Pandemic Epidemiology: Social Impacts and Strategic response on COVID-19 in Kenya

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Introduction

In December 2019, the novel coronavirus was discovered to have mutated, hence enabling it to cause disease within people. Having started in Wuhan and throughout the Hubei district in China, the disease was passed on from one person to the next. Within weeks, the disease had spread to Europe and eventually it became a worldwide problem.

The first case in Kenya was discovered on 13th March 2020. The first patient was a Kenyan citizen travelling back to Nairobi from the United States of America via London, United Kingdom on 5th March 2020. The patient was managed at the Infectious Disease Unit at Kenyatta National Hospital. The government embarked on a contact tracing for all people who were in contact with her. She was confirmed positive by the National Influenza Centre Laboratory at the National Public Health Laboratories of the Ministry of Health.

The immediate response to the onset of the pandemic was to ban all public gatherings which resulted in schools, restaurants and airports being shut down. However, airports remained operational to transport cargo in and out of the country and schools resorted to online learning with zoom, google meet and skype being the most commonly used platforms for academic instruction.

Infections have been most prominent in Nairobi County, its capital city, with 59% cases being in Nairobi. After the implementation of the curfew, the immediate number of cases reported went down but gradually began to increase after a week of the curfew. The top ten counties with the highest spread of the disease per 100,000 people were as follows as of 27th July 2020:
Nairobi - 240.5
Mombasa - 162.4
Kajiado - 92.6
Busia - 77.8
Machakos - 50.4
Kiambu 47.5
Migori -23.7
Uasin Gishu - 19.9
Lamu - 18.8
Taita Taveta - 13.8

Further into the research paper insight is provided on the novel coronavirus and its impacts in Kenya. Below you will find evidence that strives to show the current situation in the country with regards to the pandemic.

Infections and fatality rates

The first case of the Coronavirus in Kenya was recorded on the 13th of March 2020 by a Kenyan citizen travelling back to Nairobi from the United States of America via London. Since then, the virus has spread throughout the country with at least one case in each county. Nairobi, the capital city, having reported 59% of the cases.

As of August 17th, there had been 30,365 reported cases of Covid-19 present in the country, 17,160 recovered patients and 482 deaths. Out of these cases, only 44 cases were treated in the ICU. Giving the virus a recovery rate of 56.5% and a death rate of 1.6%.

92% of the cases are asymptomatic, and the rest being symptomatic. The symptoms are coughing, fever, difficulty in breathing, headache, sore throat, running nose, chest pain, general body malaise, loss of smell, pneumonia in order of their prevalence.

65% of the reported cases are men. This is due to the presence of an inactive immunity gene present in one of the X chromosomes; therefore, women have double the immunity genes compared to men. In addition to that, a study that was published by the European Heart Journal reported that men have higher concentrations of angiotensin-converting enzyme 2 (ACE2) in their blood than women. ACE2 receives the virus first before healthy cells, which explains why men are more vulnerable than women. Moreover, a study published in the Journal of Immunology and research conducted in mice, found that activating the oestrogen receptor in female mice provided them with protection against Severe Acute Respiratory Syndrome Coronavirus Infections.

The age group 30-39 years has the most number of infections with 17.5% of all recorded cases, while the age group 10-19 years has the least number of infections with 4% of all recorded cases (as of 27/07/2020). In addition to that, the lowest number of deaths was in the age group 10-19 years, and the highest number of deaths being in the age group 60+ years. This is seen as the fatality rate is 20% higher in a person in their 40's who has contracted the virus compared to a person in their 60's.

Comorbidities such as cardiovascular disease, diabetes, chronic respiratory disease, and hypertension have been reported to be risk factors associated with the virus for unfavourable outcomes with no significant evidence. There is no evidence to suggest an increased infection rate or severity among people living with HIV although those who have not received viral suppression through antiretroviral therapy have compromised immunity leaving them vulnerable to opportunistic infections.
An unpublished analysis that compared the weather conditions of 500 cities found that the virus spread fastest at an optimum temperature of 8.07^0C. Therefore the virus is transmitted faster at cooler temperatures. Kenya recorded the average lowest temperature of 9.1^0C in August and the average highest temperature of 26.8^0C in March.

