hand-holding exercise to reduce mortality. In July, the AIIMS also started an e-ICU initiative—with twice per week tele/video consultations—to build capacity of ICU doctors in clinical management of critical cases.

Box 8: Tele-ICU Partnership Reducing Mortality Rates in Karnataka

The Karnataka Health Department started a tele-ICU facility in April 2020, as a “hand-holding exercise” for effective treatment of critical COVID-19 patients at hospitals in the cities and towns of the state. The tele-ICU facility has become a key tool in reducing deaths in these hospitals and in keeping doctors abreast of latest developments in the treatment of the disease.

The tele-ICU facility, started across 28 district hospitals in major cities and towns, has now expanded to 68 hospitals, including large public hospitals in Bangalore, with medical experts from top private hospitals in Bangalore, like Columbia Asia, Manipal Hospital, and Narayana Health, doing everyday rounds of ICUs and discussing treatment for every serious patient. With the tele-ICU reportedly helping to keep case mortality rates in some of the districts as low as 0.54 percent, these services have recently expanded to large public hospitals in Bangalore, which has seen fatality rates as high as 5 percent.

Two clear benefits of the tele-ICU are that it:

- Enables standardized treatment for patients across hospitals in cities and towns; and
- Keeps doctors in these hospitals abreast of the latest and global developments in the treatment of COVID-19.

Source: Johnston 2020.

TARGETING VULNERABLE POPULATIONS

Cities in India, including Mumbai, have slums or urban settlements with inadequate basic social and sanitation services. These dense and overcrowded places render populations more vulnerable to transmittable diseases, including COVID-19. Innovations in Dharavi, one such large slum in Mumbai, serve as global best practice for control of COVID-19 in a high population density area. Dharavi shows that active case search, testing, and containment, with involvement of the private sector and local volunteers and NGOs, are critical to containing COVID-19. Home quarantine in a separate room is not a feasible option in slums, while using community and private facilities such as schools, marriage/function halls, and the like, as quarantine centers with active involvement of the private sector is a practical option.

DHARAVI PARTNERSHIP FOR SUCCESS

Mumbai's Dharavi is Asia's biggest and most densely populated slum, with about one million people living in a 2.5 square km area. Authorities took a number of proactive steps to contain COVID-19, rendering Dharavi a role model for cities in emerging economies struggling to handle the pandemic. The WHO director general praised Dharavi for focusing on community engagement and the basics of testing, tracing, isolating, and treating of all those that are sick as key to breaking chains of transmission and suppressing the virus.

With more than seven people sharing each 100 square foot room; 80 percent of residents using community toilets, homes and factories coexisting in a single building, and most people working as informal daily-wage workers who don't cook at home and have to go out to eat, traditional measures of social distancing and hygiene practices are difficult in slums like Dharavi. Thus, the MCGM took a proactive approach of "chasing the virus" with its 4Ts: (1) Tracing, (2) Tracking, (3) Testing, and (4) Treating in high-risk slum clusters, rather than waiting for COVID-19 cases to happen.

The MCGM established teams consisting of a doctor, a community health worker, and a local volunteer; since April, these teams have knocked on doors of 47,500 Dharavi homes and screened 360,000 individuals, including measuring temperatures and oxygen saturation levels. Those having oxygen concentration of less than 95 percent are taken to a quarantine center, where they are provided comprehensive care. In addition, about 2,000 older people were taken into protective quarantine. This active case search helped to identify suspected cases much faster and move them to institutional quarantine facilities. The MCGM model for Dharavi and other slums is summarized in Figure 9.

Figure 9: MCGM Approach for Dharavi

Source: Authors interpretation of the approach.

This proactive approach is complemented by passive case detection at fever camps. At each camp, a team of half a dozen doctors and health workers in protective clothing screen up to 80 residents every day for temperature and blood oxygen levels, using infrared thermometers and pulse oximeters. People showing flu-like symptoms are tested for the disease on the spot. Those who test positive are moved to local institutional quarantine facilities established in nearby schools, marriage halls, and sports complexes. More than 10,000 people have been put into quarantine so far. If the patient's condition

deteriorates, the patient is moved to the public hospital or one of the three private hospitals in the area. By proactively involving 350 local practitioners through effective dialogue and without enforcing regulatory compulsions, the MCGM was able to convince them to join this innovation. Private practitioners were provided with PPE kits, thermal scanners, pulse oximeters, masks, gloves, and assistance for door-to-door screening in high-risk zones, which enabled them to identify suspected cases early. Later, all practitioners were encouraged to open their clinics and notify the authorities about any suspected cases they came across. The MCGM sanitized clinics of all private practitioners in slums and provided PPE kits for enhanced protection. Further, regular sanitization of public toilet facilities was undertaken every day in 225 community and 100 public toilets by dedicated teams, which also sanitized homes of COVID-19-positive cases.

Building community partnership was the core of the strategy. Involving trusted local practitioners and engaging community volunteers helped. Provision of round-the-clock medical supervision free of cost and provision of free food (responding to cultural norms such as providing fruits and dates and adjusting mealtimes for those undertaking Ramadan fasting) helped to cement trust, and people started volunteering to be quarantined as soon as symptoms appeared. AYUSH medical officers were recruited on a contractual basis to provide yoga and meditation sessions at CCCs, which in addition to offering physical benefits also helped keep patients in a positive frame of mind. In addition, Mumbai introduced artificial intelligence–driven screening to identify comorbidities (diabetes, hypertension, etc.) among COVID-19-positive slum residents, some of whom were not even aware they were suffering from these conditions. The MCGM is now planning to continue this initiative as a part of its regular health care delivery.

