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Medical Anthropology, Artificial Intelligence and Gain of fUnction Research pErspective in the Management of Covid-19 pandemic in Sub-Saharan Africa.

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Abstract

Many schools of thoughts from different disciplines, including anthropology, recognize a new era of dynamics related to human impact on the planet. The new terminology called “Anthropocene” reminds us that our species has been responsible for increased carbon emissions, global warming, continuous destruction of habitat and vegetation and the direct elimination of the biomass of vast cocktail of rich diversity of fauna and flora linked to climatic oscillation. As of April 2020, the global situation of the world appears to be something alien and beyond human imagination. The COVID-19 pandemic has completely changed the global human population with impact so hard than the human race has ever witnessed. The severe acute respiratory syndrome (SARSCOV-2) the causal pathogen for COVID-19 has not overpowered the human race. However, there is certainly the shift in paradigm in health pandemic disaster global management. The term “Coronacene” might well be as worthy of attention as the “Anthropocene.” This review paper attempts to give an overview of the medical anthropology, artificial intelligence and the gain of function research perspective and the contribution in the management of COVID-19 pandemic in sub-Saharan Africa

Keywords:medical anthropology, coronacene, Anthropocene, artificial intelligence, COVID-19 pandemic, gain of function research.

Introduction

It can be difficult to predict the future in the current pandemic arena of COVID-19, embedded with lots of health uncertainties. On humanistic and community settings anthropologists are at the forefront to ponder about possible future directions and the sporadic dynamic variation in pandemic signals globally [1]. Anthropologists try to find answers to questions like ‘will populism fade as the need for strong governmental infrastructure becomes more evident? Will scientific evidence and expert knowledge return to a place of authority in some countries where it has been neglected? Will nationalistic xenophobia lose its appeal in the face of a virus that respects no borders and necessitate a global spontaneous action? Will the dichotomy in populations revealing different and worse consequences from the epidemic along lines of ethnicity, tribalism, gender inequality, racialization or age compel countries to address the profound causes of such inequities? Or will voices newly expressing a version of social Darwinism win the day? [2-5].

With these uncertainties and anthropologic questions, it has evident that anthropologists are actors to make significant and valuable contributions to explain some crucial myriads of intertwined biological and social complexities of COVID-19 [6]. The COVID-19 has presented such a situation in the human body and the natural ecosystem which adversely affect physical, mental, and the social cultural wellbeing of the community and the entire population within a given setting at particular time [7]. This situation presents an imbalance relation between host-pathogen and environmental integration of the disease triangle [8].

People will like to do anything to remain alive as easily as possible within their ecological environment. The lifestyle of people and their activities are directly related to their bodily health [2, 9]. Only physically fit and healthy individuals can actively participate in any daily life activities and meet up with their normal work cycle. Disease is a health condition that seriously in a negative cause affects our physical, social, and mental conditions [3, 10]. On one hand, people suffering from COVID 19 are unable to do their daily activities and on the other hand, family members need to spend their time for the treatment of the diseased person. In this situation time, money and knowledge are invested to make the sick person healthy. According to WHO report, health is a state of absolute physical, mental, and social well-being and not solely the absence of disease or illness [2, 11].

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COVID 19 situational Overview in Cameroon.

There are mainly two types of disease, noncommunicable and communicable disease, among them COVID-19 is a communicable disease. The causative agent of COVID-19 was named as novel coronavirus by WHO on 30 January 2020. In the context of low medium income countries (LMIC), the first case of coronavirus was detected in Cameroon on 23 January 2020 in a patient who had returned from France. Immediately after the first case was detected, the government of Cameroon started working on minimizing the spread and impact of the disease by disseminating information via public broadcasts, including caller tunes on cell phones, training the frontline health care workers, and started a domestic testing system by establishing testing laboratories. Though, many testing centres had been put in place, the infection had spread rapidly at an alarming rate. It affected all the regions of Cameroon [12]. The global statistics of COVID-19 was captured and in USA, Europe as indicated in table 1. For LMICs it is difficult to capture the global statistics for reasons that can be explained. However, the statistics for Cameroon as a developing nation has been captured to indicate that data in LMIC can be obtained by individual countries but pooling together in the entire region has been very difficult for the following reasons.