There is a limited supply of water in certain regions in the country such as Kibera which has about 200 water points for about 200,000 residents making the washing of hands very difficult. The same area is very congested with very few health care facilities for the residents making social distancing impossible in addition to the already very high spread rate of communicable diseases such as Tuberculosis.

The ignorance of citizens is a major contributor to the increasing infection rates. Disobeying of the rules set up by the government in order to curb the spread of the virus. People are seen walking around without their masks or wearing them incorrectly, people were also caught in night clubs(including politicians) despite their ban and even travelling between counties when particular counties were under lockdown.

With the majority of Kenya's population living from hand to mouth, a lot of people are still travelling to and from work which increases their exposure to the virus.

Kenya's low mortality rate is accredited to having a low population of older citizens. The median age in Kenya is 18 years. Younger people have higher chances of recovering from the virus which gives the 56.5% recovery rate.

The controlled spread is courtesy of the government for the introduction of mitigation efforts soon as the first case was recorded. Such mitigation efforts are the banning of all public gatherings, making the wearing of masks compulsory and even locking down Nairobi, Mombasa and Mandera due to their high numbers of cases.

Hospital resources and future model

The current model of the Kenya Health services follows a six-tier hierarchy. Level 1 being community services, level 2 dispensaries and clinics, level 3 health centres, maternity and nursing homes, level 4 sub-county hospitals and medium-sized hospitals, level 5 county referral hospitals and large private hospitals and level 6 national referral hospitals and large private teaching hospitals. Of these, only level 5 and 6 hospitals are qualified to be treatment centres for the pandemic.

The number of physical resources available for treatment during the first cases of the pandemic in the country on 12th March 2020, was estimated to be 7680 empty beds, 29 beds available in Intensive Care Unit (ICU), 29 available ventilators and about 100 ambulances. These numbers were arrived upon by analysis of resources available in level 4 - 6 hospitals in the country and taking an estimated 70% of resources being used by patients at any given moment. These estimations might therefore vary quite largely in the country.

The current makeup of Kenya's demographic is a fairly young population, with a median age of around 20.1 years with a significantly uneven age distribution between the rural areas and urban areas (lower median in rural areas). It was suggested by *Verity et al* that around 5% of the COVID - 19 cases would require hospitalisation. Roughly 30 % of hospitalisations will require ICU usage and ventilator usage. Thus meaning the majority of infections will require self-quarantine and self-treatment.

Taking this into account the estimates for the number of resources required by the country are as follows: between 9000 - 199,000 beds required, 2000 - 55,000 ventilators and 57 - 1496 ambulances. The upper limits of these estimates are as a result of the estimated peak of the active infections in the country being around 14 million infections.

Given the current number of resources, there was an obvious need to 'gear up' in response to the estimated predicted number of infections in the country. The ministry of health in the country has taken different approaches in providing enough resources to combat the pandemic without causing a strain on the economic wellbeing of the people. In an attempt to optimise the number of its resources available for use during the pandemic, the ministry of health opted to re-route most of its resources. This involved suspending all Elective Surgical Procedures as of 25th of March 2020. Creating protocol and procedures to be followed by different surgical departments. Controlling the number and frequency of hospital visits required by patients suffering from various comorbidities but to name a few. By doing this the country has been able to free up space and redirect the resources to focus solely on the pandemic. Donor funds from external sources and internal sources are also being used to increase the number of resources in the country.

Despite this, it is proving difficult to track the pandemic in the country. In an effect to fix this the country is to begin mapping out the trends of the pandemic in the country using mathematical epidemiology. Mathematical models are thought to be the most effective way of mapping the

pandemic. The SEIR model (Susceptible, Exposed, Infectious and Recovered), first described by mathematicians in 1969, is thought to be the more efficient model to apply in Kenya. It is an extension of the more commonly known SIR model (Susceptible, Infectious, Recovered). This mathematical model strives to create a relationship between the patients in the country at different stages of infection. Susceptible patients are at risk of infection. Exposed patients are asymptomatic patients. Infected focuses on the reproduction number that is, the number of people a single person is estimated to infect. Recovered patients are those that have tested negative after previously testing positive.

