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Are leading urban centers predisposed to global risks- An analysis of the global south from COVID-19 perspective

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ABSTRACT

COVID-19 initially spread among prominent global cities and soon to the urban centers of countries across the globe. While cities are the hotbeds of activities, they also seem highly exposed to global risks including the pandemic. Using the case of COVID-19 and the World Risk Index framework, this paper examines if the leading cities from the global south are inherently vulnerable and exposed to global risks and can they exacerbate the overall risk of their respective nations. Compared against their respective national averages, most of the 20 cities from 10 countries analyzed in this paper, have higher exposure, lower adaptive capacity, higher coping capacity and varied susceptibility. As this relative understanding is based on respective national averages which are often lower than the global standards, even high performance on certain indicators may still result in elevated pre-disposition. This paper concludes that the leading urban centers from the global south are highly likely to be predisposed to global risks due to their inherent vulnerability and exposure, and many of the drivers of this predisposition are related to the process of urbanization itself. This predisposition can enhance the overall exposure and vulnerability of the nation in which they are located.

1. Introduction

At a glance, COVID-19 may appear different from disasters that cities often face such as floods, heat stress, landslide, violence etc., however, these seemingly disjoint disasters are interconnected and can compound each other (O’Connor et al., 2021). Imploring factors behind such
environmental and anthropogenic disasters can enhance the understanding COVID-19. Researchers in different contexts have explored the interconnectedness and compounding effects of disasters on each other (Songsore, 2017); (Pescaroli & Alexander, 2018). Understanding COVID-19 from the urbanization perspective, particularly through factors that can be influenced by urban planning and management, can help in reducing the inherent vulnerability and exposure of cities and people alike from future pandemic as well as other disasters. The initial media coverage of COVID-19 portrayed it as an essentially an urban problem, brought upon by the rich for which ultimately the poor and vulnerable members of society have to pay the price (Bustos & Jacobo, 2020); (Bengali, 2020); (Karachi Urban Lab, 2020). Amidst the images of horrors unfolding across leading global cities from New York to Milan, numerous cities particularly those from the global south countries also witnessed what can be termed as a reverse migration (Lee, Mahmud, Morduch, Ravindran, & Shonechey, 2021); (Dandekar & Ghai, 2020). Cities that for long epitomized opportunity and freedom from the tyranny of life (Hall, 2014); (Romer, 2014), have come to be seen as the catalyst and abettor of disasters and cascading risks. This dichotomy was even more pronounced in the cities of the global south.

From its first detection in Wuhan, China, COVID-19 spread rapidly to leading global cities, their surrounding regions and eventually across continents. In several countries, their leading urban centers were amongst the first to register COVID-19 cases, as the disease particularly spread through international travel (Bogoch et al., 2020). As seen in cities such as New York, Guayaquil, Milan, Munich and Santiago de Chile, the leading urban centers in several countries seemingly acted as local transmission hubs for their respective countries. Additionally, rapid spread of COVID-19 has been observed in the highly-dense megacities across the world (Hamidi, Sabouri, & Ewing, 2020); (Desai, 2020). This raises the question whether leading urban centers are predisposed to global hazards and does this predisposition exacerbate their respective national exposure to such hazards? While the analysis of leading urban centers from the global north has received attention from researchers and policymakers alike, systemic analysis of the leading global centers from the global south is still scant.

Researchers have pointed to the vulnerability of global cities to climate hazards (De Sherbinin, Schiller, & Pulsipher, 2007); (Wenzel, Bendimmerad, & Sinha, 2007), while others have underlined the nexus between the process of urbanization and threat of infectious diseases (Matthew & McDonald, 2006). By contextualizing such research, this paper aims to enhance the understanding of the predisposition of 20 leading urban centers from 10 global south countries to COVID-19. Building upon the World Risk Index, this paper presents the larger comparative understanding of these 20 cities and highlights if this predisposition can exacerbate a nation’s exposure to pandemics, as seen in the case of COVID-19. In addition to contributing to the scientific understanding, it aims to inform the global as well as local policy making process.

The urbanization issues faced by the global south cities are structurally different from the global north cities (Nagendra, Bai, Brondizio, & Lvass, 2018); (Arku & Marais, 2021). They often have similar challenges (such as poorly managed urbanization, poor living conditions, thinly stretched local governance etc.) and approaches to address them can build upon their inherent similarities and synergies (Brown, Dayal, & Rumbaitis Del Rio, 2012). At the same time, many countries from the global south have very high disaster risk levels and are among those likely to be worse affected by climate change (Joern Birkmann, Welle-Solecki, Lvass, & Garshagen, 2016). Despite these, the relative understanding of cities from the global south is excruciatingly limited. By qualitatively analyzing cities such as Barranquilla, Kumasi, Santiago de Chile, Mashhad, Dhaka and 16 more from the same lenses, this paper aims to highlight the similarities in their vulnerabilities as well as drivers to such vulnerabilities, therefore assisting in collaborative efforts to address them. This study further aims to bring the distinctness of urbanization in the Global South to the attention of disaster risk reduction and climate change adaptation policy making to support the calls to make them more robust in the near and long term (M. Garshagen, Doshi, Moure, James, & Shekhar, 2021).