Populations are typically younger in LMICs so, providing good access to care, the risk of an infection leading to mortality is lower. Considering the risk of severe disease and death by age as observed in China and Europe and the country-specific demography to calibrate our model it is observed that, for example, in low-income countries our estimated infection-fatality ratio (IFR) is typically around 2-3 deaths per 1000 infections, in contrast to the 6-10 deaths per 1000 infections observed in high-income countries with older populations.

Not all COVID-19 infections are reported and as. The global testing capacity has improved substantially but both the percentage of cases that are detected and the proportion of infections that are symptomatic is likely to be highly variable by country and over time.

Table1: Global Statistics forCOVID-19 in March 2021

DISTRIBUTION	Positive cases	Recovered/ Million	Death/ Million	% Death
World wide	125.000.000	70.900.000	2.750.000	0.02
USA	30.000.000	-	545.000	0.02
EU/EEA	25.220.376	-	592929	0.02
Cameroon	40.622	35.261	601	0.01
LMIC	NA	NA	NA	NA

The availability of healthcare varies by country. It is estimated that the availability of hospital beds and intensive care units within each country using a range of publicly available datasets are typically lower in lower-income countries. As epidemics begin to exceed these thresholds in some countries the estimate of the risk of mortality upon infection continue to increase [13].

Control measures previously and currently being implemented using data on the implementation of interventions and patterns of mobility, some estimates have captured the extent to which, on average, LMICs reacted at much earlier stages in their epidemics than their HIC counterparts.

Transmission is different in different countries with the dynamics of transmission and reports on new variants globally, the data needs to be pooled together and reported, so that the scientific community understand the dynamics and educate the population on management strategies [14]

Other neglected factors for consideration;

Local factors are important. An attempt to provide a framework in which to understand how trends observed within a country relates to the global context of the COVID-19 pandemic whatever the base and local knowledge can provide a much more refined understanding (e.g. the age and vulnerability profile of observed mortalities [15]).

COVID-19 pandemics are likely to show variation at a much smaller geographical and environment scale than at the country-level. There can be sporadic sub-national variabilities in all data sources that are difficult to capture. It is difficult to capture open-non-source define data source although network collaboration can facilitate' squire' package that can be used to provide custom calibrations for countries with sub-national inputs) [15].

Deaths can also be under-reported. COVID 19 cases reports are updated daily using the latest publicly available data on COVID-19 deaths from the Centre for Disease Prevention and Control. If deaths are being under-estimated this will have an onwards impact on our estimates of healthcare demand. There is need for human and technical resources on the ground to capture broad spectrum data in the population and enclaved communities. [16].

Most scenarios only involve estimates of the direct impact of the virus. Most estimates do not include the indirect effect of the virus upon a health system (e.g. excess deaths due to reduced availability of other health services). They do not also incorporate the wider social and economic implications of the virus or control strategies of the disease management [4, 17].

COVID 19 impact on cultural and Ecological equilibrium

At the cultural front, the ecological equilibrium is conditioned by the accumulation of knowledge dealing with the relations between man's interaction with his environment. It incorporates knowledge in addressing basic needs of life such as how to secure water, food, and protection from extreme climatic conditions, dangerous animals, and the possible source of disease and illness, poisonous plants, contaminated food, and water by microorganisms [11, 18]. Theories that deal with health and illness, explain and discuss the ideas people use in maintaining a healthy lifestyle and why they can become ill [19]. Ideas about disease/illness causality may incorporate such ideas as a breach of taboo, stigmatization, tribal conflicts, soul loss, germs, or weakening of the immune system [20]. Anthropologists frequently divide theories of illness into two broad categories: personalistic and naturalistic. COVID-19 is a disease caused by pathogens (microorganisms), which directly affects the immune system within the respiratory tract and lungs

of the people [2, 7, 21]. Naturalistic theories of disease causation tend to view feeling fit and healthy state of harmony between a human being and their environment, when this balance is upset, the disease/illness will result [16]. It is reported that, the transmission of coronavirus rate is higher in urban areas than rural areas in the context of LMIC as well as around the world, due to the imbalance between activities of people and their environment. Traditional medicine, also known as alternative and complimentary medicine is part of the culture of closeness to method treatment of illness in LMIC and the population depends heavily on herbs and traditional medicine practice to rollback their illnesses and with the COVID 19 pandemic [22].