This model tracks the speed at which a patient moves from one stage to another thus, improving surveillance of the pandemic, indicating the feasibility of containing the virus and directing resources to the most important sector. In turn, this will support public health preparedness and response planning, hence equipping the country to better support itself in the eye of a pandemic. Applying this model is favoured as it provides realistic scenarios and checks the effectiveness of the different combat methods applied by a country. The model has previously been used to map out the 2009 influenza outbreak in the United States of America and the COVID - 19 outbreak in Wuhan, China.

Modelling the pandemic in Kenya however, is proving to be easier said than done. The ministry of health is in charge of controlling the pandemic in the country. The Integrated Disease Surveillance and Response (IDSR), adopted by Kenya in 2006 in accordance to its United Nations membership, has been in charge of collecting surveillance and laboratory data of possible cases and contact tracing. Overall coordination, however, is being done by the National Emergency Response Committee on Coronavirus. Both of them being government entities. Therefore challenges facing the government have been reflected upon both the divisions.

Corruption paired with money laundering is one of the problems undermining effective warning of the IDSR teams and the National Emergency Response Committee. This undermines the credibility of the information published by the ministry of health. Due to a misuse of resources, proper surveillance, contact tracing and case detection is difficult to achieve. To add to this testing and clinical diagnosis is slow. Not to mention the high number of asymptomatic patients. This means the number of cases in the country could potentially be way higher than the reported cases thus making it difficult to trace the pandemic effectively. Additionally, there is scarce information published by other counties in the country with the focus being on Nairobi County as it has the highest number of cases. The data available is also only on the infected and recovered patients. These factors working together make it difficult to apply the SEIR model in Kenya which would otherwise be an effective tool to combat the pandemic in the country.

In conclusion, Kenya lacks preparedness to face a pandemic as was seen with the limited number of resources that were available at the onset of the pandemic. Additionally, it is difficult to trace and map out a pandemic in the country due to government problems that reflect on the sectors mandated to oversee this. Due to this Kenya has been unable to properly control and maintain the spread of the pandemic. Additionally, Kenya is nowhere near prepared to face another pandemic in the future.

Mitigation Efforts

The first reported case of COVID-19 in the world was in Wuhan, China in December 2019. The disease started spreading quickly to other countries and Kenya had no choice but to be prepared. As of February 2020, the Ministry of Health had advised Kenyans to avoid contact with persons with symptoms as well as avoid non-essential travel to affected countries. Kenyans were advised to avoid crowded places and to ensure good ventilation in indoor settings including homes and offices.

The first reported case of COVID-19 in Kenya was reported on 12th March 2020. The patient was managed at the Infectious Disease Unit at Kenyatta National Unit and the government embarked on contact tracing for all the people who were in contact with her in order to bring them in for testing.

Anyone who experienced COVID-19 symptoms was advised to self-quarantine themselves for 14 days and contact a medical provider as soon as possible. Health care workers were required to use medical masks continuously during all routine activities in clinical areas. They were also advised to follow the proper burial procedure when burying people who died from COVID-19.

The president banned all public gatherings because the virus was most likely to pick. As a result schools, churches and airports were closed. Therefore, schools adapted to online learning and churches having services via social media platforms such as youtube. Additionally, the guest lists to weddings and funerals was reduced to a few people. Airports remained operational only to transport cargo.

The National Emergency Response Committee established the following measures to help flatten the curve:

- All entertainment, restaurants, bars and social places to close by 7:30 pm.
- Factories to operate using a minimum workforce on a 24-hour shift rotation system.
- People to stay at home unless on essential businesses such as transport, food and healthcare.
- Supermarkets to limit the number of shoppers- Naivas Gateway Mall enforced a rule that did not allow children inside the supermarket. This is because they are more likely to contract COVID-19.
- Local markets to disinfect regularly- This led to the youth being employed to disinfect the markets in their counties(Kazi Mtaani).
- Corporations and businesses to allow people to work from home if possible- Some organisations resorted to having a rotation system whereby 10 to 20 employees would report to work for at least 2 weeks then be replaced by different employees for the following weeks.
- County governments to ensure provisions of soap and water in all market centres- Traders were advised to be extra clean when handling foodstuffs.