This paper consists of six sections. Section 2 provides the current understanding of how urbanization can exacerbate vulnerability and risk to disasters. In section 3, the methodology employed in this paper is presented. Section 4 presents key results from case studies, which are further discussed in section 5. Section 6 discusses the limitations of this work and the concluding section 7 presents key lessons and ways forward.
in search of better opportunities (Rahman, Islam, & Ahmed, 2012, pp. 56–64). For example, informal settlements in Guatemala City, Guatemala have primarily expanded on the landslide-prone ravines around it (McGlade et al., 2019). Similarly, experiences from Kolkata, India, show how planned settlements can become anchors for lower-income populations to settle around their fringes, often in vulnerable areas (Rumbach, 2014). The unregulated growth of cities can also damage protective natural systems and, in turn, enhance vulnerabilities. In Lagos, Nigeria, urbanization caused a loss of 11% of mangroves and protective vegetation of the city between 1986 and 2002, which unsurprisingly resulted in several communities being affected by floods (Okude & Ademiluyi, 2006).

Rapid, unregulated urbanization can also enhance vulnerability to infectious diseases. For instance, a media review on African urban disasters identified thirteen epidemic outbreaks between 2003 and 2008 (Wisner & Pelling, 2012, pp. 17–42). The fragile health of residents and poor health infrastructure in the global south can also be identified by the socio-territorial predominance of epidemics. For example, tuberculosis is a curable but highly transmissible disease, it is estimated that 95% of cases and 98% of deaths are located in developing countries (MSSVS, 2009). In a particular study in Belem, Brazil, 97% of tuberculosis cases were identified in urban areas and over 57% in economically vulnerable non-white population (Freitas et al., 2016). The spatial correlation of airborne transmissible ailments can be found in several studies as presented by Pereira et al., underlining the correlation between the predominance of tuberculosis cases and factors related to income, educational access and household density (Pereira, Medronho, Escosteguy, Valencia, & Magalhães, 2015).

3. Materials and method

This paper examines twenty urban centers from ten countries of the global south: Bangladesh, Brazil, Chile, Colombia, Ghana, Guatemala, India, Iran, Mexico and Pakistan. Two leading urban centers from each of these countries were selected on the basis of following criteria:

- Selected cities should be leading urban hubs and economic centers of the country
- They should not be located in the same agglomeration
- Requisite data at the local and national level should be available (to the extent possible)

Desk study approach was adopted for this research. As these case studies span across countries and languages, a stringent set of criteria was set to ensure cohesive data collection by the different authors. The database created has analyzed secondary sources in Bengali, English, Hindi, Marathi, Persian, Portuguese, Spanish and Urdu languages. Corresponding to the objective of this study, relevant literature was reviewed for finalizing the conceptual framework. For the assessment of the disaster risk, the overall adopted methodology is based on the IPCC risk framework which defines risk as a function of exposure, vulnerability and hazards (Pörtner et al., 2019). To operationalize this concept, the risk assessment framing of the World Risk Report (WRI) (Matthias Garschagen et al., 2016) was used as the main criteria to categorize risk influencing factors/drivers. WRI presents risk as a combination of four factors: Exposure, Susceptibility, Coping capacity and Adaptive capacity. It attributes exposure to the hazard sphere while susceptibility, coping capacity and adaptive capacity are attributed to the vulnerability sphere (J Birkmann et al., 2011, pp. 13–42).

