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Please note: more analysis and regular updates related to the COVID-19 pandemic are available on the project page here (https://www.gcro.ac.za/research/project/detail/responding-covid-19-pandemic-gauteng/).

On Sunday evening, 15 March 2020, President Cyril Ramaphosa called for national disaster measures to be implemented to contain the spread of the COVID-19 virus and ensure the safety and health of all in South Africa. As of the date of publishing this Map of the Month, Friday 20 March 2020, the number of those infected by the virus in the country stood at 202.

This Map of the Month has been developed to aid understanding of the localised risk factors that might contribute to the spread of COVID-19, and might amplify its health and socio-economic impact in Gauteng communities. Specifically the maps explore two key themes: (1) the multiple risk factors to maintaining basic preventative hygiene and social distancing; and (2) the multiple risk factors in the context of major shutdowns and potential outbreaks. We have used data from the GCRO Quality of Life V (2017/18) survey to compile two indexes of these risk factors, which have then been mapped at the ward level across Gauteng.

Our approach for this work includes the framework of *syndemics* (https://rthd.co.za/2020/03/16/epidemics-pandemics-and-syndemics-vulnerable-individuals-and-vulnerable-communities/) which examines the consequences of epidemics as they interact with other diseases, in conjunction with social, environmental and economic factors that both facilitate their spread, and in turn compound their impact. See here (https://www.thelancet.com/series/syndemics) and here (https://www.smithsonianmag.com/smart-news/syndemic-little-known-buzzword-describes-our-troubled-times-180971381/) for useful articles that explain this framework. This means that many of the factors we have identified in these two maps are interrelated. For example, we have included health status and pre-existing chronic conditions as risk factors for social vulnerability in the event of outbreaks of COVID-19 but these factors may also limit the containment of COVID-19 spread as people leave their homes, and/or use public transport to access routine medication and medical care.

Theme 1: Maintaining social distance and preventative hygiene

The first theme considers variables related to preventative measures such as maintaining high levels of personal hygiene and practising social distancing. It is apparent from experiences in other countries that basic hygiene and social distancing are key to limiting the spread of the pandemic. However, maintaining basic preventative hygiene and social distancing is not equally feasible for all people in all communities.

Using QoL V (2017/18) data we have compiled six risk factors (see Table 1 below) which may be considered impediments to achieving basic hygiene and social distancing. These risk factors include crowded living conditions; the sharing of water and toilet facilities; dependence on public health care facilities; limited access to communication tools and reliance on public transit.

- Crowded living conditions make it very difficult to maintain social distancing and isolate sick persons. Crowded conditions also often include a high likelihood of sharing ablution facilities which may also compromise hygiene standards, and facilitate the transmission of the virus. About 14.4% of all respondents live in crowded circumstances.
- In addition, we considered those who do not have clean running water in their homes or yards, and are therefore either accessing water from alternative sources such as streams or rainwater tanks or from shared points such as stand pipes or street taps.
- In many circumstances this may be combined with shared toilet facilities or toilets such as pit latrines and the absence of running water. In these situations of less than ideal water and toilet facilities, it may be more difficult for people to ensure appropriate levels of hygiene and to practise social distancing.
- About 66% of respondents who use healthcare facilities usually use public healthcare facilities (this excludes those who said they do not usually need healthcare). During this time, public health services and professionals are going to do everything in their power to manage the spread of COVID-19, but the usual high volumes and long queues in public health facilities are more likely to be an impediment to containing the spread of the virus.
- Effective communication is key to empowering residents with critical information, for example about the need to limit social contact, or what to do if they do start presenting with symptoms. In these times it is vital that residents have access to publicly broadcast information through, for example television, as well as the means to contact family and friends, or health services if they suspect they have contracted COVID-19. A small proportion of Gauteng respondents, about 1.1%, do not have any form of electronic communication (no internet, no cellphone, no TV/satellite TV and no radio).
- Lastly, it is extremely difficult to maintain social distancing with the use of public transport and some 44% of respondents in the GCR rely on public transport. Many people working in essential services will still need to use public transport to work in hospitals, pharmacies and supermarkets.