The strategy helped to reduce mortality and improve recovery. Since the first case was reported on April 1, there were as many as 491 positive cases, with a doubling period of 18 days. In May, the area saw 1,216 cases with more than 56 deaths. In June, however, Dharavi reported zero deaths to the pandemic. The case doubling time improved to 43 days in May and to 78 days in June.

OPTIMIZING EXISTING HEALTH SYSTEMS

Coordination across different levels of care: Most municipalities/municipal corporations in India have primary care (dispensaries) and secondary care (hospitals). Poor coordination between different levels of care within the public sector is a major challenge. Mumbai also has tertiary care (medical colleges) as a part of the municipal corporation health services. This makes Mumbai unique in that it can provide a better coordinated approach, as all levels of health care come under one administration; however, this is a challenge in other cities, as tertiary care (medical colleges) falls under the Directorate of Medical Education, and secondary hospitals under a different administration.

COVID-19 response requires multiple information systems covering transport, police, frontline health care workers, COVID-19 treatment centers, and laboratories—all of which are important for decision making to contain the spread and save lives. All states have created state-level war rooms, and some cities have created city-level war rooms. Notably among these are Bangalore and Mumbai City. Such multiple vertical datasets require rigorous data cleaning and formatting before any analytics can be done. Bangalore tried to address this by involving technology (IT and data analytics) companies. Involving highly skilled private sector partners helps achieve prompt and comprehensive analysis of data to inform decisions based on evidence and develop relevant data standards. However, caution is required in data-use and data-sharing policies.

One of the key issues in data management is data availability from the private sector. Over the years, sustained efforts under the IDSP, TB, and HIV programs helped to increase the notification and reporting of cases by the private sector; however, there is still a long way to go. Creative use of technology like mobile phone- or app-based reporting systems need to be established for improved private sector reporting of data. Elements of data collection should ensure user-friendliness for better compliance supported by appropriate legislation.

Coordinated planning and supply chain management: Municipal corporations are independent bodies with their own budget and implementation structures. They are generally excluded from the state annual action plans for various health-related procurements and planning. Pandemic situations require hiring of temporary staff, nonsalary recurring costs, and consumables, all of which are expensive and need priority support from state and federal governments. Including municipalities in integrated state health plans and emergency supply chains may be a good way forward.

Private sector engagement: A key issue in health systems management is the involvement of the private sector across the country. Cities are the hub of private practices and hospitals. There needs to be a proactive, meaningful approach to involving the private sector in the COVID-19 pandemic response. Investment in collaboration and partnerships between the public and private sectors will facilitate a more coordinated and resilient response to future pandemics in cities.

The private sector can also be used for support areas like emergency transport. Mumbai Corporation of Greater Mumbai (MCGM) collaborated with Uber to automate the ambulance system, which helped in real-time tracking of the vehicle and approximating the time needed to reach the beneficiary or facility.

In Bangalore, as COVID-19 cases increased, civil society and the private sector came together to improve access to COVID-19-related health care. Though the beds and bed availability were mentioned in the website, real-time updates and availability was a problem. Civil society joined hands with the Bruhat Bengaluru Mahanagara Palike (BBMP) and become an interface for navigating care and bed allocation (*Deccan Herald* 2020). They launched an app to help patients get admission in public or private hospitals (Johnson 2020). Similar strategies of meaningful involvement of the civil society/private sector are crucial in other cities. Cities like Mumbai will surely benefit from having a dedicated call center and a mobile-based application to help navigate patients to the required hospital for admission.

Civil society involvement: There have been several troubling reports of people absconding from quarantine facilities and hospitals, partly due to fear and partly due to lack of trust in the public health system. Another key issue is fear of stigma and discrimination attached with COVID-19 diagnosis, quarantine, or treatment (Chetterje 2020). Effective community engagement plays a critical role in avoiding such situations. Several cities, including Mumbai, have taken steps to involve Resident Welfare Associations (RWAs) and have come out with specific guidelines. Actively involving communities and RWAs as full partners in the COVID-19 response is important. The MOHFW also released guidelines for RWAs to set up small CCCs in their communities, and several RWAs have created such facilities. Strategies for arranging home visits by doctors/nurses, including scheduling specialist consultations at agreed times by RWAs, can be explored.

Local volunteers stepped in to support the Thane Municipal Corporation (TMC) for COVID-19 control. Several general practitioners (GPs), priests, and volunteers supported TMC in the control of COVID-19. The GPs kept their clinics open to provide essential health care; the priests spread awareness about COVID-19 in their morning prayers; and local volunteers/residents supported efforts by participating in surveys conducted by the civic body staff (Pol 2020). Delhi is training its local volunteers to triage and manage mild COVID-19 cases admitted at isolation facilities in neighborhood community centers and marriage halls (Dutt 2020).

Targeted risk communication: Several instances of ostracizing or refusing entry or stay of people who had COVID-19 by their communities, or denying neighborhood entry to health care workers, reflect the stigma surrounding the disease. The existing stigma and discrimination have to be systematically addressed by designing key messages for specific target groups. An effective mix of media should be used to deliver messages, including interpersonal communication, radio talk/jingles, video shows, and group talks. In urban areas, in particular, communication plays a critical role for assurance and gaining confidence of the communities. Identifying communication leaders within wards or communities, maintaining a database of their contact information, and continuously engaging them to deliver key messages are all important steps. Several cities, including Mumbai, are already using many of these modalities. Still, intensifying this effort and following a systematic approach with active participation of local leadership—specifically encouraging social distancing and reducing stigma and discrimination—remains important.