### Table 1

| Variable | Reference literature | Key finding(s) |
|----------|---------------------|----------------|
| **Exposure** | (Findlater & Bogoch, 2018); (Kein, 2020) | Air travel is leading to an increase in frequent spread of infectious diseases, more connected countries have higher exposure |
| **International air connectivity** | | Increased dependency on global networks can have a ripple effect in different countries, developing countries appear to be disproportionately affected |
| **Participation in international trade** | (Bharran, Rith, Ahmad, & London, 2009); (Wiedmann & Lenzen, 2018) | Chronic atmospheric pollution is likely to favor the spread of COVID-19 |
| **Air pollution** | (Fattorini & Regoli, 2020); (Frontera, Gianfanneli, Vlachos, Landoni, & Cremona, 2020) | People with comorbidity are more likely to be severely affected by COVID-19 |
| **Comorbidity** | (Wang, Li, & Huang, 2020); (Sanyael et al., 2020) | The spread of COVID-19 is positively correlated to population density |
| **Susceptibility** | | Poor people are more susceptible to the socio-economic impacts of COVID-19 |
| **Population Density** | (Ahmadi, Sharifi, Dorsoti, Ghouachki, & Ghanbari, 2020); (Bhadre, Mukherjee, & Sarkar, 2021); (Chiu, Liu, & Guan, 2021) | Healthier communities are more resilient to disaster risk, life expectancy is an important indicator of disaster risk |
| **Poverty** | (Mamun & Ullah, 2020); (Alkire, Dirkse, Nogales, & Oldiges, 2020) | People living in informal areas as well as working in the informal sector can be more vulnerable to COVID-19 |
| **Health** | (Egawa et al., 2018); (Frank & Wali, 2021) | Urban poor and those with poor living conditions are more susceptible to disaster risks |
| **Informality** | (Wilkinson, 2020); (Narula, 2020) | Decentralization of governance and urbanization can strengthen disaster risk reduction |
| **Poor living conditions** | (Ivan & Justin, 2021) (Baker, 2012) | Urban inequality can enhance disaster risks |
| **Centralized urbanization** | (Scott & Tarazona, 2011); (Matthias Garschagen, 2016) | Maintaining higher hygiene can help in reducing the spread of Coronavirus |
| **Inequality** | (de Almeida et al., 2016); (Ivan & Justin, 2021) | Accessibility to the digital tools can enhance individual coping capacity to disaster and support climate change adaptation |
| **Coping capacity** | | Well-coordinated, accessible health care centers can help in reducing the spread of COVID-19 |
| **Hygiene** | (World Health Organization, 2020); (Gwenzi, 2020) | Trust in government has a significant impact on disaster and health emergency preparedness |
| **Accessibility to digital means** | (Adnan & Anwar, 2020); (Balogun et al., 2020) | Community plays a very significant role in reducing disaster risks |
| **Health infrastructure** | (Summers et al., 2020); (Benjamin, 2020) | Low income people and communities are disproportionately affected by disasters |
| **Trust in government** | (Hong, Lee, & Kim, 2019); (Longstaff & Yang, 2008) | Economically unequal countries have higher human costs of disasters than more equal countries |
| **Community network** | (Shaw, 2016); (Ishiwatari, 2012) | Gender mainstreaming and parity adds to the adaptive capacity |
| **Adaptive Capacity** | | Education can help in enhancing disaster preparedness |
| **Income** | (Rentschers, 2013); (Masuera, Bailey, & Kerchner, 2007) | |
due to significant data gaps. Source: authors.

Identified indicators for exposure and vulnerability spheres regarding the impact of COVID-19 in urban areas. Indicators highlighted in gray were not analyzed

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were randomly selected, as the spread of COVID-19 later became a
cases i.e. 27 June 2020, July 18, 2020 and October 10, 2020. These dates

collected for each case study city. The number of COVID-19 infections

tifiable indicators for the purpose of this research (Table 2). Once these

On the basis of WRI (Matthias Garschagen et al., 2016) and disaster risk indicators from de Almeida et al. (de Almeida, Welle, & Birkmann, 2016), a systematic literature review of 38 recent publications was done to identify the most significant variables influencing aforementioned four factors with COVID-19/airborne infectious disease as the main hazard (Table 1). These variables were further divided into appropriate quantifiable indicators for the purpose of this research (Table 2). Once these variables were identified, different authors collected data for different countries. Additionally, data on the number of COVID-19 infections was collected for each case study city. The number of COVID-19 infections used in this paper is taken from the sources as available at the time of data collection. COVID-19 infection data was collected for six different observation points. The first three of these points were subjective: the first data point was termed week 1, which is the 7th day after the total number of infections for a particular country had crossed 100 (hence week 0 would be the date on which total national cases crossed 100), this was done to avoid analyzing random outbursts of COVID-19 which could have been due to one or few random groups of infected people arriving from abroad. It was assumed that once the total number of national infections crosses 100 (on week 0), it can potentially lead to further local infections. The second data point, week 2, was fixed at 14 days after week 0. The third data point called week 4 was fixed at 28 days after week 0. As COVID-19 spread at different rates in different countries, week 0, week 1, week 2 and week 4 were different dates for different countries. Next three data points were fixed dates across all cases i.e. 27 June 2020, July 18, 2020 and October 10, 2020. These dates were randomly selected, as the spread of COVID-19 later became a highly local phenomenon. By the middle of June 2020, COVID-19 had already spread to more than 190 countries and territories (World Health Organization, 2020a), therefore, selecting random dates provided a comparative snapshot at that time point in different contexts. No COVID-19 data was collected for later dates, as the main objective of this paper is to understand common factors behind the spread of COVID-19 in the initial stages of the pandemic across 20 case study cities. The spread of the pandemic in different cities eventually started getting highly influenced by their local handling of the situation (for example, certain countries imposed partial lockdown, others imposed strict lockdown and some did not have any lockdown; wearing masks and maintaining safe distance was compulsory in some, advised in others, while some did not provide any official guidelines). The political discourse also played a significant role in how COVID-19 spread across countries. While the initial response across majorities of countries at the outset of the pandemic was similar (such as limiting international travel, infection containment measures etc.), diverging risk perception and management at the political level started pushing countries along different paths. For example, while India imposed stringent lockdowns to prevent the spread of the pandemic, the federal government in Brazil did not do so. After initial months, the paths of different countries had diverged substantially to render any further comparison incompatible. It was assumed that after six months, the spread of COVID-19 was much more due to local factors than the global exposure and 10 October 2020 was chosen as the cutoff date for this study.