Table 1: Definition of risk factor indicators for maintaining social distance and preventative hygiene

COVID-19: Index of risk factors for maintaining social distance and preventative hygiene

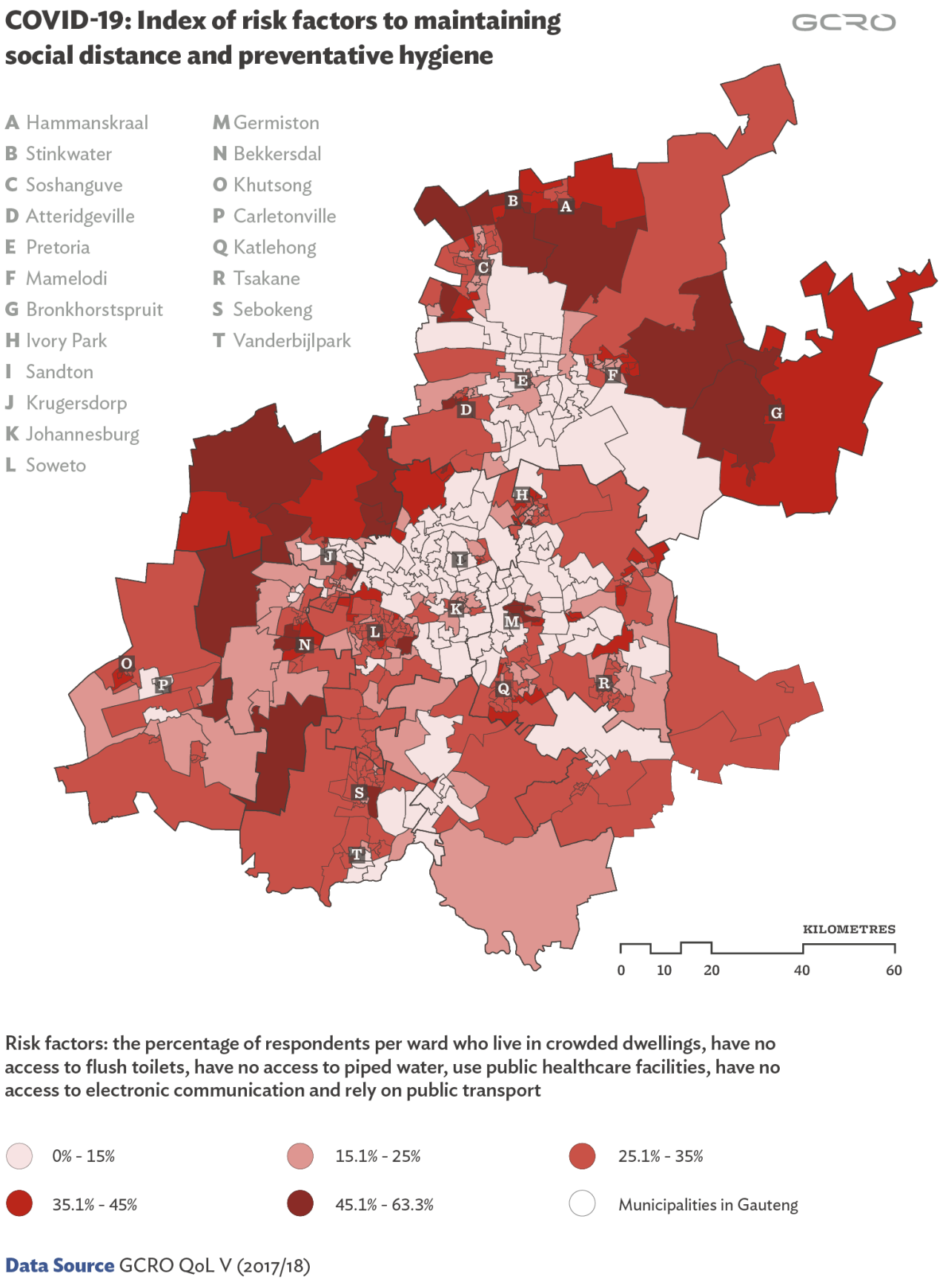
Indicator name	Indicator definition	Rationale for inclusion
1.1 Household crowding	Percentage of respondents per ward who live in dwellings with 3 or more people per functional room, OR where more than one household is sharing a single room dwelling.	Household crowding is also a known risk factor for a range of health challenges, particularly respiratory illness (Ref: https://www.ncbi.nlm.nih.gov/books/NBK535289/). Maintaining adequate sanitation is also challenging under these circumstances. Multiple people living in a small dwelling or single room poses challenges in isolating sick people, or simply maintaining social distance, as it is hard for people to remain at home in crowded dwellings. Additionally, requirements for social distancing and closure of public spaces are likely to place substantial strain on individuals living in these conditions. Spending additional time in these dwellings may increase vulnerability to other medical conditions, and is likely to induce substantial psychological strain.
1.2 Shared or inadequate sanitation	Percentage of respondents per ward whose households do not have a flush toilet connected to the sewerage system or septic tank.	Sharing of toilet facilities across households limits the effective implementation of social distancing, by forcing interactions between households. This is likely to be a particular challenge in less formal settlements and other areas where large numbers of households share public ablution facilities. Maintaining high levels of hygiene in shared toilet facilities is also extremely challenging, and there is a significant risk that without preventative measures, shared ablutions may contribute to transmission of COVID-19. Households using non-flush toilets, even if not shared, face additional challenges in maintaining appropriate levels of preventative hygiene.
1.3 No access to clean running water in dwelling or yard	Percentage of respondents per ward whose households do not have piped water in their dwelling or in their yard.	Reliance on shared water sources limits effective implementation of social distancing, by forcing interactions between households. Maintaining appropriate preventative hygiene, such as regular hand washing, is likely to be more challenging in households without piped water. Households reliant on non-piped water are also likely to be at increased risk of contracting other water-borne illnesses, weakening immune systems, and increasing general likelihood of needing other medical care.