Maintaining Essential Health Care Delivery and Priority Disease Control Programs

In India and in Mumbai, during the initial four months of the COVID-19 pandemic, private sector medical facilities either halted or drastically limited services, while the public sector was mostly providing COVID-19 care. Now the private sector is slowly but cautiously opening up services for COVID-19 and other essential health care. Despite improvements in the supply side of service delivery, clients were reluctant to access care, for fear that visiting health facilities would enhance their risk of contracting COVID-19. Both routine and critical care services were badly hit. To address these concerns, the MCGM made 105 dialysis units (80 from public and 25 from private sector) available, along with a special dialysis dashboard to ensure effective access. One hundred and ten beds were allocated for COVID-19-positive pregnant women nearing delivery in one major hospital, and an additional 100 beds were allocated in maternity homes run by the MCGM.

PART VII – WHAT MUMBAI HAS DONE WELL AND WHAT MORE NEEDS TO BE DONE?

WHAT MUMBAI HAS DONE WELL?

1. Chasing the virus by targeting vulnerable populations residing in high-risk slum clusters using Tracing, Tracking, Testing, and Treating (four Ts), rather than waiting for cases to happen. Dharavi has become a global role model for effective containment of COVID-19.
2. Decentralizing management response and accountability to 24 ward administrations to provide a swifter, more integrated response.
3. Integrating vertical streams of data into one dashboard, providing the most comprehensive information available in the public domain.
4. Involving the private sector—especially local practitioners in slum clusters who are trusted by communities—in active case finding, and operating fever clinics to identify symptomatic early.
5. Increasing the health infrastructure to ramp up facilities with emergency beds, essential medical equipment, and oxygen.

WHAT MUMBAI NEEDS TO DO MORE?

Increase testing. From the data available, it appears that Mumbai—which is primarily focusing on RT-PCR (reverse transcription-polymerase chain reaction, the gold standard for diagnosis of COVID-19)—is testing less. Mumbai needs to augment testing with urgency, including addressing supply-side bottlenecks in sample collection and processing. The new ICMR guidelines that allow on-demand testing require more laboratory capacity.

Table 2: Trends in COVID-19 Cases, Testing, and Case Fatality Rates in Selected Cities of India (September 6, 2020)

City	Cumulative cases	Positivity Percent	Corrected case fatality Percent	Tests (Millions)
Ahmadabad	32,351	0.84	5.93	11,882
Bangalore (Urban)	144,757	10.6	1.76	101,705
Chennai	140,685	8.55	2.34	219,054
Delhi	188,193	8.59	2.76	93,232
Mumbai	155,622	16.78	5.00	64,509

Source: Authors compilation from media reports.

Reduce case fatality rates. Case fatality rates in Mumbai and Ahmadabad are still much higher than in other cities. Mission Save Lives is a welcome initiative to address this challenge. Introduction of "near-miss" death audits could enhance participation of ICU staff in the process, as the focus will be on what they did to save a life rather than the faultfinding that happens in the case of death audits. Further strengthening e-ICU support through daily interaction and constant updating of treatment protocols as new evidence is emerging (such as corticosteroids for serious cases) will help.

Address new challenges with unlocking. As the nerve center for the Indian economy, Mumbai needs a clear strategy for dealing with the unlocking process until effective treatment or a vaccine is available for COVID-19. Introduction of repeated "Assurance Testing" for high-risk groups (migrant labor, industrial workers, and frontline staff) using pooled samples and sewage testing (which can detect the virus upward of four days before people show symptoms) in specific institutional settings (such as old-age homes, dormitories, and industrial townships) will help. Antibody testing at periodic intervals, covering representative samples of populations should continue.

Create networks. Mumbai must strengthen networking between the private sector, NGOs, philanthropists, RWAs, and government (both city and peri-urban administrations) by creating appropriate institutional mechanisms for sustained coordination after the COVID-19 pandemic subsides to develop ward-specific microplans for pandemic preparedness. Networking with global cities that managed to contain the pandemic, such as Seoul or San Francisco, could help.

Engage citizens through targeted risk communication. Mumbai is the first city in India to make the use of masks in public spaces mandatory. The civic body in Mumbai collected a total of 2.748 million *Indian* Rupees in fines from 2,798 citizens between April 9 and August 31, 2020, and 9,954 citizens were issued warnings for not wearing masks correctly during that period. For sustained behavior change, it is important to promote voluntary compliance through effective risk communication, specifically targeting groups that are not complying. This requires involving local leaders and community volunteers and recognizing locations/wards achieving progress.

Develop models for metropolitan disease surveillance. With its vast experience and public health capacity, Mumbai can support development of models for metropolitan disease surveillance envisaged under Pradhan Mantri-Atmanirbhar Swasth Bharat Yojana (PM-ASBY).

PART VIII – MEDIUM-TERM ACTIONS TO BETTER PREPARE CITIES FOR FUTURE PANDEMICS

MORE COORDINATED PUBLIC HEALTH SYSTEMS

Due to population concentration and connectivity, cities will remain gateways to infectious disease transmission, with consequences that extend beyond health, as seen with COVID-19 and Ebola. Therefore, early detection and control of epidemics remains an important capability of cities, requiring robust city-based surveillance, supported by outbreak identification, confirmation, and control. These activities should be well-coordinated with neighboring municipalities, city hospitals, and laboratories, both public and private. The National Centre for Disease Control (NCDC) needs to issue specific guidelines for proposed metropolitan disease surveillance. It is also important to have norms for smaller municipalities, which are often neglected in routine disease surveillance. Beyond the guidelines for disease surveillance in urban settings, the NCDC, states, and other central agencies need to provide technical support to municipal corporations to systematically develop and roll out disease surveillance systems.