The literature reviewed in Table 1 conclusively correlates discussed variables to the risk from airborne diseases and helps in breaking them down into quantifiable indicators. The variables identified in Table 1 were further broken down into appropriate quantifiable indicators, Table 2 shows the next step where each variable is broken into one or more indicators (variable – indicator).

While some of the indicators presented in Table 2 are readily measured across the globe, data related to others is more limited and difficult to access. Different countries have different thresholds and definitions for these indicators. To avoid this first the indicators that more universal are chosen and second, they are compared against their respective national averages (in most cases).

Finally, to quantitatively understand these indicators (18 indicators were chosen for quantification), appropriate measuring units were assigned (Table 3). Collected data was converted to standard units to ensure cohesiveness (for example, per capita income and GDP data were collected in US$ for each country irrespective of their national currency). While it would have been very interesting to do the relative ranking as per the absolute performance of cities across different indicators, resources needed for analyzing such as vast dataset from different parts of the world precluded such exercise. Instead, we have employed the binary analysis of all indicators, i.e. if a factor leading to increased predisposition is present then it is counted as 1 and if not, it is counted as 0. This research aims to identify larger trends across leading centers from the global south and the binary analysis indicates the presence or absence of certain factors, which assisted us in identifying such trends.

Cities analyzed in this paper are: Dhaka, Chittagong, São Paulo, Rio de Janeiro, Santiago (also known as Santiago de Chile, here we refer to the area known as Gran/Greater Santiago which is used interchangeably with Santiago in this paper), Antofagasta, Bogotá, Barranquilla, Accra, Kumasi, Guatemala City, Quetzaltenango, Delhi (referred as both Delhi and New Delhi interchangeably in this paper), Mumbai, Tehran, Mashhad, Mexico City, Guadalajara, Karachi and Lahore. Their selection criteria are presented in annex 1.

4. Results

Most of the data analyzed in this paper is from the city level. In case the data for any particular variable was unavailable for any city, it was not counted in the final analysis for that particular city (referred to as DNA in Table 4). As different countries have different definitions of

| Exposure | Vulnerability | Coping Capacity | Adaptive Capacity |
|----------|---------------|-----------------|-------------------|
| International air connectivity – international survival | Population density - person per square kilometer | Hygiene - % households (HH) with toilet | Income – Per Capita Income (PCI) |
| Participation in international trade - export as % of GDP | Population density - open space per capita | Hygiene - % HH with water | Economic inequality - Gini index |
| Air pollution - PM10 level | Population density - person per household | Access to digital means – % HH with internet connectivity | Economic inequality - % share of top 1 percent in national income |
| Comorbidity | Poverty - % of people below national poverty line | Health infrastructure - doctors per 100,000 people | Education |
| | Health - life expectancy at birth | Health infrastructure - hospital beds per 100,000 people | Trust in the government |
| | Inequality - % of workforce in the informal sector | Informality - % of poor living conditions - % of population living in slums | Community network |
| | Centralized urbanization – primate city | Inequality - spatial concentration GDP in cities | |

Table 2
Identified indicators for exposure and vulnerability spheres regarding the impact of COVID-19 in urban areas. Indicators highlighted in gray were not analyzed due to significant data gaps. Source: authors.
Table 3
Quantification matrix for 18 indicators. For indicators highlighted in gray, national level data was used as city level data was not available for any of the 20 cities. Source: authors.

| Exposure Variable | Standard | Quantification |
|-------------------|----------|----------------|
| International arrival | n/a | Are there people arriving from abroad = 1<br>No = 0 |
| Export | n/a | Are there export based industries = 1<br>No = 0 |
| Pollution (PM10 level) | WHO guidelines (permissible upper value is up to 50 μg/m³ 24 h mean (World Health Organization, 2018) | ≤50 = 0<br>≥50 = 1 |

| Susceptibility Variable | Standard | Quantification |
|-------------------------|----------|----------------|
| Population Density | National average (avg.) | > national avg. 1, < 0 |
| Open space per capita | 9 m² per person (unofficial WHO standard (World Health Organization, 2010) and Badiu (2016)) | ≥9 = 0<br><9 = 1 |
| % people below national poverty line | National poverty line | > national avg. 1, < 0 |
| Life expectancy at birth in years | International average (world average 72 years in 2018) (The World Bank, 2021b) | > International avg. 1, < 0 |
| Workforce in informal sector | National avg. | > national avg. 1, < 0 |
| % People in slum | National avg. | > national avg. 1, < 0 |
| Centralized urbanization | Relative population | Brain city: yes = 1<br>No = 0 |

| Coping Capacity Variable | Standard | Quantification |
|--------------------------|----------|----------------|
| Households (HH) with Toilet | National average (avg.) | > national avg. 1, < 0 |
| IH with water | National avg. | > national avg. 1, < 0 |
| HH with internet | National avg. | > national avg. 1, < 0 |
| Hospital beds per 100,000 | National avg. | > national avg. 1, < 0 |