1.4 Reliance on public health facilities	Percentage of respondents per ward who normally use public health services.	Public health facilities are usually far more crowded than private facilities, often requiring long waits in queues in crowded waiting areas. Resource constraints and supply chain challenges mean that protective equipment is more likely to be in short supply than in the private sector, a challenge likely to be exacerbated by the fact that a far larger proportion of the population will attend public health facilities in the event that they do get sick. These factors may mean that the challenges of maintaining appropriate social distancing and preventative hygiene will be relatively greater in public health facilities than private ones.
1.5 Lack of access to electronic communication	The percentage of respondents per ward who do not access the internet at all, AND who also do not have a TV, satellite TV, radio, or cellphone in their households that is in good working order.	Access to information is critical in ensuring that households understand the reasons for social distancing and preventative hygiene, and that they understand how to appropriately implement the measures outlined by the government. Connectivity, whether by internet, phone, TV or radio means that information can reach a household without any direct human contact. Additionally, having easy access to information and entertainment in the home is likely to make it easier for households to practice social isolation. Finally, having no access to the internet or a phone will make it difficult for households to seek medical assistance without leaving the home.
1.6 Reliance on public transport	The percentage of respondents per ward who did not have a car in good working order in the household, AND whose mode of transport for the longest part of their most frequent trips was a lift club, minibus taxi, train, or bus.	Reliance on public transport involves exposure to many other people, both in queues waiting for the transport, and on the trip itself, making it difficult to maintain social distancing. Minibus taxis, which are the most widely used form of public transportation in Gauteng, are likely to pose particular challenges, because passengers are all seated in extremely close proximity, there is high passenger turnover, there is limited air circulation/ventilation, and there is a high level of exchange of money in the vehicle.