Municipal public health departments have responsibility for quarantine, isolation, and contact tracing, for which appropriate capacity and infrastructure should be available. Cities also have a role in disease prevention measures, such as immunization and distribution of prophylaxis (e.g., mass deworming). All cities participating in the Smart Cities Mission[3] should focus on addressing such needs while planning multi-use community infrastructure.

An important route for introduction of infections in cities is species-crossing of infectious disease agents in wholesale and retail markets. Limiting such risks requires a One Health approach with critical interfacing between animal and human health, which also needs to guide agricultural practices. City-level One Health coordination structures need to be created to provide early alerts on zoonotic diseases.

To ensure continuity of non-COVID basic and emergency health care services, cities can follow the WHO's operational guidance for maintaining essential health services (WHO 2020). The WHO recommends that cities: separate governance and coordination mechanisms to deliver essential health services; prioritize and optimize facilities delivering essential services; create public awareness and reorient referral pathways for non-COVID-19 repurposed facilities; use technologies like telemedicine/teleconsultation; establish a safe and effective patient flow at all levels; and optimize health care workforce capacity though staff reassignment and mobilization of the private sector to ensure delivery of essential health services.

PROACTIVE ENGAGEMENT WITH PRIVATE SECTOR

COVID-19 opened opportunities for the GOI to review and develop new strategies and policies for partnering with the private sector. The ICMR's expansion of the laboratory network performing COVID-19 RT-PCR tests from 18 public laboratories to 1,415 laboratories—with nearly a third from the private sector—by August 11, 2020, is an excellent example of such potential.

Lab expansion came with operational demands, such as stricter enforcement of accreditation norms for private labs, with more flexibility for public sector labs. There were also issues of pricing. With the inclusion of testing under Pradhan Mantri Jan Arogya Yojana (PM-JAY), this challenge of inequitable access is expected to be addressed.

Private sector engagement, however, did not work effectively for case management in most metropolitan cities, with claims and counterclaims of overcharging, and poor compliance with government guidelines on bed allocation and treatment. Many states prescribed prices and mandated the private sector to share a portion of their bed capacity for treating severe COVID-19 cases. Learning from the COVID-19 pandemic, it would be helpful for all major cities to have a system of regular engagement with the private sector and actively include private sector partners in city-specific pandemic preparedness plans.

HOLISTIC APPROACH

Urban slum focus: COVID-19 has exposed the deep vulnerability of urban slums, which need to be a central focus of urban planning (Box 9). Currently, one billion people globally live in slums, and it is estimated that by 2030, this will increase to two billion, mainly in Africa and Asia (UN Habitat 2003). Most of this growth will occur in smaller cities with populations of 50,000 to 99,999, where urbanization tends to continue without adequate planning or expansion of infrastructure. It is important to note that not all

[3] Smart Cities Mission is an urban renewal and retrofitting program implemented by the GOI to develop 100 smart cities across the country, making them citizen-friendly and sustainable.

people living in slums are poor, and there will be poor people among urban residents outside slums. More than half of dwellings classified as slum households in Chennai, Delhi, and Hyderabad fall outside areas classified as slums. Slums are usually formed close to areas where work is available. Security of tenure becomes a key issue as these dwellings are often set up on unclaimed or municipal land, and the decision on whether or not to recognize them is left to authorities. Slums can also be found in dangerous sites such as ravines, flood-prone areas, or under powerlines.

Box 9: Lowering COVID-19 Risk in Slums

1. People living in slums share environmental risks arising from poor sanitation, and benefit collectively from interventions such as improved sanitation, water, and access to health.

2. Social and health improvement interventions that work in non-slum localities might not be transferable to slum areas without appropriate adaptations.

Source: Ezeh et al. 2017

Higher infant and neonatal mortality in slum areas compared to rural areas has been reported in Brazil, Ecuador, Haiti, Kenya, and the Philippines (Van de Poel, O'Donnell, and Van Doorslaer 2007), with the most common causes being diarrhea and pneumonia. Two systemic reviews of cholera outbreaks in Africa identified slum neighborhoods as their source. Poor water and sanitation, along with accumulation of rubbish and water logging, offer a breeding ground for parasites and vectors. Leptospirosis due to proliferation of rats in rubbish and dengue fever and chikungunya due to breeding of the Ades mosquito are common in slums. Young and highly mobile populations in slums contribute to higher incidence of HIV and sexually transmitted diseases (STDs). Surveys suggest food insecurity in slums as high as 77 percent in northern India (Chinnakali 2014).

The living and working conditions in slums predispose stress, which could lead to psychological disorders, as reported in garment factories of Bangladesh. There is also evidence that children living in slums have more behavioral and emotional problems than children in rural or non-slum urban areas (Ernst, Phillips, Duncan 2013). Slums are also found to have high prevalence of childhood asthma, which is aggravated by indoor cooking and unsanitary conditions. While rates of hypertension tended to be lower, a study in Kenya showed that control of hypertension was less in slum settings (Van de Vjver et al. 2013), which is consistent with problems of accessing health care in slums. Slum dwellers also tend to weigh more and exercise less than rural residents.

Environment: Cities need to target vulnerable groups and improve their access to safe water, while also improving system efficiency, minimizing distribution losses, and promoting conservation, including the use of rainwater. This needs to be combined with more efficient stormwater collection and drainage. Learning from COVID-19 on potential risks of spread through shared toilets, improving access to safe sanitation, and sold waste management requires priority attention for slum populations. Other important environmental issues include handling of air and noise pollution, and effective sold waste management, including electronic and industrial wastes, which tend to get concentrated in urban areas.