| Adaptive Capacity Variable | Standard | Quantification |
|----------------------------|----------|----------------|
| PCI | National avg. | > national average = 0<br>Lower = 1 |
| Gini index (The World Bank, 2021a) | Slovenia (lowest in the world) | >Slovenia = 1,< Slovenia = 0 |
| % share of top 1 percent in national income (World Inequality Database, 2021) | Netherlands (lowest in the world) | >Netherlands = 1,< Netherlands = 0 |
Table 4 shows the performance of cities across eighteen indicators pertaining to four factors: Exposure, Susceptibility, Coping Capacity, and Adaptive Capacity. If we look at Exposure, with cumulative scores of 18, 20 and 16, almost all case study cities are highly predisposed across all three indicators analyzed i.e., international travel, participation in international trade and air pollution. The networking of leading urban centers in this globalized world is likely to contribute to their higher exposure to infectious disease outbreaks in other parts of the world.

Indicators related toSusceptibility present a mixed picture. The population density in all the cities in the global south is higher than corresponding national averages with just one exception: Antofagasta, Chile, which interestingly is a mining based city located along the fringes of the Atacama Desert. Very limited data available on living space per capita presents a different picture between Delhi, Mumbai and Kumasi. On other indicators pertaining to Susceptibility, people below the national poverty line, life expectancy at birth, workforce in the informal sector and percentage of the population living in slums, majorities of cities analyzed fare better than the national average, with only 1, 6, 5 & 7 cities being more susceptible than their corresponding national averages for these indicators respectively. However, even within these indicators, cities seem to be doing better in reducing poverty than in providing access to healthcare, secure employment and decent housing. At the same time, urban poverty is complex and multilayered, extending beyond the mere deficiency of income or consumption (Asian Development Bank, 2014). Even though the household income of the urban poor can be higher than the national average, the relative cost of living can offset perceived gains. In many cities from the global south, a substantial population either lives in slums or slum-like conditions. In Mumbai, 41% of the population resides in slums, their often dilapidated housing and poor living conditions increase vulnerability to a plethora of disasters. Further, a large proportion of the workforce in the global

| City          | PM10 | Pop. density | Life expectancy at birth | Workforce in informal sector | People in slum | Toilet | Water | Internet | Doctor | Hospital beds | DHA | Gini Index | PCI | Top 1% national | share | DNA |
|---------------|------|--------------|--------------------------|-------------------------------|-----------------|--------|-------|----------|--------|---------------|-----|-----------|-----|----------------|-------|-----|
| Dhaka         | 1    | 1            | 1                        | 1                             | 1               | 1      | 1     | 1        | 1      | 1             | 1   | 1         | 1   | 1              | 1     | DNA|
| Chiangmai     | 1    | 1            | 1                        | 1                             | 1               | 1      | 1     | 1        | 1      | 1             | 1   | 1         | 1   | 1              | 1     | DNA|
| Jakarta       | 1    | 1            | 1                        | 1                             | 1               | 1      | 1     | 1        | 1      | 1             | 1   | 1         | 1   | 1              | 1     | DNA|
| Bogota        | 1    | 1            | 1                        | 1                             | 1               | 1      | 1     | 1        | 1      | 1             | 1   | 1         | 1   | 1              | 1     | DNA|

4.1. Factors influencing risk to COVID-19

We conducted a binary analysis for this paper, where the presence of factors leading to increased predisposition is counted as 1 and absence as 0. Higher the number of 1s, higher predisposition to a particular indicator is more likely, while a higher number of 0s indicate the likelihood of lower predisposition to that particular indicator. The performance of 20 case study cities across 18 indicators is presented in Table 4.
south is employed in the informal sectors as seen in the case study cities as well. During lockdowns obligated by COVID-19, informal and migrant workers were disproportionately affected (Estupinan & Sharma, 2020).

Primate cities are interesting as they are often the economic engines of their countries; however, they often carry the risk of triggering cascading effects across the country due to the spatial centralization and higher dependency on a few urban areas. Most of the cities analyzed are either the most or second most populous city in their respective countries Dhaka, Gran San Andreas, São Paulo, Mumbai, Bogota, Accra, Guatemala City, Tehran, Karachi and Mexico City – most populous; Lahore, Chattogram, Rio de Janeiro, Antofagasta, Delhi, Mashhad, Guadalajara and Kumasi – second most populous) and out of 20 cities analyzed, 9 are primate cities. This indicates a higher spatial concentration which in turn can enhance susceptibility.

Coping Capacity is analyzed through the understanding of access to five key amenities: toilets (within the household), potable water, internet, availability of doctors and hospital beds. A significant majority of cities analyzed have a higher availability of these amenities than corresponding national averages. However, the absolute number of hospital beds is of concern in four cities analyzed. Additionally, even in cities like Tehran, Mashhad and Lahore get added to this list as well. With the presence of these amenities, cities are putting pressure on the resources in leading urban centers, making them more vulnerable to the COVID-19 pandemic. This can enhance spatial asymmetry in national coping capacities.