These six factors have been compiled into a single index and mapped to highlight areas where these factors combine to indicate multiple risks to maintaining social distance and preventative hygiene. The percentage of respondents in each ward affected by each of these factors was added together and divided by six to derive the index. This index has been mapped in Map 1 below.

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Map 1 highlights that the challenge to maintaining social distance and preventative hygiene is proportionately higher in some wards in Gauteng than in others. There is a particularly clear distinction between the lower average level of risk in suburbs (light red shaded wards north of Johannesburg, south-east of Pretoria and central Ekurhuleni) and the higher average level of risk in townships and (darker red shaded wards in Hammanskraal, Atteridgeville, Ivory Park, Soweto, Bekkersdal, Khutsong and Katlehong). This distinction is noticeable when we compare the average levels of risk around Sandton with the average levels of risk in Alexandra (east of Sandton). Challenges are further likely to be concentrated in informal settlements in areas like Stinkwater, the eastern edge of Soweto, those north of Germiston, and a number of other peripheral areas where the lack of basic services and the lack of access to electronic communication have a significant influence (see individual maps here (https://www.gcro.ac.za/documents/340/March_MOTM_maps_of_risk_factors_and_vulnerabilties_to_covid19_in_GCR_2.pdf)). Wards with higher population densities and more crowded dwellings (like various parts of townships and those in inner city Johannesburg and Pretoria) are also indicated as areas of some risk to maintaining social distance and preventative hygiene.

Our analysis highlights the average level of risk at a ward-level, and while an entire ward might be shaded a specific colour (such as the large dark red wards east of Mamelodi), it is important the spatially targeted interventions take the sub-ward level context into consideration to ensure that they are directed towards the appropriate individual settlements within each ward.



Map 1: Average of the percentages of respondents per ward affected by each of a set of risk factors to maintaining social distancing and appropriate preventative hygiene

Theme 2: Vulnerability during an outbreak or broader shutdown

The second, and complementary map, is based on an index of risk factors that will likely increase health and socio-economic vulnerability during an outbreak or broader shutdown. Whilst government has thus far focused on critical measures to prevent the spread of COVID-19 in the immediate term, its responses will need to evolve over time to consider how the pandemic will have significant effects on the economy and livelihoods, especially given existing poor health conditions in many areas. Once again, these impacts are likely to be felt unevenly. Poorer communities are likely to bear the brunt of the dire health and socio-economic consequences as COVID-19 spreads. In addition, with various shutdown measures already in place, they will be the most vulnerable to these dramatic changes in the patterns of social functioning, and the downturn in economic activity that will inevitably result. For example, taking a syndemic perspective, those who are unemployed or in precarious labour (represented by those who do not have medical insurance and find it difficult to save money), adults and children who suffer hunger, and those who may need to access healthcare for chronic or existing conditions may be more affected by efforts to contain the spread of the virus - particularly the closing of schools; limiting of non-emergency health care; and the closing of non-essential businesses. Should an outbreak occur, those who have pre-existing chronic conditions, and those who have had poor health in general are likely to be more vulnerable. We have compiled these risk factors into a second table and map (see Table 2 below).

The first three indicators draw from questions in the GCRO Quality of Life V (2017/18) survey that ask respondents about their health status:

- About 7.2% of respondents considered their health status to be poor or very poor in the four weeks before the interview - a small group of people who may be at an increased risk of infection. Poor health and existing chronic conditions can weaken people's immune systems and make them more susceptible to catching COVID-19 and may also exacerbate symptoms and recovery time.
- About a third (33%) of respondents said that at least one member of their household had a pre-existing chronic. Households that have individuals with pre-existing medical conditions are particularly vulnerable during a pandemic or a shutdown. Vulnerability is increased due to ongoing medical needs requiring regular visits to health facilities and many conditions may weaken immunity. There is clear evidence that these conditions significantly increase risk of serious illness or death in individuals infected with COVID-19.
- Additionally, we included respondents who reported that they needed medical attention in the past year but were unable to access it. The inability to access healthcare in the past may make these individuals more vulnerable if symptoms develop and perhaps less inclined to seek medical care or follow up treatment. These individuals may also have underlying conditions that have gone untreated making them more vulnerable.