Housing: The high cost of housing in cities leads to inequalities in housing and neighborhoods. It also reduces income available for food, health care, and education (Ezzati et al. 2020). The vulnerability of urban slums, where millions of people reside in crowded, windowless, and flimsy structures without access to essential services, was laid bare by COVID-19. City governments, supported by state and national governments—through appropriate fiscal policies and regulations—should promote public housing for the urban poor that ensures safe and healthy living, while ensuring access to essential services. Such an approach specifically requires partnerships with the private sector, especially builders; small- and medium-scale industry; and housing finance to enhance investments and provide access to low-cost financing. India, for example, started a public-private partnership initiative to promote quality low-cost housing for poor urban populations.

Nutrition: Demands on time and limitations of space affect cooking healthy and balanced meals for the family, especially for young children. Most migrants also do not have access to a public distribution system in cities and end up paying higher prices. Absence of social support systems that exist in rural areas to care for sick and invalid people causes the urban poor go hungry, exacerbating their vulnerability. The recent One Nation, One Ration Card scheme will help to address these challenges. Effective Integrated Child Development Services (ICDS) projects—for example, cooking demonstrations for high-energy balanced foods and innovations in the provision of emergency dense ready-made/easy-to-cook food—have been implemented in urban areas as part of the emergency response. These partnerships with the private sector and civil society groups require a more sustained effort to give them a more proactive role in improving nutrition.

FUTURE CITY PLANNING – SMART CITIES OPTIMIZING TECHNOLOGIES

In the early history of American cities, planning and public health were inextricable. Doctors and engineers worked together to produce a lot-by-lot survey of the entirety of Memphis, Tennessee, in 1878—after yellow fever infected 17,000 of the 19,000 residents who hadn't fled the epidemic, and claimed 5,000 lives—and eliminate breeding spaces such as street beds, freshwater and sewage systems, and filled-in marsh and coastal wetlands. Planners also started to build "breathing spaces," parks, and recreational centers, breaking up increasingly crowded neighborhoods with green space. But a split emerged, as American municipal governments grew and balkanized into more departments, and as health and planning professionalized and the respective academic fields were divided (Owens 2016). We notice similar patterns in India. Box 10 lists four challenges to planning healthy cities that reflect the gulf between city planners and public health professionals.

Box 10: Four Challenges to Planning Healthy Cities

- The gulf between professionals of the two disciplines: city planners and public health officials
- A tendency toward approaches hewed to science, rather than collaborative planning based on a "vision of a healthy city"
- An overreliance on urban design to create ideal social climates
- The overlap of clearing waste and pushing out undesirable populations

Source: Corum 2014.

Lack of robust integrated spatial planning remains an Achilles' heel for metropolitan cities in India. The constitutional mandate for formation of Metropolitan Planning Committees (MPCs) in all metropolitan areas with more than a million population has not been fully implemented, with only half of 18 cities having such mechanisms in place on paper (Janaagraha 2019). The key role of MPCs is to ensure integrated planning for the entire metropolitan area and to synthesize priorities set by local authorities, states, and central governments. The absence of such comprehensive and integrated planning has been starkly visible during the COVID-19 crisis. Only a medium- to long-term plan will be able to focus on equal access to essential services (i.e., water, sanitation, housing, and health) and offer social security to the urban poor (Vachana 2020).

Advances in remote sensing and information and communication technologies are creating unprecedented opportunities and challenges for the pandemic response. Some benefits include use of mobile phones and digital foot prints (ATM or credit card use) for contact tracing (as in Singapore, Taiwan, and Korea); sensor technologies for monitoring air pollution; and car hail services for sharing transport, which was used for operating ambulance services in Mumbai at the outset of the pandemic.

These novel initiatives require carefully considered policies and regulations to safeguard individual identity and privacy. High-resolution spatiotemporal data analysis was found to be helpful in identifying clustering of COVID-19 cases in the Canton of Geneva, Switzerland (De Ridder et al. 2020). This approach combines spatiotemporal diffusion dynamics of SARS-CoV-2 clustering with modern geospatial tools, leveraging the precise location of patients. Such approaches have great potential from a prevention perspective, especially in avoiding lockdowns. The pilot involved tracing and testing 12,918 close contacts of 2,877 COVID-19 confirmed cases based on the daily clustering dynamics of these cases. First clusters emerged in areas of high population density inhabited by the highest number of persons per room, highlighting the risks of residential overcrowding. Geographical clustering of positive cases across space and time, combined with an effective testing strategy, has the potential to (1) inform origin of disease, (2) identify zones where disease is currently spreading, and (3) introduce accurate prevention and containment measures.

TRANSPORTATION

COVID-19 has raised new challenges for public transportation in cities. Private transportation or biking is not a viable option for all urban poor who typically ride on crowded public transportation. Physically locating public housing near industrial areas with land contributions from the private sector will reduce the need for transportation for industrial labor. However, other urban residents, especially those in peri-urban areas, will still need public transportation, and enhanced use of private transportation will leave a huge carbon footprint. Some innovations tried in Japan's underground system, such as mandatory masking and avoidance of loud speaking, could help. This could be combined with improving airflow by avoiding air-conditioning, limiting occupation to 50 percent of available seats, enhancing sanitization, and using mobile payment platforms to avoid cash transactions, such as on public transportation in Nairobi, Kenya.

GOVERNANCE

Weak capacity, low revenue generation, fragmented and poorly coordinated administration, and inadequate staffing hamper the ability of municipalities in India, to provide effective governance and responsive civic services, especially during an emergency response. Most cities in India are dependent

on state governments for their budget support; the average share contributed by revenue out of total budget expenditure ranged from 35 percent in Chennai to 48 percent in Bangalore and Kolkata (Vachana 2020). While most large cities around the world have directly-elected mayors with robust accountability mechanisms, India's situation is quite different. Mayors are elected indirectly and have shorter tenures: one year for Delhi and Bangalore, and two and a half years for Mumbai. In addition, utility services are handled by state parastatal agencies that report directly to the state government.