Furthermore, health infrastructure is often concentrated in the leading urban centers in developing countries, leaving small and medium towns at higher risk. This can enhance spatial asymmetry in national coping capacity, while putting pressure on the resources in leading urban centers (Kramer, Khan, & Kraas, 2011). In general, cities analyzed seem to be doing relatively better in terms of coping capacity.

The adaptive capacity is understood through three indicators, per capita income, Gini index and the income share of the top 1% population. The assessment of income inequality for all 20 cities is done using national level data due to the lack of reliable granular data in most of the cities. Though most of the cities analyzed have higher per capita income, the income inequality (in both Gini index and income share of top 1%) is higher in all of them. Despite gains made in increasing the income of their residents, the growing income inequality of cities in the global south can compromise such gains and may diminish their adaptive capacities.

The data analyzed presents country and region specific insights as well. While all the cities analyzed have indicators leading to their predisposition, certain cities have more such indicators than others. More than half of the indicators (9 or more) analyzed for Dhaka, Chattogram, Santiago, Antofagasta, Accra, Mumbai, Mexico City, Guadalajara and Karachi increase their predisposition. If we consider DNA as contributing to predisposition, Bogota, Barranquilla, Kumasi, Rio de Janeiro, Tehran, Mashhad and Lahore get added to this list as well. With the exception of Rio de Janeiro and Delhi, both cities from seven out of ten case study countries (Bangladesh, Chile, Colombia, Ghana, Iran, Mexico and Pakistan) are on this list. This indicates possible differences in the risk profiles of different countries within the global south where cities from certain countries are likely to have vulnerability across multiple indicators. Brazil and India are particularly interesting as they both have one city each where indicators analyzed predominately increase predispositions (Rio de Janeiro and Mumbai, considering DNA as well), while Delhi and São Paulo have 7 and 8 such indicators. However, the impact of pandemic in both India and Brazil has been devastating and all four cities have witnessed severe cascading impacts of the pandemic. Early research has attributed this significantly to the political leadership and risk preparedness in both countries (Kar, Ransing, Arafat, & Menon, 2021); (Barberia & Gomez, 2020). This highlights the significance of political leadership as well as systemic vulnerability in enhancing predisposition to risk. The prevalence of DNA (data not available) in cities from Ghana, Iran and Pakistan indicates the scarcity of relevant and updated data sources in such contexts, which can compromise comprehensive planning and implementation of risk mitigation policies.

The only country where both cities have less than nine indicators contributing to predisposition is Guatemala, which interestingly has the lowest population out of all ten countries covered in this paper. The top four cities with predisposition across maximum number of indicators are Santiago (11), Dhaka (10), Chattogram (10) and Mexico City (10). If we consider DNA as increasing predisposition, this changes with Mashhad (14), Tehran (13), Lahore (13), Accra (13) and Karachi (12) topping the list. While cities with very high predisposition need to have comprehensive strategies in place, it can be even more challenging for cities where the factors driving predisposition are not clearly known. A granular understanding of factors enhancing the vulnerability of individual cities needs to be explored further.

4.2. COVID-19 trends in case study cities

COVID-19 is likely to have entered countries through their leading urban centers and spread further from there. Understanding what percentage of total national COVID-19 cases were present in the case study cities and how that changed over time can help in first, understanding the overall exposure of these leading urban centers and second in analyzing their roles as national hotspots. The case study cities are divided into two groups: group 1 comprises cities where at least one data point crossed 20%, while for group 2 cities almost all data points remained below 25%. This distinction facilitated clear visualization and clustering of cities with similar trends. Each group comprises ten cities. The timeline of cases in group 1 and 2 are shown in Figs. 1 and 2 respectively.

Group 1 consists of Accra, Dhaka, Santiago, Bogota, São Paulo, Tehran, Chattogram, Guatemala City, Karachi and Kumasi. Apart from Kumasi, by 10 October 2020 all cities in group 1 registered a fall in the overall contribution to the respective national COVID-19 case percentages in Ghana, at week 1, 100% of cases were recorded in Accra (none in Kumasi). Further, Fig. 1 indicates that as Ghana entered into weeks 1 & 2, the percentage share at the national level fell in Accra (the capital city) and surged in Kumasi, which witnessed a short dip during week 4. Interestingly, Accra has the only functional international airport in Ghana.

National caseload share for Bogota, Karachi, São Paulo and Accra appear to be reasonably stable after 18 July, whereas in the case of Santiago and Guatemala City, the percentage share started dipping after 18 July. In the beginning, Dhaka contributed 83% of the total cases in Bangladesh, however, it recorded a sudden fall around week 4 and dropped to 15% by the last data point. While the percentage share of caseload in other cities dropped over time, Accra and Santiago remained the highest contributors in Ghana and Chile respectively. Though multiple factors determine the spread of COVID-19, it is interesting to note that six cities from this group, namely Dhaka, Santiago, Bogota, Tehran, Chattogram and Kumasi are primate cities. At the same time, Bangladesh is one of the densest countries in the world while both Santiago and Accra are major international hubs for their country and almost exclusively receive all incoming international air travelers.