As the syndemic framework illustrates, social, environmental and economic factors interact with health conditions and contribute to the spread of disease. We have therefore included three socio-economic risk factors to indicate this relationship.

- We looked at respondents who do not have medical aid - about 67.4% of respondents. Households without medical aid are less likely to have secure employment, less likely to have a cushion against shocks, and are more likely to experience difficulties accessing appropriate medication and care.
- We have also examined the risk of hunger by combining households where adults or children have skipped meals and households who have children that depend on school feeding schemes. About 37.3% of households face some hunger risk. The risk of hunger serves as a proxy for a level of poverty severe enough that meeting basic needs is not always possible, even without the additional difficulties of a shutdown or a serious local outbreak. This is compounded by schools closing which may mean children miss out on meals, placing an additional resource burden on households already struggling to meet basic needs, particularly at a time when good nutrition might be vital for those fighting an infection.
- The last factor is the percentage of respondents per ward who find it difficult or impossible to save money - some 80% of respondents. If respondents find it difficult to save money it is indicative of a limited financial cushion to protect against shocks such as a shutdown or pandemic.

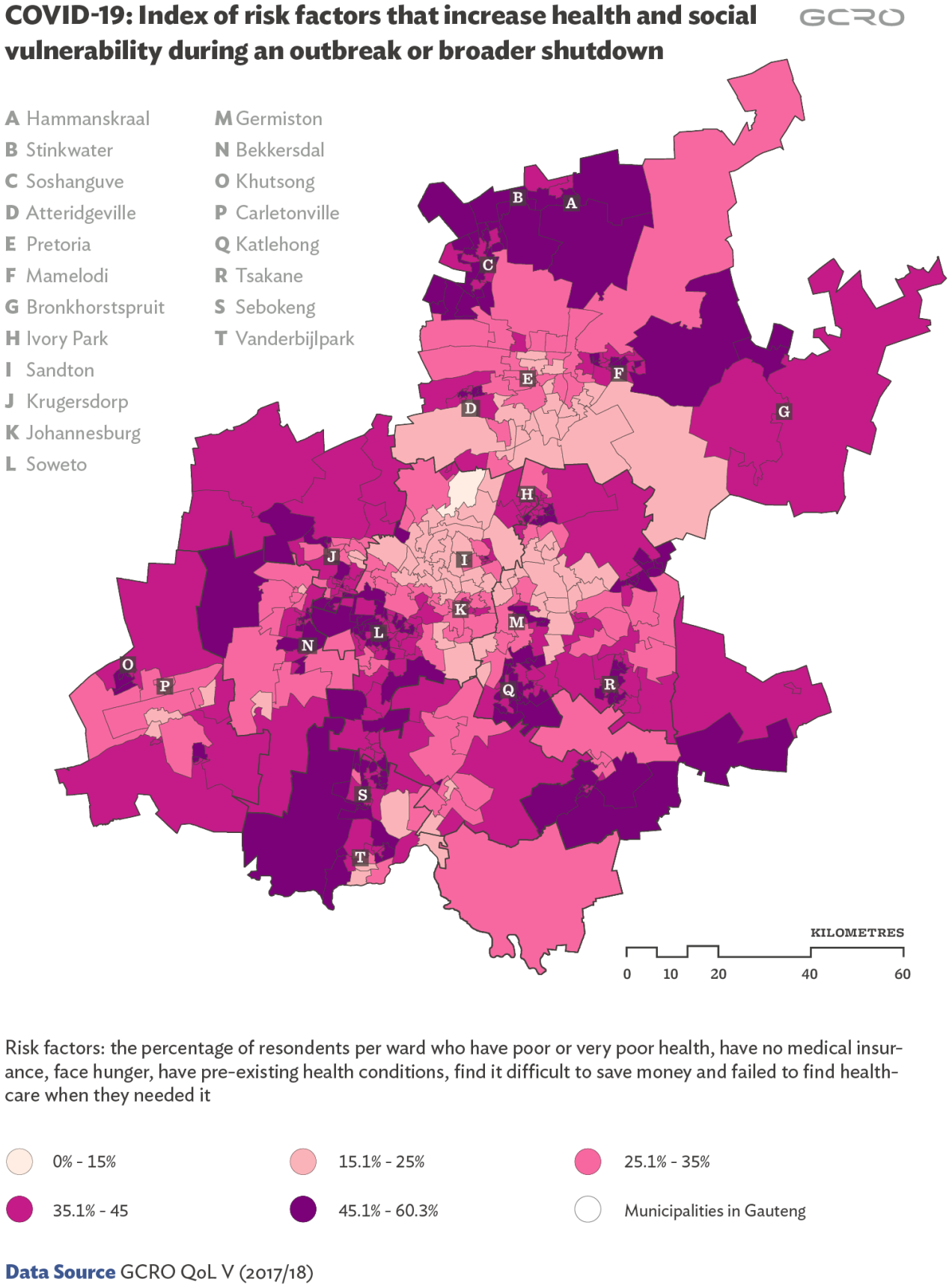
Table 2: Definition of risk factor indicators that increase health and social vulnerability during an outbreak or broader shutdown