By May 2020, the number of infected people rising dramatically pushed the president to enforce travel restrictions into and out of the most affected areas such as the Nairobi metropolitan area and the counties of Kilifi, Kwale and Mombasa. The president enforced a daily curfew running from 7 pm to 5 am which was later reduced to accommodate workers.

“We are confronting a global enemy and one of the defence artillery we have is water. Its availability will be a crucial determinant for a successful outcome in this war”- Mr Siddharth Chatterjee(UN Resident Coordinator in Kenya) The Ministry of Health in collaboration with the Ministry of Transport advised matatu and bus owners to adhere to the 1m apart rule as well as sanitising travellers before they boarded the vehicles.

The Kenyan Ministry of Health COVID-19 Taskforce implemented the initial prevention and mitigation measures which included encouraging the public to wash hands, wear masks and stay at home. The president announced an economic initiative called the **National Hygiene Programme** to employ workers to initially produce face masks with plans to expand in phases throughout the country.

As the COVID-19 cases increased, the government embarked on mass testing in order to determine the number of people that have contracted the virus. “The key to returning to normal life is keeping our infection rates falling and raising our testing rates”- President Uhuru Kenyatta.

Graffiti artists from Mathare Youth Organisation paint murals advocating safety practices to curb the spread of the novel coronavirus. Other organisations used their platform to advocate for the citizens to observe the initial prevention and mitigation measures such as washing hands, wearing masks and staying at home.

Economic Impacts

Since the first case of COVID-19, on 12th March 2020, Kenya, similar to other countries, has been facing massive economic destruction. Without a doubt, this pandemic has added on to Kenya's economic troubles. It added insult to injury.

COVID-19 came about abruptly and impacted Kenya in one way or another. Unfortunately, these impacts have been negative. For example, there has been a major decline in the agricultural sector, poor performance in the financial market, volatility on the Kenyan currency and sadly this is nothing but the tip of the iceberg of Kenya's problems.

Horticulture and floriculture exports in the agricultural sector are being directly affected by the virus. With limited flights and weak demand in major markets in Europe and Asia, the agricultural sector struggles. The floriculture industry is crying in pain as many large farms are laying off their workers and reducing their outputs. Many large scale farmers are struggling to service their loans despite having a general off-season for their farms running at 30-40% capacity. There has also been a decline in the demand for tea and coffee and they are being sold at low prices to the target market. Moreover, vegetable exports are witnessing strong demand, but due to the decrease in freight services, there has been little revenue earned from this sector. In many major European and Asian countries, there has been an uprising demand for fruit and vegetables due to the whole world economic crisis but sadly there is not much Kenya can export, even though it would work to its advantage. This is because of the limited outbound air freights.

According to research, it has been observed that the Kenyan shilling will be managed within the 10% range of the dollar ($1 - Kshs 110) then it will fluctuate between Ksh 104- Kshs 108. This is as a result in the decline of horticulture and floriculture exports, less tourism and hospitality receipts and a suspected decrease in diaspora remittances in the year as Kenyans abroad try to mitigate their situations in the declining economies across the world. In this period, remittances are continuously declining due to the COVID-19 pandemic. This inverse relationship of declining economic outcomes resulting in higher remittances is one that needs to be confirmed but is a silver lining. One of the things that may lead to the devolution of Kenyan shilling is the increase in the price of oil which is expected.

Since the first reported case, a majority of foreign investors who had huge investments in Kenyan securities at Nairobi Stock Exchange started taking back their securities fearing a market collapse leading to a major decrease in the number of securities traded at the exchange. The Nairobi Securities Exchange-20 share index has been steadily losing its value declining by -10.76% as of August 21st 2020. Large-cap stock companies record huge losses in their Year to date performance during times of local crisis since many investors are selling off their stocks and they are moving to safer havens as opposed to holding their risky securities traded in the Nairobi Stock Exchange market.