The second group contains Rio de Janeiro, Guadalajara, Mumbai, New Delhi, Lahore, Quetzaltenango, Antofagasta, Barranquilla, Mexico City and Mashhad. The percentage interval of total national COVID-19 cases for cities in group 2 lies between 0 and 22%, which is smaller than group 1. Interestingly, two cities with the highest percentage caseload in this group, Rio de Janeiro and Mexico City are primate cities. Two cities with the least increase in caseload percentage over data points are Antofagasta and Quetzaltenango and interestingly they both have the lowest percentages of international air travel arrival amongst all 20 cities (along with Kumasi). New Delhi, Mumbai and Barranquilla, registered a sudden rise between week 4 and June 27, 2020 and thereafter witnessed steep decline. At 0.9%, 1.0% and 2.5% respectively, these three cities are home to a relatively smaller percentage of the total
national population. The availability of only one data point for Mashhad (week 4, 0.9%) severely limits findings from here. Lahore is an interesting case, it is home to close to 9.3% of the total population of Pakistan and though its percentage caseload started from low, it did not witness the steep fall towards later data points unlike other populous cities. This trend is witnessed in only one other city – Santiago. Percentage caseload in Rio de Janeiro peaked earlier than other cities and subsequently recorded a steady fall.

As Figs. 1 and 2 show, COVID-19 spread at different rates in different cities and across the nation. While certain factors such as primate city seem to influence the spread of pandemic across the nation (primate cities among the case study cities have higher national caseload at the final time point than non-primate ones), any direct correlation and causation need case specific granular understanding. In addition to all this, the spread of COVID-19 in different contexts was highly included by different political discourses and risk mitigation approaches employed which varied significantly across countries. This is further analyzed in section 5.

5. Discussion

The impacts and consequences of the COVID-19 pandemic are still evolving and many questions regarding its spread remain unanswered. With more than 266 million infections in nearly 200 countries, resulting in more than 5.2 million deaths as of 06 December 2021 (CSSE, 2021), the true extent of the damage done by COVID-19 might only be known in years to come. However, in more than one and half years since it was declared a pandemic, its immediate impact has wreaked unprecedented social and economic havoc across the globe. It also threatens to reverse some of the progress made in achieving the SDGs (Nchanji & Lutomia, 2021); (Shulla et al., 2021), while its medium and long term impacts are barely conceivable at this moment.

COVID-19 has an inherently urban character (Mishra, Gayen, & Haque, 2020). We would like to further argue that within human settlements, leading urban centers from global south countries are more predisposed to such disasters and global risks than others, and they can even enhance the collective vulnerability of the countries they are located in. Despite doing better on certain factors, they have higher
Fig. 3. Predisposition of case study cities (total 20) across 18 indicators, BPL stands for below national poverty line, PCI stands for per capita income. Source: authors.
COVID-19 also highlighted the vulnerability of cities from the global north to global risks; several European and American cities are deeply impacted. While research explaining the underlying drivers and vulnerabilities will only emerge in due time and many drivers of vulnerability are likely to overlap to varying degrees across global north and south cities, some of the factors related to urbanization that have featured prominently in this research (such as unplanned and poorly managed urbanization, lack of open space, poor living conditions etc.) are not as prominent in early researches focusing on the cities from the global north. Demography, comorbidity, socio-economic and racial inequality feature more prominently in such researches (Wiki, Marek, Hobbs, Kihgton, & Campbell, 2021; (Kim & Bostwick, 2020); (Mahan & Larks-Pettigrew, 2020); (Amran, Amiri, Lutz, Rajan, & Monivais, 2020); (Karmakar, Lantz, & Tipirneni, 2021). This is not to say that these factors don’t impact the global south cities, they very much do, however the process of urbanization in the global south due to its additional dimensions and dynamic nature presents a complex and distinct picture.

While this paper primarily focuses on the indicators and factors that can be significantly influenced by urban planning and management, COVID-19 underlined the importance of political discourse, policy making and risk communication which if not managed well can compromise any sustainable and resilient human settlement planning. The countries covered in this study provide a broad spectrum of political discourse and decisions related to COVID-19 which have affected the pandemic. The political response to the pandemic in four Latin American countries Chile, Colombia, Guatemala and Mexico has been swift and included measures such as lockdowns, mandatory use of masks and travel restrictions (ECLAC, 2021a; 2021b; 2021c; 2021d). The political response from India was swift as well, however, its effectivenessparticularly during the second wave of the Pandemic in 2021 and the mass exodus of migrants due to lockdowns in 2020 has been questioned (Ghosh, Nundy, & Mallick, 2020); (Jain, Iyengar, & Vaishya, 2021).