COVID-19: Index of risk factors that increase health and social vulnerability during an outbreak or broader shutdown		
Indicator name	**Indicator definition**	**Rationale for inclusion**
2.1 Pre-existing poor health status	The percentage of respondents per ward who considered their health in the four weeks prior to the interview to be poor or very poor.	Respondents with poor health status are spatially concentrated in certain areas, such as townships and informal settlements. This may reflect a higher prevalence of some diseases, such as TB, HIV/AIDS and hypertension, in poorer communities. It may also reflect how certain areas are more affected by environmental health factors such as poor water quality or air pollution. Pre-existing poor health status will likely increase susceptibility to COVID-19 infection, placing both these individuals and other household members at greater risk. If they do become sick, they will be more susceptible to serious illness and death.
2.2 Pre-existing relevant health conditions	The percentage of respondents per ward who said that a member of their household had been affected by one or more of the following in the past year: cancer, diabetes, emphysema/bronchitis, asthma, pneumonia, heart disease, hypertension, or tuberculosis (TB). Note: It is very important to note that this is self-reported health data from a sample survey, rather than any official record of the condition in the District Health Information System. We have limited this analysis to conditions expected to increase COVID-19 morbidity and mortality. We have excluded HIV/AIDS from this analysis as we do not have data on whether individuals reporting this condition are on treatment. There is currently no evidence that individuals on effective treatment are at increased risk, although those with untreated HIV/AIDS are thought to be.	Individuals with pre-existing medical conditions (and by extension their households) are particularly vulnerable during a pandemic or a shutdown. Due to the significance of environmental and social factors in contributing to conditions such as diabetes, hypertension, heart disease and asthma, there is substantial spatial clustering of these households. Vulnerability is increased due to ongoing medical needs requiring regular visits to health facilities. If health facilities become overwhelmed, chronic services are likely to suffer. Additionally, many conditions weaken immunity. There is clear evidence that these conditions significantly increase risk of serious illness or death in individuals infected with COVID-19 (ref: https://www.nejm.org/doi/10.1056/NEJMoa2002032).
2.3 Difficulty accessing health care	The percentage of respondents per ward who indicated that in the past year there was someone in their household who needed healthcare but was unable to access it. We have excluded those who said that the reason for this was that the sick person did not have time to seek care, did not think it was worth seeking care (e.g. thought they would get better on their own), or gave another unspecified reason.	An inability to access healthcare in the past - for example due to distant health services, overcrowding, costs, or refusal of services - will likely mean that individuals are more vulnerable during a shutdown or an outbreak. Vulnerability is likely to be enhanced by undiagnosed or untreated pre-existing conditions. If they develop COVID-19 symptoms, they may also be particularly constrained in their ability to seek care - particularly if they have been refused care in the past. An inability to access health care is also often indicative of a level of social alienation, and alienation from other vital government services. Consequently, these individuals and households may be particularly unlikely to receive critical services from other spheres of government during shutdown or illness.
2.4 No access to medical aid	The percentage of respondents per ward who are not covered by any form of medical aid or insurance.	Medical aid acts as a proxy for relatively secure employment, and adequate economic resources to provide a cushion to shocks such as unexpected medical expenses, a shutdown or a pandemic. Households with access to medical aid are also likely to have easier access to medication and medical care. Households without medical aid are less likely to have a cushion against shocks, and are also more likely to experience difficulties accessing appropriate medication and care related to both COVID-19 and other health conditions, both immediately and in the longer term.
2.5 Hunger	The percentage of respondents per ward who live in a household where an adult or child had to skip a meal in the past year, because there was not enough money to buy food, as well as those living in households where children benefit from a school feeding scheme.	This variable serves as a proxy for a level of poverty severe enough that meeting basic needs is not always possible, even without the additional difficulties of a shutdown or pandemic. The closing of schools may mean that children miss out on meals, placing an additional resource burden on households already struggling to meet basic needs. An inability to meet basic nutritional needs is likely to substantially increase vulnerability to severe infection, as well as mortality.
2.6 Difficulty in saving money	The percentage of respondents per ward who say that it is difficult or impossible to save money.	Difficulty in saving money is indicative of a limited financial cushion to protect against economic or medical shocks. The economic effects of a shutdown are likely to be severe, with many businesses closing or needing to reduce staffing. Temporary workers and service sector workers may be particularly vulnerable. Under these conditions, households without savings are likely to struggle to meet basic needs. Additionally, where household budgets are already tight, capacity to manage unanticipated medical expenses is likely to be very constrained.
These six factors have been aggregated into a single index, and mapped to highlight areas where these factors combine to indicate multiple risks to health and social vulnerability during an outbreak or broader shutdown. The percentage of respondents in each ward affected by each of these factors was added together and divided by six to derive the index. This index has been mapped in Map 2 below.		

