

Research Articles

Effects of increased residential mobility and reduced public spaces mobility in containing COVID-19 in Africa

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Background

The rising COVID-19 crisis threatens to disproportionately hit African countries. As a result, most African governments have temporarily closed schools and non-essential businesses or banned social gatherings to contain the disease. It is therefore important to estimate the level of transmission reduction as a result of these measures. This study aimed at predicting COVID-19 cases in Africa based on COVID-19 community mobility report.

Methods

Our study focused on 26 African countries whose community mobility data were available online. The number of daily confirmed cases for the period of February 15th, 2020 to May 29th, 2020 for each country was obtained from European Center for Disease Prevention and Control (ECDC) COVID-19 cases geographic distribution data. Multiple linear regression was performed to investigate the relationship between COVID-19 community mobility and confirmed cases.

Results

The maximum public place mobility change was -38.15% with an average of -18.85% (± 3.47); residential mobility was at 23.17% with an average of 11.268% (± 1.448). The number of confirmed cases had a significant negative correlation with residential mobility change ($r = -0.878$, $P < 0.01$) and positive correlation with public place mobility change ($r = 0.881$, $P < 0.05$). Both mobility changes in public spaces and residential are significant predictors of COVID-19 cases. More specifically, about 1% change in a public place and residential mobility would result in 167 less COVID-19 daily cases, while total lockdown would result in 581 fewer daily cases.

Conclusions

Our analysis shows that a COVID-19 containment strategy that focuses on increasing residential mobility and reducing public spaces mobility is effective. Therefore, the finding supports containment measures that aim to limit the movement of people.

COVID-19 pandemic is the greatest public health threat ever encountered in the 21st Century. Confirmed cases continue to rise having reached almost 2 million worldwide by the beginning of April with a 6.4% case fatality rate (CFR).¹ Africa accounts for 0.8% of the confirmed cases with a CFR of 5.3%.¹ Currently, Africa has very few cases of COVID-19 compared to Asia, America and Europe. But it needs to be more prepared for greater action to contain the COVID-19 as the virus is on the rise in the continent. Considering the increasing number of cases in Africa, albeit slow, the growing COVID-19 crisis threatens to disproportionately hit African countries. This is because they have under-resourced hospitals and fragile health systems which are like-

ly to be overwhelmed.²

In laying ground for aggressive management of COVID-19 in Africa, the African Centre for Disease Control and Prevention (Africa CDC) in collaboration with the World Health Organization (WHO) and African countries established the Africa Task Force for Novel Coronavirus on February 3, 2020. The task force had six strategies: i) laboratory diagnosis ii) surveillance, including screening at points of entry and cross-border activities iii) prevention and control of infections in health care facilities iv) clinical management of people with severe COVID-19 v) risk communication and community engagement and vi) supply-chain management and stockpiles. However, test kits are in short

supply, making it difficult to know the true extent of the epidemic in Africa. The capacity and infrastructure for disease surveillance in Africa are also not uniform.³ Given the challenges in dealing with the pandemic in countries such as United States, Italy, Spain, and the United Kingdom that supposedly have better health systems and public health response. The transmission potential of COVID-19, determined by reproduction number (R0) of 3.28, is much higher than that of severe acute respirator syndrome, SARS.⁴ Therefore, Africa must scale up its containment and mitigation strategies—quarantine, isolation, and social distancing.⁵

Countries such as China demonstrated that quarantine, social distancing, and isolation of infected populations can contain the epidemic.⁶ These responses and their success in containing the virus are encouraging for African countries with confirmed COVID-19 cases. Encouraging people to stay home or avoid crowds, and stay at least one meter away from others when they are out, can slow the spread of the virus and reduce the burden on healthcare systems.⁷ Moreover, slowing transmission would thereby protect many populations vulnerable to COVID-19 fatality.⁸

To date, most African country governments have temporarily closed schools and non-essential businesses or banned social gatherings.⁹ It is therefore necessary to estimate the level of transmission reduction for social distancing that are in place¹⁰ in Africa. Model-based predictions can aid African governments in making the right and timely decisions. With the ongoing data collection, epidemiological analysis are essential parts of assessing the impacts of mitigation strategies, alongside clinical research on how to best manage seriously ill patients with COVID-19.¹⁰ The availability of Google community mobility reports provides an opportunity to estimate transmission reduction. This report shows the percentage mobility change in grocery and pharmacy, parks, transit stations, workplaces, retail and recreation, and residential.¹¹ The percentage is generated by comparing the current movement in those places by the average movement before the lockdowns were enforced. Therefore, we purposed to predict COVID-19 case in Africa based on COVID-19 community mobility report.