The political reaction in Ghana was swift and targeted and it imposed complete lockdowns twice to address different waves of the pandemic. The political response to the pandemic in four Latin American countries Chile, Colombia, Guatemala and Mexico has been swift and included measures such as lockdowns, mandatory use of masks and travel restrictions (ECLAC, 2021a; 2021b; 2021c; 2021d). The political response from India was swift as well, however, its effectiveness particularly during the second wave of the Pandemic in 2021 and the mass exodus of migrants due to lockdowns in 2020 has been questioned (Ghosh, Nundy, & Mallick, 2020); (Jain, Iyengar, & Vaishya, 2021).

The political reaction in Ghana was swift and targeted and it imposed restrictions to limit the spread of the virus (Ampwi-Boasiako, Abbey, Ogbey, & Ofori, 2021). Iran was an early epicenter of the COVID-19 pandemic, which hit it during a period of economic stress and social distress (Murphy, Abdi, Harirchi, McKee, & Ahmadnejad, 2020) however, the initial response was seen as inadequate and oriented primarily to manage the economic situation (Calabrese, 2021). The political response in Pakistan was to mitigate the risk early on as well (Akhbar et al., 2021). On the other end of the spectrum, the political situation of Brazil during the pandemic can be characterized as intentionally confusing and manipulative (Malta, Vettore, da Silva, Silva, & Strathdee, 2021); (Biancovilli, Makszin, & Jurberg, 2021). A similar picture is emerging regarding vaccination as well. Many of the case study countries have made substantial progress on vaccination against COVID-19 including Chile and India, while the political discourse around vaccination in Brazil has been confusing.

6. Limitations

Analyzing an ongoing event can often look inadequate in hindsight. Analyzing an event as dynamic as the COVID-19 pandemic can have several limitations and this paper has its limitations as well. Any result and discussion presented in this paper should be interpreted with caution. As this pandemic is ongoing and our collective understanding of it is very dynamic, the indicators used in this study are based on the prevalent contemporary scientific and practitioner understanding of this issue. The number of COVID-19 infections used in this paper is taken from the sources as available at the time of data collection, as the pandemic is ongoing and countries are likely to update the infection and related numbers in times to come, values used in this paper may differ from the revised values.

Many of the indicators analyzed are not comprehensive enough for developing an exhaustive understanding of associated risks. For example, though the number of hospital beds and the number of doctors can allow us to assess the overall situation, a more granular, spatial distribution and access mapping needs to be done to understand the coping capacity across space and socio-economic groups. At the same time, for two indicators due to the lack of suitable city level data, national level data was used as a proxy which slightly obscures the granular understanding. Using indicators influenced by the process of urbanization in countries that are located thousands of miles away from each other, this paper aims to highlight their shared challenges. This pandemic is ongoing and our understanding of it is evolving almost on a daily basis. This study is based on predominant scientific understanding at the time of writing of this paper, however, certain additional or even contrary factors may emerge in time. While cognizant of such inadequacy in understanding the drivers and impact of COVID-19; this paper provides early indications to urbanists and policy makers to assist them in adapting to the ongoing and future global risks. To get a clearer picture and make tailored localized policies, a granular understanding of individual cases is recommended.

7. Conclusion

The understanding gained from this paper is relative, it shows how a particular city is doing vis-à-vis the country it is located in. It is not an absolute understanding, as even though a city might be doing better than the rest of the country, the national average used for such comparison might be very low from the global standards and desired state. Nonetheless, all 20 cities analyzed have very high exposure and relatively lower adaptive capacity. While certain cities perform better on some indicators of susceptibility such as poverty reduction and provision of formal jobs, high population density and lack of open space are two key areas of concern. Coping capacity is the only factor where leading urban centers from the global south seem to perform satisfactorily. Cities are complex, there are multiple layers of decision making, implementation and feedback loops and the different rates spread of COVID-19 in different cities illustrate this. While certain vulnerability of cities can be endogenous and directly related to the urban planning process, the role of urban management and overall governance can either diminish or aggravate disaster risks as this paper shows. The leading urban centers from the global south are more predisposed to global risks and they can further exacerbate the exposure of their respective countries to such risks. However, to understand what exactly drives such risk, a granular and multi-dimensional understanding on a case to case basis is needed. The aspect of urban management, political discourse, governance, and capacity building remains at the center of any attempt to mitigate, avert and minimize such risks. The role of the community in risk preparation and reduction must be equally incorporated in any such attempt. This paper presents a comprehensive framework to understand the predisposition of global south cities from disaster using the COVID-19 perspective and suggests future research to include timely and accurate local data across different indicators, which can further the understanding of the larger implication of the process of urbanization in global south cities on COVID-19 and vice versa. Furthermore, city specific research that delves into the spatial, social, economic and political dimensions of indicators and risk management for each case study city is recommended.

This paper presents key intrinsic and extrinsic factors that are likely to predispose leading urban centers in the global south to first getting affected by global hazards and second exacerbate their spread across the country. These indicators are directly or indirectly affected by the process of urbanization, and this underlines why addressing urbanization should be at the heart of a comprehensive disaster risk reduction strategy, including that for a pandemic.
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Declaration of competing interest

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Appendix A. Supplementary data

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