Map 2 highlights that the risks which increase health and social vulnerability are relatively higher in some wards (shaded dark purple) in Gauteng than in others (shaded light pink). Importantly, although there are various wards to be concerned about at this time, it indicates that health and social vulnerabilities are not as spatially clustered compared to the risk distribution in Map 1, and therefore suggests that a much broader group of residents in the GCR might be affected by an outbreak or broader shutdown. This is partly because respondents' lack of access to medical insurance, experience of pre-existing relevant health conditions and difficulty to save money is widespread throughout the province (see individual maps here (/documents/340/March_MOTM_maps_of_risk_factors_and_vulnerabilties_to_covid19_in_GCR_2.pdf)), even in middle and upper class areas.

Wards of particular concern include those in townships and informal settlements, like Stinkwater, Atteridgeville, Mamelodi, Ivory Park, Soweto, Katlehong, Tsakane, Bekkersdal, Khutsong and Sebokeng. In these wards, more than 45% and up to 60% of respondents experience various risk factors which increase their health and social vulnerability. In townships and informal settlements, health and social vulnerability is particularly influenced by pre-existing poor health status, limited access to medical insurance, food insecurity and past inability to access healthcare when it was needed.

Map 2 also points to some of the relationships that exist between Map 1 and Map 2 and how many of the factors we have identified in these two maps are interrelated. For example, wards with higher population densities and likely crowded dwellings (like various parts of townships and those in inner city Johannesburg and Pretoria) in Map 1, are also indicated as wards with moderate risk to health and socio-economic vulnerability. Further, the lack of quality sanitation in townships and informal settlements that is part of the index in Map 1 overlaps with the food insecurity that forms part of the index in Map 2 - creating a double challenge to stay healthy during the COVID-19 outbreak or a broader shutdown.



Map 2: Average of the percentages of respondents per ward affected by each of a set of social and health vulnerability factors related to COVID-19

The individual maps making up both indices can be seen in this report downloadable here (/documents/342/2020.03.25_March_MOTM_maps_of_risk_factors_and_vulnerabilties_to_covid19_in_GCR.pdf).

These maps give some indication of areas in Gauteng that might experience significant challenges or increased vulnerability during the spread of the COVID-19 virus and broader shutdowns. The maps can also help the Gauteng Provincial Government to direct communication strategies, as well as health and social support to areas experiencing the greatest risk first. Some of the key insights from these maps are that challenges to maintaining social distance and preventative hygiene are spatially clustered but that the limited ability to cope with health and social shocks is more widespread, but also significantly influenced by the challenges to maintaining social distance and preventative hygiene.

Technical notes:

