POLICY BRIEF

MODELLING THE DYNAMICS OF COVID-19 EPIDEMIC IN UGANDA AND THE IMPLICATIONS FOR NATIONAL MITIGATION MEASURES

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Current COVID-19 global pandemic

As of May 1st, 2020, COVID-19 disease, caused by the SARS-COV2 virus, has resulted in 3.26 million confirmed cases and over 233,000 deaths globally. So far, Uganda has registered a total of 85 reported cases, 52 recoveries and 0 deaths. This scenario is unique and markedly different from what has been reported in other countries across the globe. Due to timely government interventions led by the president in enforcing the different forms of "social distancing measures", the COVID-19 epidemic has not become fully established within the local communities. The majority (93%) of cases so far have been people who were infected from outside Uganda and "imported" through airports and by truck drivers arriving from neighboring countries **(See Figure 1).** As in many other countries, Uganda is in discussion to lift lockdown measures. In this regard, we provide scenarios derived from mathematical models to inform decisions on lifting the lockdown.

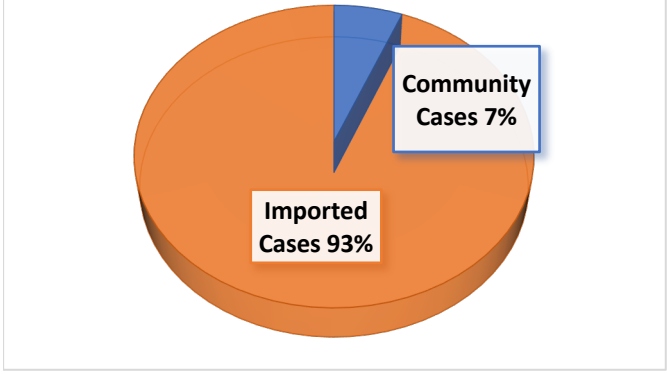
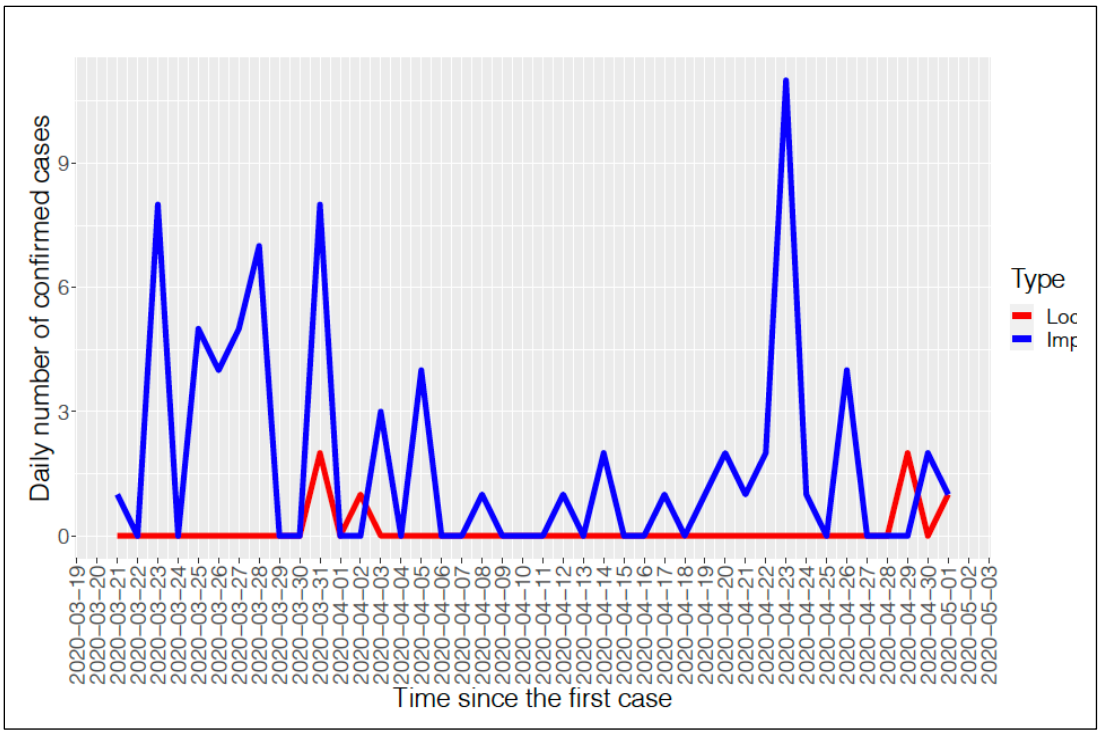


Figure 1: Distribution of COVID-19 cases in Uganda

In attempting to understand the spread and possible control of COVID-19, mathematical approaches have been used to forecast the future trends of the epidemic worldwide. The predictions from such models have had far-reaching consequences regarding how quickly and how strongly different countries have moved to halt the epidemic. The model used in these simulations is a modified version of the SEIR model that captures local transmission dynamics with additional compartments to capture imported cases. We have categorized the Ugandan population into four major compartments, namely: the susceptible (those at risk of

catching the disease), exposed (infected but not yet detectable), infected (both symptomatic and asymptomatic), and removed (either dead or recovered) populations. Importantly, given what is known about COVID-19 so far, we have made the



assumption that once infected with COVID-19, one is temporarily immune from re-infection. We have also assumed that both exposed and infected individuals can transmit the SARS-COV2 virus. Details of this modelling work have been submitted for publication and are currently under review.