Socio-Cultural Impact

People, the socio-cultural living being has had far-reaching consequences beyond the spread of the disease COVID-19 shows political, cultural, and social implications in the life of people of the globe.

Cultural Activities

Culture is such an important domain that holds the identity of the people within their community and acts as an adaptive function within their local environment. It binds all the members within and between the community in an adhesive and cohesive manner. It is the central foci of people which bring solidarity with the development of knowledge on both material and nonmaterial objects and established ideology, rules, norms, values, customs, religion, and belief with long trial and error test method to adapt within their ecological environment [4, 23]. At the moment, due to COVID-19, all the cultural activities has been severely affected and people are demotivated all around the world. In terms of cultural values, the UN (23, April 2020), declared that the pandemic was forcing us to do self-reflection. However, needs to remain at the top since it helps cities to be stronger in their position of identity [24]. There is a need to capitalize on culture with a cross-cutting approach as an essential element for the recovery, considering communities' needs and local demands.

Political and Economic Impact

This issue has to be highlighted due to the fact that coronavirus has made many poor communities in sub-Saharan Africa undergo very challenging socio-economic and livelihood consequences. This situation directly affects sovereignty because of the potential erosion of political and economic sovereignty that may affect some already poor indebted countries [11, 23]. The World Bank and Global Infrastructure Facility in 2020, refers to "the pandemic as "the Greater Financial Crisis", that will bring to the surface pent-up financial and dysfunction. National economics will suffer as a result, and their political sovereignty itself may be severely eroded" [24].

The COVID-19 situation has a great negative consequence on both developed and developing countries, especially in the areas of production, networks, reduction in agricultural activities, tourism, trade, and industries in the present capitalistic mode of the economy of the world [25]. The negative effect is also reflected in world peace conflict dynamics seems to have worsen [26] In the context of Africa, most communities are seeking for increased efforts from their government sectors to improve on their non-impact production activities. COVID-19 has led to a worsen economic condition of the people in Africa. There are millions of workers earning their livelihoods in sectors deemed most at risk in economic output caused by the effect of the coronavirus pandemic [2, 27]. Reports have shown that job risk in accommodation and food service, transport and wholesale storage sectors, construction have suffered major setbacks and personnel redundancy.

Most workers in the tourism sectors are directly affected due to no job protection and no income with the economic meltdown. Many families who depend on remittance from relations in developed countries are directly affected by the COVID-19 pandemic as foreign job have also been as lock down has caused people to stay at home and some have returned home after losing their jobs [28]. The situation clearly indicates the worsening economic condition of Africans caused by the COVID-19 pandemic. The rural population on the other hand have continued their agricultural activities in order to survive and feed those in the city, and as the rural exodus trends have reduced with no job opportunities in the city [29].

Educational Impact

Nearly all states throughout the globe temporarily closed educational institutions like schools and universities, in an attempt to reduce the cases of COVID-19 pandemic. The closure of educational institutions directly affected the educational system worldwide. In about 191 countries globally, this affected over 1.6 billion students [5, 30]. The shutdown of educational institutions, impacted not only students, teachers, and families but had a far-reaching economic and societal consequences on student debt, digital learning, food insecurity, and homelessness [9]. In addition, the access to childcare, health care, housing, internet, and social services was limited. The social impact has been more critical for disadvantaged children and their families, relating to intersperse learning, compromised nutrition, childcare problems, and resultant economic cost to families who could not work [16, 31].