- Multiple risk factors for maintaining social distance and appropriate levels of preventative hygiene:
  - Crowding in dwelling. We have defined a crowded dwelling as 3 or more individuals per functional room, as well as any single-room dwelling shared by multiple households. About 14.4% of all respondents live in crowded dwellings. About 17.4% of all African respondents live in crowded dwellings, compared to 9.5% of coloured, 3.2% of Indian/Asian and 0.9% of white respondents. About 5.8% of respondents aged older than 65 years live in crowded circumstances. About 12.7% of respondents who live in households reporting pre-existing health conditions of concern also live in crowded dwellings.
  - Sanitation shared. About 12% of respondents do not have access to a flush toilet that is connected to the sewerage network or a septic tank.
  - Main water source. About 9% of respondents do not have access to piped water in their dwelling or yard.
  - Use of public health facilities. About 66% of respondents who use healthcare facilities usually use public healthcare facilities. This suggests that a minimum of 10 million Gauteng residents rely on the public healthcare system.
  - Communication. About 1.1% of respondents do not have access to any form of digital communication (no internet, no cellphone, no TV/satellite TV and no radio).; About 5% of respondents do not have access to a cellphone, 8% do not have access to TV/satellite TV or radio and about 38% of respondents never access the internet.; About 48% of QoL V interviews were conducted in English. This suggests that 52% of respondents are more comfortable in another language (22% isiZulu, 9% Sesotho, 8% Sepedi, 7% Setswana), which makes communication in other languages very important. Further, only 12.3% of respondents indicated that their main household language is English.
  - Public transport. About 44% of respondents rely heavily on public transport.

- Multiple risk factors contributing to increased vulnerability during an outbreak or shutdown:
  - Health status. About 7.2% of respondents considered their health status to be poor or very poor in the four weeks before the interview.
  - Pre-existing health conditions. About 33% of respondents indicated that they or someone in their household experienced one or more of the pre-existing health conditions that might increase their vulnerability to and ability to recover from COVID-19.
  - Failed to find healthcare. About 4% of respondents indicated that, in the year before the interview, they or someone in their household needed healthcare but were unable to find it. This excludes respondents who provided unclear reasons as to why they didn't get health care, or said it was because of time constraints or because they did not think it was worth trying to get healthcare.
  - Access to medical insurance. About 67.4% of respondents indicated that they do not have any medical insurance.
  - Hunger risk. About 37.3% of households face some hunger risk.
  - Difficult to save money. About 80% of respondents indicated that they find it difficult or impossible to save money, but it is much harder to save money for respondents in poorer households.

Inputs and edits: Richard Ballard and Melinda Swift

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