As we present results from our modelling work on the Ugandan COVID-19 epidemic, we caution that the primary role of such mathematical models is to test how effective the different social distancing measures are in reducing the COVID-19 epidemic burden. For such an approach to be effective, the models have to be customized to the settings of the particular country. In the Ugandan case, we have formulated a model that clearly delineates local transmissions from the imported cases.

Model Outputs

When describing epidemics there are important terms to understand such as the "basic reproductive number (R_0)", defined as the average number of "secondary" cases that would result if one infected individual was introduced into a completely susceptible population. This term should be interpreted cautiously in Uganda's context, due to the absence of a secondary community transmission of COVID-19. If the R_0 is less than 1, no epidemic can be sustained within the population. The roll out of interventions is meant to suppress the R_0 to below 1. Given that the number of reported community cases (5) in Uganda are very few (**see Figure 2**), the R_0 for COVID-19 is almost zero.

Imported cases and COVID-19 transmission

Although the Ugandan government has implemented stringent measures to contain the transmission of COVID-19 since March 2020, truck drivers were allowed to continue to transport goods. However, since the Ministry of Health implemented routine testing for COVID-19 at the airport and border points, a number of truck drivers have tested positive, posing a danger of introducing the infection into the community. Therefore, there is need to understand the potential impact of truck drivers interacting with the community. In figure 2, four scenarios are presented showing the effectiveness of lock down measures which prevent interactions between truck drivers and local communities.

In this first Uganda-based model predicting the COVID-19 epidemic, if control measures preventing infection from imported cases such as truck drivers were 60% effective, there is potential for a community epidemic to arise. Several scenarios are shown in **Figure 3.**

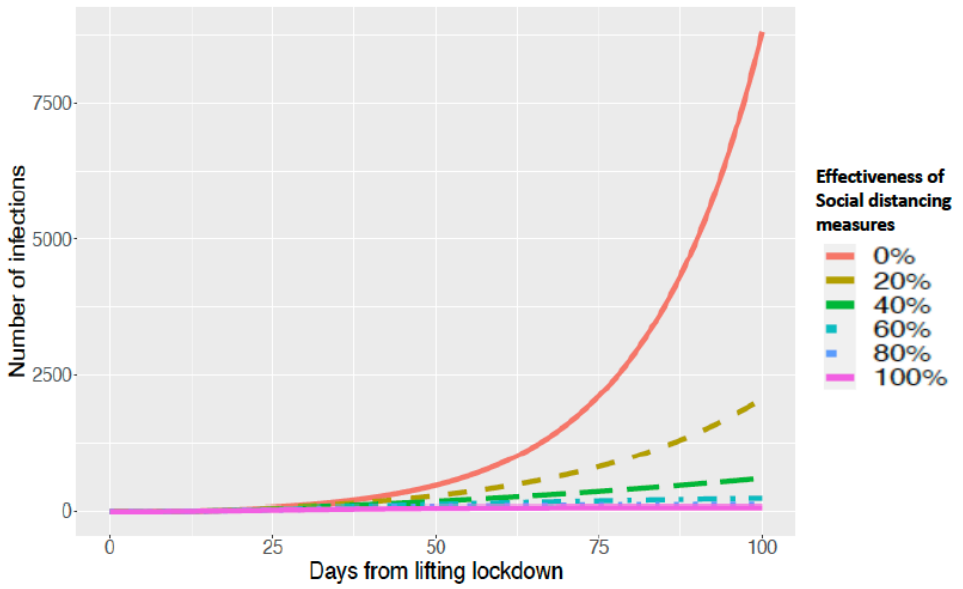


Figure 3: Potential Impact of imported COVID-19 cases in Uganda

Scenario1: No social distancing measures are implemented, and the epidemic grows exponentially; *Scenario 2*: Achieving 20% of lock down measures; *Scenario 3*: Achieving 40% of lock down measures; *Scenario 4*: Achieving 60% of lock down measures; *Scenario 5*: Achieving 80% of lock down measures; *Scenario 6*: Achieving 100% of lock down measures. It is shown in Figure 3 that if lock down measures are between 40-100% effective, we expect less than 500 COVID-19 cases within 100

days from lifting the lockdown. In our model, the R_0 is estimated at 2.2 which means that one infected person can potentially infect more than 2 people in the community.

Conclusions:
Given the natural of the Uganda COVID-19 epidemic, lifting the lockdown and opening the borders may not be disastrous, as long as there are effective measures which prevent interaction between imported cases, particularly truck drivers, and the local community. There is an urgent need to implement strict mitigations measures that strongly impede the penetration and interaction of imported cases with the local Ugandan community. As and when a full-blown epidemic gains momentum within the country, mitigation measures such as reducing the influx of truck drivers and closing borders cease to be effective and predictions from this modelling work become applicable.

We provide empirical evidence and justification for the following measures:

1. Continued rigorous surveillance and testing for COVID-19 at all border points
2. Deployment of rapid testing at the boarder points to remove the threat of asymptomatic COVID-19 cases interacting with the local community.
3. Mass testing of COVID-19 and immediate isolation of cases, provided resources are available.
4. Deployment of ICT enabled technologies to track high risk individuals such as truck drivers for easier contact tracing.
5. Continued social distancing practices should be adhered to even after the lock down is lifted to prevent further spreading of COVID-19 in the community.

Results from the ongoing COVID-19 sero-survey by the Ministry of Health and investigators from Makerere University will be critical in estimating possible prevalence within the Ugandan community. This estimate will be valuable in defining important compartments of our mathematical model, particularly in understanding and identifying those most susceptible within the Ugandan population. Furthermore, there is need for accurate estimation and quantification of Uganda's lockdown measures and their impact on the local COVID-19 epidemic.