In the context of Cameroon, the pandemic has had serious impacts on students learning and well-being, and has potentially widen the gaps between advantaged and disadvantaged children in their equitable access to quality education [32]. Due to the government decision of the lockdown, schools and universities in Cameroon were temporarily closed down for nearly six months. It can be estimated that nearly three million students were affected due to closures in response to the pandemic. Despite the governments' effort to institute e-learning system of education using the state television and google classrooms especially for private schools, very little part of the population has access to the internet, or regular power supply. An estimated 13% of schools in Cameroon were able to run online classes from the stand point of ICT infrastructure, access to internet, people capacity to manage internet, laptop or cellphone, as well as teacher's capacity and effectiveness of training, urban and rural areas as well as richer and poorer people [15, 33]

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Inequality and Domestic Violence

COVID-19 pandemic has led the community of people towards inequality. People from poor socioeconomic background, are more likely to contract coronavirus and die from it [32]. Poorer families are more likely to live in crowded housing and work in low-skill jobs, such as supermarkets, plantations, blue collar jobs, which are deemed essential during the crisis. These group of people lack access to health care, and majority have been laid off their jobs or given technical unemployment holidays [33]. When the gap between the haves and the have- not increases within the community/country, this can lead to conflict as the process of production and reproduction activities becomes very demanding [34]. The rate of inequality in the economy, education and other socio- cultural activities are rapidly increasing in sub-Saharan Africa and will take a long time to decrease the gap between different people and communities [13, 35].

Currently, lockdown is the most popular and applied strategy all over the world to manage corona virus infection. But this situation severely increases domestic violence directly or indirectly due to monetary insecurity, stress, and uncertainty, which has forced unanticipated changing behaviour at homes [36]. Gender-based domestic violence was already a growing problem in a country like Cameroon prior to COVID-19 pandemic. In terms of domestic violence about 35% of women in Cameroon had experienced violence at some point in their lives, with 25% of them more of physical violence experiences [36]. The physical abuse of girls and women has exacerbated within the quarantine period or physical distancing process in homes. On the other hand, collective responses about gender base violence have created even more obstacles on the path of gender equality and worsen pre-existing inequalities as well as multiple impacts on women's wellbeing [37], their sexual and reproductive health [9]. COVID-19 pandemic highly increased social norms and gender inequalities, economic and social stress with restricted movement, and social isolation.

Religious Impact

The COVID-19 pandemic has a severe impact on religious activities in various ways, including the cancellation of the worship service of various faiths. Religious activities is a phenomenon in sub-Saharan Africa, with an increasing population of very religious extremist. To restrict people to stay at home and not attending church services or the mosques was not a popular measure by the government. There was a strong resistance and some Christian communities need total sealing of their church premises by the state to force respect of the distancing measures. Most people had to spend their life inside their homes during the government lockdown measures [38]. They were restricted and controlled to observe, celebrate, and participate in their religious work. This situation led to frustration, less interest in daily activities. Many temples, churches, mosques have members who have not be accustomed to the practices to offer worship through Livestream amidst the pandemic. Many ritual rites, ceremonies, and festivals also faded away.

Psychological Impact

Psychologically people of all ages are in fear and more depressed than normal with the advent of COVID-19 pandemic. Every person is afraid of each other and suspects others to be infected. Similarly, due to doubts that pets or other livestock may pass this coronavirus to humans, many people are more unwilling to keep their pets afraid of the virual transmission [39]. In this situation, the mental health of people has remained an important issue and most psychologists accept that there has been an intense feeling of depression after this, especially as we are dealing with the aftermaths of the economic meltdown. People's feelings have been exacerbated to the extremes at the moment, especially due to the uncertainty of what is going to happen. People worrying about their financial condition is one of the main challenges during the lockdown. Some couples have tension at home as they cope with the new life style of staying at home instead of the late night home coming. They were accustomed to staying away from their family in drinking joints till late when they return home [40].