Achieving integrated development of metropolitan areas and readiness for future pandemic response requires serious reforms of governance structures and accountability arrangements. Active participation of elected representatives on health facility committees, as done by Kolkata Metropolitan Development Authority in municipalities in Howrah and Hubli, is an example of how local bodies can be effective partners in the delivery of health care services. These measures need to be complemented by efforts to actively involve citizens in key decisions. The recent initiative to involve RWAs in the operation of Urban Health and Wellness Centers is a welcome move in this direction.

Regional Platforms for Knowledge Sharing on Innovations

With rapid urbanization, it is important to learn from ongoing innovations and implementation experiences of programs such as the Smart Cities Mission (https://smartcities.gov.in/). An appropriate virtual forum for knowledge exchange will help cities throughout the Asia region, in particular, to respond to COVID-19 and prepare for future pandemics.

ANNEX 1: SERO-PREVALENCE OF COVID-19 IN SELECTED CITIES

City	Date and coverage	Sample size	Sero-prevalence (%)
Delhi (First sero survey) [i]	• June 27–July 10 • 11 districts of NCR	21,387	• 23.00
Delhi (Second sero survey) [ii]	• 1–7 August • Representative sample from 11 districts (excluding those in the first survey)	15,000	• 29.10
Chennai [iii]	• July 18–28 • 51 wards, 15 zones of Greater Chennai Corporation	12,405	• 21.50 (Tondiarpet 44.20, Madavaram 7.10)
Mumbai [iv]	• First half of July • 3 civic wards	6,936	• 57.00 slums and 16.00 residential areas
Indore [v]	• August 11–23	7,103	• 7.75 (five wards had >20.00)
Pune [vi]	• July 20–August 5 • Five wards worst hit by COVID-19	1,664	• 36.10–65.40; ~50.00
Ahmedabad [vii]	• July and August	10,000	• August 23.24 • July 17.68

Source: i: The India Today Webdesk. 2020.; ii: Sharma M. 2020.; iii: Scroll 2020.; iv: Kar S 2020.; v: Jain N 2020.; vi: India TV Webdesk 2020.; vii:The New Indian Express 2020.

REFERENCES

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Acharya, R., and A. Porwal. 2020. “A Vulnerability Index for the Management of and Response to the COVID-19 Epidemic in India: An Ecological Study.” *Lancet Glob Health* 8 (9): e1142–51. doi: 10.1016/S2214-109X(20)30300-4.

Adhikari, S., Pantaleo, N.P., Feldman, J.M., Ogedegbe. O., Thorpe, L., Troxel, A.B. 2020. “Assessment of Community-Level Disparities in Coronavirus Disease 2019 Infections and Deaths in Large US Metropolitan Areas.” *Jama Network Open* 3 (7).

Aron, Ravi. 2020. “Combating COVID-19: Lessons from Singapore, South Korea and Taiwan.” *Knowledge@wharton,* April 21.

Brooks, S. K., R. Dunn, R. Amlot, G. J. Rubin, and N. Greenberg. 2018. “A Systematic, Thematic Review and Social and Occupational Factors Associated with Psychological Outcomes in Healthcare Employees during an Infectious Disease Outbreak.” *J. Occup. Environ Med* 60 (3): 248–57.

Census of India. 2011. “District Census Handbook Mumbai Town Directory.” Directorate of Census Operation, Maharashtra, Government of India: 2014.

Chaudhry, Rabail, George Dranitsaris, Talha Mubashir, Justyna Bartoszko, and Shiela Riazi. 2020. “A Country Level Analysis Measuring the Impact of Government Actions, Country Preparedness and Socioeconomic Factors on COVID-19 Mortality and Related Health Outcomes.” *EClinical Medicine* 1000464.

Chetterje, P. 2020. “Gaps in India's Preparedness for COVID-19 Control.” *The Lancet Infectious Diseases* 20 (5): 544.

Chinnakali, P., R. P. Upadhyay, D. Shokeen, Singh, K., Kaur, M., A.K. Singh, A. Goswami, et al. 2014. “Prevalence of Household-Level Insecurity and Its Determinants in an Urban Resettlement Colony in North India.” *Journal of Health Population and Nutrition* 32: 227–36.

Chokshi, Dave A. 2020. “Emerging Lessons from COVID-19 Response in New York City.” *The JAMA Forum* 323 (20), May 26.

Chopra, V., E. Toner, R. Waldhorn, and L. Washer. 2020. “How Should U.S. Hospitals Prepare for Coronavirus Disease 2019 (COVID-19)?” *Ann Intern Med*. 172 (9):621–22. doi: 10.7326/M20-0907.

Corum, Jason. 2014. “Confronting the Challenges in Reconnecting Urban Planning and Public Health.” *American Journal of Public Health* (April).

De Ridder, David, Jose, S., N. Vuilleumier, S. Stringhini, H. Spechbach, S. Joost, et al. 2020. “Geospatial Digital Monitoring of COVID-19 Cases at High Spatiotemporal Resolution.” *Lancet Digital Health* 2: 8 (June 16).

de Souza, W. M., L. F. Buss, D. d. S Candido, J.P. Carrera, S. Li, A.E. Zarebski, R.H.M. Pereira, et al. 2020. “Epidemiological and Clinical Characteristics of the COVID-19 Epidemic in Brazil.” Nat Hum Behav 4: 856–65. https://doi.org/10.1038/s41562-020-0928-4.

Deccan Herald. 2020. “COVID-19 Bed Allocation: Civil Society Joins BBMP.” Video, August 12.