METHODS

STUDY AREA

Our study focused on 26 African countries including Angola, Burkina Faso, Benin, Botswana, Cote d'Ivoire, Cameroon, Cape Verde, Egypt, Gabon, Ghana, Kenya, Libya, Mali, Mauritius, Mozambique, Namibia, Niger, Nigeria, Rwanda, Senegal, Togo, Tanzania, Uganda, South Africa, Zambia, and Zimbabwe. These countries were chosen based on the availability of their Community mobility data online.

DATA COLLECTION

Daily confirmed cases for each country were collected from European Center for Disease Prevention and Control (ECDC)'s geographic distribution of COVID-19 cases geographic distribution data as from February 15 to May 29, 2020.¹ The ECDC's COVID-19 cases present official counts of confirmed COVID-19 cases; however, there could be vari-

ation between this data and other sources of COVID-19 data using different inclusion criteria and different data cutoff.

COVID-19 community mobility reports were obtained from Google website (<https://www.google.com/covid19/mobility/>). Google team generated the report to help people and public health officials understand responses to social distancing guidance related to COVID-19. They also provide insights into what changed in response to work from home, shelter in place, and other policies aimed at flattening the curve of the COVID-19 pandemic. The reports show how visits and length of stay at different places change compared to a baseline. The changes were calculated using the same kind of aggregated and anonymized data used to show popular times for places in Google Maps.¹¹ Public spaces such as grocery and pharmacy, parks, transit stations, workplaces, retail and recreation had negative percentage change, indicating decrease in mobility. While residential had positive percentage change, indicating an increase in residential mobility.¹¹ The Google mobility is measured relative to a normal value for each day of the week providing a good data, because of varying activities of people during weekends and weekdays.

STATISTICAL ANALYSIS

Seven mobility trends were assessed, which we categorized into two, the trends of mobility in public spaces such as retail and recreation; grocery and pharmacy; parks; transit stations; and workplaces. While the other was mobility in residential places which is staying at home. For the former, we calculated the average mobility change in the public spaces for each country using daily mobility change for 105 days since February 15th 2020 when the first case was reported in Africa. While the latter was retained as it is for all those days.

To perform multiple linear regression for investigating the relationship between COVID-19 community mobility and daily confirmed cases, the data was processed with SPSS version 22 software (Chicago, IL). The model was defined as follows:

$$y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \varepsilon \dots \dots \dots 1$$

In the model, y is the daily confirmed cases, β_0 is the intercept, β_1 and β_2 are coefficients for changing trends on going to public spaces and staying at home respectively.

RESULTS

DESCRIPTIVE ANALYSIS

Table 1 summarizes the descriptive statistics for COVID-19 daily confirmed cases and COVID-19 mobility variables. The maximum public place mobility change was -38.15% with an average of -18.85±3.47%; residential mobility data revealed a maximum mobility change of 23.17% with an average of 11.27±1.45%.

TREND ANALYSIS FOR PUBLIC SPACE MOBILITY CHANGE, RESIDENTIAL MOBILITY CHANGE, NUMBER OF DAILY COVID-19 CASES AND DEATHS

There are indications that containment measures put in

Table 1: Summary of COVID-19 confirmed cases and COVID-19 mobility variables

	Number of days	Minimum	Maximum	Mean	SD
Public place mobility change	105	-38.15%	3.53%	-18.85%	3.47%
Residential mobility change	105	0.65%	23.17%	11.27%	1.45%
Confirmed COVID-19 Cases	105	0	470	195.94	38.58

Table 2: Regression analysis summary for COVID-19 community mobility predicting COVID-19 cases

Model	β (95% CI)	Std. Error	t	Pvalue
Constant	-163.051 (-335.20 - -109.19)	37.26	2.189	0.047
Public space mobility change	136.258 (79.20 - 193.33)	28.77	4.74	<0.001
Residential mobility change	-281.487 (-18.89 - -13.78)	1.27	-5.60	<0.001

place by the 26 governments in Africa are being relaxed either by the governments or citizens themselves. Because both public space mobility change and residential mobility change are moving towards zero change. However, the number of cases and fatality are increasing. From week 7 to 9, the trend of COVID-19 cases was at a plateau phase with an observed significant decrease in public space mobility and increase in residential mobility. However, from week 9 onwards there was a sharp increase in the number of cases perhaps due to increasing public space morbidity and decreasing residential mobility changes both of which are moving towards zero as shown in Figure 1. This is an indication of either government relaxing restrictions or citizens defying containment measures.