Risk Perception and Suicide

When the mind of people focuses on the opposite effect on the more immediate threat of the pandemic rather than others, risk perception appears to cross it. The result of the risk may be positive or negative. In the current dispensation of COVID-19, the situation to take risks against pandemic becomes negative and lead to death [6, 41]. Suicide which is an unpleasant situation generally occurs because of mental illness, physical/ sexual abuse, losses, aggressive behaviour, lack of social support/ social isolation, and poor coping skills. WHO reports that cause of the huge public mental health impact has been in the form of stress and impatience, and foretell a revolt in depression, suicide, and substance of abuse use during this period of COVID 19 pandemic [42]. So far, the global community are suffering from the world of great uncertainty and this encourages a type of suicide as individual feel isolated from society and does not receive moral guidance needed to operate in their social environment [43]. In this situation, more people who feel hopeless and has no control of their lives would be more likely to commit suicide.

Coping Strategy

COVID-19 the viral communicable disease has infected hundreds of millions of people and more death caused by it. If the present trends of infection continue to increase, it will kill many more people in the world. The symptoms of this disease are different for different people and different places [44]. It depends on the physiology of people and their immune responses. There are now vaccines developed to eradicate the virus. In each epidemic and pandemic, the disease caused by the virus is suppressed by using developed vaccines [3, 45]. In this context, traditional knowledge to use plants as medicine also appears ahead according to their indigenous as well as acquired knowledge by people in different parts of the world. In sub-Saharan Africa they use different medicinal plants and their parts based on their ecological environment and knowledge to manage COVID-19 pandemic. There has been a lot of controversies for the traditional knowledge and practices of traditional medicine at this time of COVID-19. WHO has stepped in and many countries trying to create platforms to accompany

traditional medicine application in the management of COVID-19 [45]. In this mysterious situation about the nature of the disease WHO prefers individual health care as in sanitation, and food taking behaviour [24, 46]. It is better to focus on personal safety (as oneself, family, and community), complete social responsibility, and develop skills to adjust within our own local environment. To control and manage this COVID-19 pandemic there are travel restriction, testing, tracing, tracking, treatment. Most of the researchers in different countries are striving to develop vaccine by following six steps of research-identify and sequence the virus, determine the target, conduct preclinical trials, clinical trials, obtain regulatory approval, manufacture and distribution [12, 47]. In all these initiative and movement of research African countries have not aligned on track. They are depending on the therapeutic solution to come from the western nations.

Food sector

The food sector, including food distribution and retailing, has been put under challenge as a result of people panic-buying and stockpiling food [48]. This has led to an increased concern about shortages of food products. Panic buying especially during the early days of the pandemic resulted in an increase of food supply in homes [48]]. This high demand on food products also affected online food delivery. Companies struggled with excessive bookings, with deliveries arriving late or not at all only in well-organized cities in Africa [49] In countries with no such delivery services and poor internet services, most of the population were cut off from food supply. Moreover, food banks do not exist in most countries in sub-Saharan Africa and where they do exist, they were affected by panic-buying and food stockpiling as donations reduced. The concerns of food running out of supply also meant that vulnerable populations who cannot afford to stockpile, may not find food [3, 50]. In response to these concerns, some government has made efforts to provide certain populations with food parcels and free meals to collect and take home. These populations include high-risk vulnerable individuals such as the elderly who have no support network, and school children of low-income families [51-53].]. In addition, despite reassurance by the government, stores have made drastic changes by restricting the amount of each product that an individual can buy. Although supermarkets have seen a huge demand on food products, restaurants and cafes have been forced to close or slow down activities. As a result, many of these stores are at risk of permanent closure and many of their employees have lost their jobs [54]. The impact of COVID-19 on the food industry has forced food merchants to change in some cases their business model, with some restaurants for example completely closed down, and some turn into shops that sell refrigerated ready -meal [55]