The spread of the virus has also disrupted the global supply chain and Kenya has not been spared either. Imports from China account for approximately 21.0% of Kenya's total imports and with the current lockdown and limited flights, activities within the manufacturing sector have been disrupted. In addition to this, the low supply of imports from China and South Korea has led to an increase in prices of various imported commodities in Kenya making it difficult for consumers to purchase. The Kenya Association of Manufacturers has warned that the outbreak could cause a shortage of intermediate goods used to manufacture products that are exported. The manufacturing sector heavily relies on intermediate goods from China and with the supply chain disruption, the sector is likely to be adversely affected negatively. The decline in business conditions is already being felt according to Stanbic Bank's Monthly Purchasing Managers Index (PMI) report having declined to 49.0 in February 2020 from 49.7 recorded in January 2020 majorly due to a decline in business conditions.

The employment rate has also reduced by 11.8% and real income decreases by 7.9% and 6.8% for rural and urban households respectively. This lower income has led to a decrease in domestic demand The impacts of the pandemic would be amplified if a new COVID-19 wave were to emerge in the second part of 2020. Also, the GDP would see a contraction of approximately 0.8% of GDP relative to 2019 in case this hypothetical wave would only occur outside Kenya, and a GDP contraction of 3.8% in case a new set of lockdown measures would need to be imposed in Kenya as well. Employment levels would see a significant reduction of 19.1% while the government deficit would further expand.

This virus has also affected the health sector in various ways, for instance, the health sector has had to increase its spending and direct funding towards public sensitization and training of much medical personnel to deal with the pandemic. The government has also had to increase its fiscal spending to ensure hospitals are well equipped to deal with this pandemic and thus the fiscal deficit is more likely to increase given the current situation with numerous cases recorded per day.

Treatment and vaccine developments

The novel coronavirus has caused a rush in the medical sector. Scientists across the globe are in a rush to invent or discover a vaccine and cure that will save millions and Kenya is no exception. Carrying 31,015 positive coronavirus patients as of 19th August 2020, the pressure overlying our leaders and science geeks continues to intensify. However, even with the pressure, there seems to be a light at the end of this dark tunnel.

Swiss multinational Pharmaceutical giant, Roche made a medical development in discovering a vaccine, using Actemra. Actemra is a drug used in the treatment of moderate to severe rheumatoid arthritis. A medical trial was conducted in Italy where 126 patients were tried. However, the trial failed hence leaving the drug unapproved sending scientists back to the drawing board. Meanwhile, in Kenya, doctors and scientists still persisted to push the study.

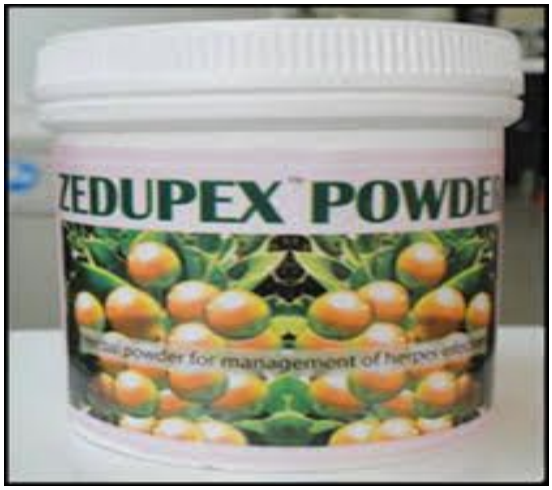
Launched in Aga Khan University Hospital, was a clinical trial using 11 COVID-19 patients. This is the first clinical drug trial testing the effectiveness of Actemra. The study was scheduled to terminate in October, where doctors will have collected sufficient data hence enabling them to make substantial conclusions that will change the course of their medical research. The study to identify the effectiveness of Tocilizumab (Actemra) within the early COVID-19 stages were dominant. There was a need to identify the role of the drug in reducing the risk of invasive mechanical ventilation and death in patients with severe cases.

Recent studies have also shown that administration of Tocilizumab, whether intravenously or subcutaneously, might reduce the risk of invasive mechanical ventilation or death in patients with severe cases of COVID-19 pneumonia.