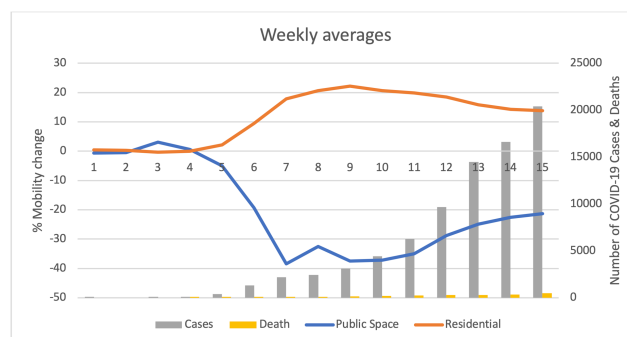
CORRELATION BETWEEN COMMUNITY MOBILITY AND COVID-19 CONFIRMED CASES

Correlation coefficients results shows that daily confirmed cases were negatively correlated with residential mobility change ($r = -0.878$, $P < 0.01$) but positively correlated with public space mobility change ($r = 0.881$, $P < 0.01$).

RELATIONSHIP BETWEEN COMMUNITY MOBILITY AND COVID-19 CONFIRMED CASES

A multiple linear regression was calculated to predict COVID-19 cases based on public place and residential mobility change. A significant regression equation was found ($F(2, 102) = 24.44$, $P < 0.001$), with an R^2 of 0.78. Therefore, $y = -163.05 + [136.26] (\text{public spaces mobility change}) + [-281.49] (\text{residential mobility change})$. Both mobility changes in public spaces and residential spaces are significant predictors of COVID-19 cases as shown in Table 2.

Suppose public place mobility declines by 1% and residential mobility increases by 1%, $y = -163.05 + 136.26(-0.01) + [-281.49](0.01) + 0 = -167.23$. In such a scenario, we would expect daily COVID-19 cases to be reduced by 167. Suppose there is 100% change both in residential and public space mobility, then $y = -163.05 + 136.26(-0.01) + -281.49(0.01) + 0 = -580.796$; therefore, daily cases would reduce by 581.

**Figure 1: Mobility change and trend in COVID-19 cases and deaths**

From week 7 to 9, there was a slowing down trend in the number of cases with an observed significant decrease in public space mobility and increase in residential mobility. However, with the reverse in the mobility trend, there is a sharp increase from week 9 onwards on cases. The fatality seems to gradually gain ground as from week 10.

DISCUSSION

Our understanding of the COVID-19 pandemic is constrained by several challenges including gaps in the demographic characteristics of cases. Similarly, countries have adopted seemingly comparable yet substantially different containment strategies making it difficult to appreciate what strategy is successful. Here, albeit data limitations, we have employed freely available datasets to show that “stay-at-home” clarion call and its concomitant reduction in mobility in residential and public areas is a successful containment measure against the virus.

This finding supports containment measures that aim to limit movement of individuals and thus contact with others including those who might be sick, or asymptomatic carriers of COVID-19. What is beyond the scope of our analysis is the temporal aspect of such a strategy. In other words, our analysis did not address the question of how long should both public or residual mobility be constrained to sustainably contain the virus. This remains an important question in light of the negative impact of isolation including psy-

chological and physical effects associated with sudden shifts in routine and the more sedentary lifestyle during mass lockdowns. For African countries where large chunks of the population earn wages from the informal sectors, the tradeoff between livelihood and reductions in mobility to safeguard public health will remain a difficult choice. However, available evidence to which our analysis builds suggest that reductions in public space mobility and increase residential mobility are successful in containing the spread of COVID-19 (Figure 1 and Tables 1 and 2).

Additionally, it must be noted that in some cases, especially in countries with low or a reduced COVID-19 cases, a containment strategy similar to the Australian, during the early phase of the pandemic, would be appropriate. In brief, the Australian government's response was based on modelling of the impact of COVID-19. The model found that their health system will cope if they continue to: i) have effective social distancing, ii) increase their health system capacity, and iii) isolate people with the virus and their close contacts. Together with screening and self-isolating travelers, and strict border surveillance.¹²

The results match epidemiological expectations of diseases that are transmitted through human contact, via respiratory droplets aerosols and contaminated surfaces or air-borne. Available evidence on COVID-19 strongly suggest that the SARS-CoV-2 virus is transmitted through these routes.¹³ Additional risks derive the fact that many individuals remain asymptomatic and may be playing an active role in transmission of the virus¹⁴ especially when restrictions are eased or lifted altogether.

Limitations of this study relate to: i) the ecological nature of the study, and ii) the existence of possible confounders. The ecological nature of the study means that one cannot make conclusion based on individuals with regard to observed community mobility changes and COVID-19 cases. This is due to lack of individual data on COVID-19 cases and community mobility. Therefore, conclusion is made based on group not individuals. Moreover, Google mobility data are based on data from users who have opted-in to

sharing their location history for their Google account,¹¹ so the data represents a sample of Google Maps users. As with all samples, this may or may not represent the exact behaviour of the wider population.

Despite the limitation of this study, our analysis shows that a COVID-19 containment strategy that focuses on increasing mobility in residential areas and reducing mobility in public spaces is an effective strategy in Africa.

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