Agriculture

The resilience of the agricultural sector has been tested by the COVID-19 outbreak. A global crash in demand from hotels and restaurants has seen prices of agricultural commodities drop by 20% [7, 56]. Countries around the world have imposed a number of protective measures to contain the exponentially increasing spread. This includes social distancing, avoiding unnecessary travel, and a ban on congregations. The advice on self-isolation upon contact with suspected carriers of the virus is likely to impact the number of available inspectors and delivery staff critical to ensuring verification and transportation of agricultural products. This will have serious implications for perishable foods such as meat and vegetables. In addition, markets have gone a step further by shutting down floor trading which has impacted the ability to exchange commodities. With restriction barrier measures less people are in intensive farming activities. In Cameroon for example farmers had to abandon their farms in fallow for months and this affected significantly the country that is agrarian in nature. Food crops, fruits perished in the bushes and increased hunger and short-term food inflation.

Pharma industries

Pharmaceutical industries have undergone major changes to the dynamics of healthcare in order to ensure a good lead to massive investment into disease prevention infrastructure, and the accelerated digital transformation of healthcare delivery [58, 59] It has been highlighted that there must be a change in healthcare policy and clinical management as new therapeutic research evidence emerges [60, 61]. While the rest of the world is making advances in developing new chemical entities for COVID-19, sub-Saharan Africa is still to mobilize a research and development platform of alignment for COVID-19 treatment/ management. In the US for example, active pharmaceutical ingredients are imported largely from India (18%) and the EU (26%), while China accounts for 13%. China is also the biggest exporter of medical devices to the US, accounting for 39.3% [62]. Production slow-downs and limitations in supply would inadvertently lead to revenue loss [62, 63]. In the UK also, AstraZeneca indicated that COVID-19 was likely to affect its 2020 revenue growth. On the other hand, opportunities for companies engaged in vaccine and drug development simultaneously emerged, with US-based companies including Johnson & Johnson, Vir Biotechnology, Novavax and NanoViricides announcing collaborative plans to develop a viral vaccine which is already developed and approved for use [64].

HOSPITALITY, TOURISM AND AVIATION

The hospitality and travel industry have perhaps been most hard hit, with hourly workers facing potentially devastating hardships. Hotels for international tourist have placed tens of thousands of workers on technical unemployment holidays or completely laid off [65]. Hotel industry revenue per available room fell in most cities, International Resorts also announced a temporary suspension in operation at its activity's properties, with casino operations closing down followed by hotel operations [66]. Since March 1, 2020, hotel occupancy in most African countries and the World over decreased by over 36% [67]. Most cities have been inadvertently affected with a current occupancy rate of 6%, even though in some developed countries like UK, the city of London remained the most stable with a hotel occupancy rate of approximately 47% [68, 69]. Overall, the COVID-19 crisis has led to international distortions for the hospitality industry, and significant slumps not only for African businesses but for the European hotel market [70]

The tourism sector is currently one of the hardest-hit by the outbreak of COVID-19, with impacts on both travel supply and

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demand [72] The World Travel and Tourism Council has warned that 50 million jobs in the global travel and tourism sector may be at risk [73]. In Europe, the European Tourism Manifesto alliance, made of over 50 European public and private organizations from the travel and tourism sector, highlighted the need to implement urgent measures to safe tourism [74]. These measures included temporary state aid for the tourism and travel sector from national governments as well as fast and easy access to short- and medium-term loans to overcome liquidity shortages, including funds made available by the EU through the Corona Response Investment Initiative, and fiscal relief [71, 75]. The alliance also called for the launch of the European Unemployment Reinsurance Scheme [72]. With the African tourist sector there is little or no coordinated alliance to support the survival of the industry. The tourist sector in a country like Cameroon came to a standstill during the lockdown period. Most hotels closed down and has not been able to get into business so far. The tourist business is not protected by the government or have secured insurance policy or access to bailout loan facilities. In other LMIC countries like Vietnam who received approximately 1.45 million Chinese visitors in the first quarter of 2019, dropping by 644,000 in January of 2020. It is estimated that Vietnam's tourist sector suffered a $5bn loss due to COVID-19 pandemic [76].