Generally, as scientists are still on the look, doctors have opted to treat patients with supplemental oxygen, hydroxychloroquine, azithromycin, antiretrovirals and low molecular weight heparin. Use of hydroxychloroquine has also become a lead to finding a possible treatment course. Early studies show that hydroxychloroquine may be able to shorten the duration of symptoms experienced by infected people.

Worldwide, Solidarity trials have been conducted in over 400 hospitals in 35 countries in order to test the effectiveness of the drug. Contrary to expectation, trials were paused due to concerns on the efficacy of the drug.

According to Kenyan scientists and medical experts, a vaccine is the greatest chance to return to normalcy. The Kenya Medical Research Institute(KEMRI) is testing the efficiency of a herbal drug, Zedupex, which was developed in 2015, for the treatment of herpes. However, contrary to the RNA coronavirus, Zedupex is a DNA virus. This, therefore, brings about a conflict as its chances of being a suitable vaccine start to fade. Additionally, Zedupex is only effective in the early stages, leaving scientists wondering, “What next?”



Additionally, being a herbal drug, most scientists and ethnobiologist are quite concerned. Dr Kefa Bosire, an ethnobiologist, says that mass production of the herbal cure could be an issue. This is due to the presence of a high number of infected and possible insufficient supply of the

drug. Moreover, Rudi Eggers in the World Health Organization says that there is a need to identify the working compound, which is a challenge.

Conclusion

COVID - 19 has affected the whole world, economically, socially, politically and culturally and Kenya is no exception. As seen above the paper provides an analysis of the pandemic's epidemiology in Kenya. By writing this research paper we hope to shed more light on the pandemic and its effects in Kenya.

The sections handled in the paper include infections and fatality Rates, hospital resource use and future models, mitigation efforts, economic impact and treatment and vaccine development as discussed above.

Faced by the pandemic, thorough research was carried out in order to determine the best way to combat this disease. This research focused on the trends followed by the virus based on age, co-morbidities and even climatic conditions of the area. Following this research, the Government of Kenya has been able to predict the course the virus will take and in turn plan to control it.

At the onset of COVID - 19, Kenya was in no shape, economically, to face a pandemic. With barely enough resources to handle pre-existing health issues, adding a pandemic to our list of troubles was not beneficial for anyone. Nevertheless, we were able to make do with the resources that were available to us and have somewhat been able to control the spread of the pandemic in the country. However, there is a need for more preparedness and better steps of action. For this, Kenya has been looking at mathematical models for mapping out and tracing of disease for future use. These models can only be applied if the country manages its corruption otherwise proving to be redundant.

Having the best interests of the nation, the president in collaboration with the National Emergency Response Committee established prevention and mitigation measures such as dusk to dawn curfew, a ban on public gatherings and a countrywide lockdown. These measures were very strict at the beginning because the number of COVID-19 cases was rising dramatically. The Ministry of Health advised Kenyans to wear masks while in public spaces, wash hands with soap and water and to stay at home unless on essential businesses. However, as the year progressed the president became lenient and reduced the severity of the mitigation measures. As a result, the lockdown was lifted, people were allowed to travel as long as they put on masks and sanitised themselves.

COVID-19 came about abruptly and has had a drastic effect on Kenya's economy. Unfortunately, most of these impacts have been negative. Since the first case was reported the government has implemented many safety measures to deal with this pandemic and without a doubt these measures have affected the Kenyan economy in one way or another. For instance: the agricultural sector has been impacted negatively due to the limited flights in and out of the country and there has also been a decline in the foreign exchange market. As a result of all these various impacts, Kenyans are advised to brace themselves for worse. This is because the number of COVID-19 cases is continuously rising by the day.

Having had first-hand experience in the manufacture of cures and vaccines, experts medical research teams and scientists continue to put in their best effort to ensure success. They are embarking on a tough and long journey through numerous theories and trials in the search for hope through these dark and uncertain times. However, it is necessary to understand that such processes take time due to testing and analysis. A cure or vaccine will not show up out of the blue and it is important to take care of ourselves now as the saying says, better safe than sorry.

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