Devulapalli, Sriharsha. 2019. “Migrant Flows to Delhi, Mumbai Ebbing.” *Mint*, September 20.

Dutt, Anonna. 2020. “Local Volunteers Being Trained to Look after Community.” *Hindustan Times*, June 24.

Ernst, K. C., B. S. Phillips, and B. D. Duncan. 2013. “Slums Are Not Places for Children to Live: Vulnerabilities, Health Outcomes, and Possible Interventions.” *Adv Pediatr* 60 (1): 53–87.

Ezeh, Alex, O. Oyebode, D. Satterthwaite, Y.-F. Chen, R. Ndugwa, J. Sartori, B. Mberu, et al. 2017. “The History, Geography, and Sociology of Slums and the Health Problems of People Who Live in Slums.” *Lancet* 389: 547–58.

Ezzati, M., C. J. Webster, Y.G. Doyle, G.M. Leung. 2020. “Cities for Global Health; Analysis British.” *Medical Journal* K3794 (October 3).

Fernandes, Marcella, Andréa Martinelli, and Grasielle Castro. 2020. “Brazil’s Disastrous COVID-19 Response Exposes Profound Inequalities.” *Huffpost,* June 7.

Gaikwad, Rahi, and Alka Dhupkar. 2020. “ASHAs. Community Health Workers, Do Door-to-Door Health Tracking, without PPE, with Poor Pay.” *Mumbai Mirror*, May 5.

Gawande, Atul. 2020. “We Can Solve the Coronavirus Test Mess Now—If We Want To,” *The New Yorker,* September 2.

Gill, Indermit. 2020. “Corona Virus Lessons from New York and San Francisco.” Brookings, April 7.

Goodman, David J. 2020. “N.Y.C. Health Commissioner Resigns after Clashes with Mayor over Virus.” *The New York Times*, August 4.

India TV Webdesk. 2020. “Half the population of Pune shows COVID-19 antibodies: Sero-Survey”. India TV News. August 18.

Jain N. 2020. “Sero survey suggests 7.75% people in Indore have Covid-19 antibodies”. The Hindustan Times. August 28.

Janaagraha. 2019. “Annual Survey of India’s City-Systems (ASICS) 2017.” Janaagraha Centre for Citizenship and Democracy, January 10.

Johns Hopkins University of Medicine. 2020. “Coronavirus Resource Centre.” Available at: https://coronavirus.jhu.edu

Johnson, T. A. 2020. “Bengaluru Bed Crisis: Karnataka Moves to Set Up App, Helpline for Hospital Admission.” *The Indian Express*, July 3.

Kar S. 2020. “Mumbai: Sero Survey Finds 57% People in Slums Had COVID-19, Only 16% in Other Residential Areas”. India.com. July 29.

Karan, A., H. Negandhi, R. Nair, A. Sharma, R. Tiwari, S. Zodpey. 2019. “Size, Composition and Distribution of Human Resource for Health in India: New Estimates Using National Sample Survey and Registry Data.” *BMJOpen* 9: e025979. doi: 10.1136/bmjopen-2018-025979.

Koppikar, Smruti. 2017. “In Mumbai’s Poorest Slums, Water and Sanitation Carry a Steep Price Tag—Sometime Death.” *Scroll*, February 15.

L. L. Silva, A. de.C.Dutra, P. H. Lora, G.L.R.Ramajo, G.A.F.Messias, L.A.P.Gualda, J.F.H.C. Scheidt, et.al. 2020. “Brazil Health Care System Preparation against COVID.” medRxiv (May 9): 20096719. doi: https://doi.org/10.1101/2020.05.09.20096719.

Mahajan, Poonam. 2014. “Poonam Majhajan Explains Why Mumbai Is at the Very Heart of India Story.” *DNA*, July 26.

Mishra, Lata. 2020. “COVID-19: With Nurses from Kerala Gone, City Hospitals Struggle to Cope.” *Mumbai Mirror*, June 3.

MOHFW (Ministry of Health and Family Welfare). 2020. “Guideline for RT-PCR Based Pooled Sampling for Migrants/Returnees from Abroad/Green Zones.” New Delhi, May 14.

New York City Department of Health. 2020. Data derived from the Bureau of Communicable Disease Surveillance System as of April16, 2020.

New York State Department of Health COVID-19 Tracker. Available at https://covid19tracker.health.ny.gov/views/NYS-COVID19-Tracker/NYSDOHCOVID-19Tracker-DailyTracker?%3Aembed=yes&%3Atoolbar=no&%3Atabs=n. Accessed on 03 April 2020

Owens, Cassie. 2016. “Reconnecting Urban Planning and Public Health.” *Next City,* January 29.

Pavithra, K. M. 2020. “Explainer: What Is Pooled Testing and How It Is Being Done.” *Factly,* May 27.

Pol, Megha. 2020. “GPs, Volunteers, Priests: Mumbai’s Covid Warriors.” *Hindustan Times*, July 24.

Potter, Christina. 2020. “Zero COVID-19 Deaths in Vietnam.” Outbreak Observatory, Center for Health Security, Johns Hopkins Bloomberg School of Public Health, July 9.

Praja. 2019. “State of Health in Mumbai.” September. Avaialable at: https://www.praja.org/praja_docs/praja_downloads/Report%20on%20The%20STATE%20of%20HEALTH%20in%20Mumbai.pdf

Raghavan, P., T. Barnagarwala, A. Ghosh. 2020. “Covid Fight: Govt System in Front, Private Hospitals Do the Distancing.” *The Indian Express*, April 30.

Rasmussen, S., P. Sperling, M. S. Poulsen, J. Emmersen, and S. Andersen. 2020. “Medical Students for Health-Care Staff Shortages during the COVID-19 Pandemic.” *The Lancet* 395 (10234): e79–80.