Aviation

The travel industry in the onset of COVID-19 had to grapple with an unprecedented wave of flight cancellations and a significant drop in demand amid strict government instructions to implement social distancing and the restriction of unnecessary travel. Globally, there has been a rising number of border closures globally. In the US for example, all foreign nationals from China, Iran and certain EU countries were barred from entering the country [77,78]. This ban included anyone who visited these countries within the 14 days prior to their US trip. The UK Foreign Office also advised UK nationals against all but essential international travel [79]. In Europe, the president of the EU commission proposed all non-essential travel from outside the EU to be suspended for 30 days. Travel suspensions was also implemented across Asia and Africa [80]. In light of these events, many Africa airlines for local and international flights suffered a major setback. For example Kenyan airways, and Pan African Airline and others reported a 30% decline in international passenger traffic [80, 81]. Ministers in the Netherlands reported implementing strategies to ensure the continued operation of Air France-KLM and Amsterdam's Schiphol airport, whilst the Italian Government took full control of ailing airline Alitalia.

Real estate and housing sector

The real estate industry has faced great uncertainty due to COVID-19 pandemic. At an individual level, social distancing precautions have reduced house views, a key part of the selling process, and both buyers and sellers are having to reconsider their plans. Increasingly, sellers are looking for reassurance regarding the health of potential buyers coming to view properties [84]. Some brokers are offering house tours via Skype and Zoom to minimize the risk of infection propagation. Brokers around the cities of African countries oblige potential buyers to preregister for viewings in order to gauge their level of interest and likelihood of purchase [85]. Additionally, thousands of workers around the world have been made redundant or have been placed on temporary unpaid leave of absence. Inevitably, this has had a significant impact on individuals' abilities to pay rent, mortgages and various household expenditures. In developed countries like in the UK some measures have been put in place to tackle this problem, part of the £350bn lifeline United Kingdom (UK) government released to allow mortgage lenders to offer a three-month mortgage holiday to those in financial difficulty [86]. In most African countries relieved mortgage packages are not in place [86. 87]. In most countries the government recommended that buyers and lenders delay negotiations of mortgages during the lockdown, bringing transactions to a halt [86].

Sports Industry.

In the Sports industry, COVID-19 has had a substantial impact on sporting schedules as some of the world's largest sporting events were seriously affected in 2020. Football's much anticipated African Nation cup was postponed for 12 months while play-offs were postponed till June 2020 at the earliest [89]. The international Olympic committee that was committed to staging the Tokyo 2020 Olympics in the summer of 2020, later made a decision to postpone the games to 2021, a decision that was supported by athletes and their respective nations [89–91]. Other sporting events like golf, tennis, athletics, basketball, rugby, cycling, boxing, fixtures all faced cancellations and delays in an attempt to curb the spread of disease. Inevitably this have had a significant financial burden, the gravity of which has yet to come to light [92].

INFORMATION TECHNOLOGY, MEDIA, RESEARCH & DEVELOPMENT

With the WHO raising COVD-19's status to a pandemic, 35 companies and academic institutions got into the race to develop an effective vaccine, with none featuring from sub-Saharan Africa. Many potential vaccines are currently in place [92]. The Coalition for Epidemic Preparedness Innovations (CEPI), led the various efforts to finance and coordinate COVID-19 vaccine development [93]. The funding was directed to a $4.4m partnership fund with Novavax and University of Oxford to develop a viable solution [92]. The Gates Foundation, Wellcome Trust, and Mastercard committed $125m to find new treatments for COVID-19 [93]. With the absence of Africa in the vaccine development initiative, no funding was allocated for research for Africa target vaccines. In addition, COVID-19 has left several hospitals in sub-Saharan

Africa in turmoil, having reached maximal capacity of hospitalized patients' occupancy. As a result, various countries turned towards technological solutions, to care for patients and at the same time, minimize the risk of person to person transmission [40, 94].