Reynolds, Isabel, and Gearoid Reidy. 2020. “Tokyo Finds Record 224 Virus Cases, Blames Increased Testing.” Bloomberg, July 9.

Safe Water Network. 2016. “Drinking Water Supply for Urban Poor: City of Mumbai.” Avaialble at: https://www.safewaternetwork.org/sites/default/files/Safe%20Water%20Network_Mumbai%20City%20Report.pdf

Scroll 2020. “Coronavirus: Chennai sero survey shows one-fifth of residents have been exposed to infection”. Scroll. September 02.

Sharma M. 2020. “29% in Delhi developed Covid-19 antibodies, shows new sero survey”. The India Today. August 20.

Shi, Le, et. al. 2020. “Prevalence and Risk Factors Associated with Mental Health Symptoms among General Population in China during Coronavirus Disease 2019 Pandemic.” *JAMA Network Open* 3 (7).

Sim, K., Y. Huak Chan, P. N. Chong, H. C. Chua, S. Wen Soon. 2010. “Psychosocial and Coping Response within the Community Health Care Setting towards a National Outbreak of an Infectious Disease. *J. Psychosom Res* 68 (2): 195–202.

Singh, Laxman. 2020a. “BMC’s Community Health Volunteers: In the Frontline of Covid Fight, but Poorly Paid, Exposed to Risk.” *The Indian Express*, April 28.

Singh. 2020b. “Mumbai: 1,500 Community Health Volunteers Yet to Be Paid for June.” *The Indian Express*, July 25.

Sparks, John. 2020. “Coronavirus: South African Community Starts Own COVID-19 Healthcare System as Government Response Falters.” Sky News, Eyewitness, August 17.

Stringer, Scott M. 2020. Press release, Comptroller, City of New York, July 17.

Taylor, M. R., K. E. Agho, G. J. Stevens, and B. Raphael. 2008. “Factors Influencing Psychological Distress during a Disease Epidemic: Data from Australia’s First Outbreak of Equine Influenza.” *BMC Public Health*: 8: 347.

Telangana Today. 2020. “Covid-19: Three Hospitals in Hyderabad Roll Out ‘Quarantine’ Packages,” July 18.

The India Today Webdesk. 2020. “Delhi sero-survey report says over 23% people affected by Covid-19, experts call it good news”. The India Today. July 22.

The Lancet Public Health. 2020. “COVID-19: From a PHEIC to a Public Mental Health Crisis?” *The Lancet Public Health* 5: 8 (August).

The New Indian Express. 2020. “Ahmedabad: Sero-survey suggests 23.24 per cent people have COVID-19 anti-bodies”. September 03.

Trotochaud, Marc. 2020. “Taiwan’s COVID-19 Response,” Outbreak Observatory, Center for Health Security, Johns Hopkins Bloomberg School of Public Health, April 30.

Tufekci, Zeynep. 2020. “We Need to Talk about Ventilation.” *The Atlantic,* July 30.

UN Habitat. 2003. *The Challenge of Slums: Global Report on Human Settlements 2003.* UN Habitat: London and Sterling, VA.

United Nations Department of Economic and Social Affairs. 2014. “2014 Revision of World Population Prospects, Highlights.” New York: UN.

Vachana, V. R. 2020. “The COVID-19 Crisis as a Metropolitan Battle.” *The Hindu*, August 1.

Van de Poel, E., O. O’Donnell, and E. Van Doorslaer. 2007. “Are Urban Children Really Healthier? Evidence from 47 Developing Countries.” *Social Science & Medicine* 65 (10): 1986–2003.

Van de Vjver, S. J., S. O. Oti, Agyemang, G. B. Gomez, and C. Kyobutungi. 2013. “Prevalence, Awareness, Treatment and Control of Hypertension among Slum Dwellers in Nairobi Kenya.” *Journal Hypertension* 31 (5): 1018–24.

WHO (World Health Organization). 2020. “Maintaining Essential Health Services: Operational Guidance for the COVID-19 Context: Interim Guidance.” Geneva: WHO, June 1.

Metropolitan areas drive economies, yet the same elements that contribute to economic growth—such as industrialization accompanied by migrant influx—result in overcrowding and poor housing and sanitation. These factors, coupled with intensive international connectivity, make cities extremely vulnerable to pandemics. Experiences from New York and São Paulo show that complex administrative structures; conflicting messages from federal, state, and city governments; human resource shortages; supply chain mismanagement; weak coordination between hospitals and public health systems; and poor linkages with the private sector are all limiting factors of a comprehensive pandemic response. COVID-19 has seriously impacted the delivery of essential health services, especially in cities, where the private sector and public hospitals deliver a significant share of primary care. COVID-19 also presents a major public mental health challenge both for health professionals and the general public. This paper brings together various local and global lessons, best practices, and emerging innovations to contain the COVID-19 pandemic in large urban areas. This paper aims to provide aid/guidance to municipal and national authorities, policy makers, and agencies leading COVID-19 responses across India and globally. Because COVID-19 is a relatively new disease, and evidence on effectiveness and impact of interventions and innovations is patchy, anecdotal, and still evolving, findings from this note must be interpreted with caution.

This paper does not address broader urban health systems challenges, but rather: (i) outlines factors that make Mumbai vulnerable to pandemics and describes the city's COVID-19 response; (ii) summarizes evolving global lessons from cities and urbanized countries in response to COVID-19; (iii) highlights initiatives and innovations of pandemic response with a focus on India; (iv) emphasizes what Mumbai has done well and what more needs to be done; and (v) presents medium- and long-term actions for integrated development of cities to prepare for future pandemics.

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