In various cities across Africa, there was lack of tele-response bots powered by fifth-generation wireless networks as was the case in some developing countries initiative like in China, utilized to allow health care staff to communicate with patients, monitor their health and deliver medical supplies [95]. Some developed

nations had Drones that delivered medication and work-from-home apps adopted. Unfortunately, most sub-Saharan African countries are deprived of these facilities and it poses a major challenge for the emergency intervention in COVID-19 management and regional coordination. The poor Automation of services in Africa which is a major goal for China and other advanced countries is also a drawback for health interventions [96]. The demand for respiratory ventilators has skyrocketed due to the outbreak of COVID-19. However, it is clear that the current supply across the developed countries like the United States and Europe does not meet demand. For sub-Saharan African countries, having supplies just for a start has been a challenge [97, 98]. It has been a big challenge for industry leaders to meet up with supplies as many of these companies do not produce medical equipment such as ventilators [98] In addition to this, production of ventilators requires strict regulation and testing to ensure their safety which can be a lengthy process

Application of artificial intelligence in COVID-19 disease management

Soon after the covid-19 pandemic was declared, the World Health Organization signaled that artificial intelligence (AI) could be an important technology to manage the crisis caused by the virus. AI, a core technology of the fourth industrial revolution, is an important non-medical intervention to overcome the current global health crisis, to build next-generation epidemic preparedness, and to move towards a resilient recovery [99]. While AI holds much promise it also raises serious questions concerning fairness, reliability, accountability, privacy, transparency, and safety. AI has gained popularity based on best practices and lessons learnt from using artificial intelligence during the covid-19 pandemic. In December 2019, coronavirus disease (COVID-19) broke out in Wuhan [99]. It was reported that this virus was first transmitted from animals to humans, and then spread rapidly in the humans [100]. According to the data reported by the WHO, as of 12:43 am GMT+8 on 9 January 2021, 86,749,940 people were infected worldwide and 1,890,342 people died [13, 45].

AI is being successfully used in this current pandemic in the identification of disease clusters, monitoring of cases, prediction of the future outbreaks, mortality risk, diagnosis of COVID-19, disease management by resource allocation, facilitating training, record maintenance and pattern recognition for studying the disease trend. Several applications of AI that are generating a lot of interest and raising hopes in the fight against COVID-19 are as follows:

AI in prediction & tracking

AI can be harnessed for forecasting the spread of virus and developing early warning systems by extracting information from social media platforms, calls and news sites and provide useful information about the vulnerable regions and for prediction of morbidity and mortality. Blue dot identified a cluster of pneumonia cases and predicted the outbreak and geographical location of the COVID-19 outbreak based on available data using machine learning. HealthMap collects the publicly available data on COVID-19 and makes it readily available to facilitate the effective tracking of its spread. Recently, the role of AI in identification and forecasting of COVID-19 outbreaks by employing multitudinal and multimodal data has been emphasized [101-102].

AI in contact tracing and monitoring

AI can increase mobile heath applications where smart devices like watches, mobile phones, cameras and range of wearable device can be employed for diagnosis, contact tracing and efficient monitoring in COVID-19. Applications like AI4COVID-19 that rely on audio recording samples of 2 s cough can be used in telemedicine [103]. In monitoring COVID-19 cases. AI techniques are being applied for monitoring patients in clinical settings and prediction of course of treatment. Based on the data derived from vital statistics and clinical parameters, AI may provide critical information for resource allocation and decision-making by prioritizing the need of ventilators and respiratory supports in the Intensive Care Unit [103]. AI can also be used for predicting the chances of recovery or mortality in COVID-19 and to provide daily updates, storage and trend analysis and charting the course of treatment.

AI in early diagnosis

AI has been used for the detection and quantification of COVID-19 cases from chest x-ray and CT scan images [104]]. Researchers have developed a deep learning model called COVID-19 detection neural network (COVNet), for differentiating between COVID-19 and community-acquired pneumonia based on visual 2D and 3D features extracted from volumetric chest CT scan [105]. Team of researchers have developed a novel deep learning model using Multi-Objective Differential Evolution and convolutional neural networks for COVID-19 diagnosis using a chest CT scan [105]. COVID-ResNet has laso been developed using automatic and discriminative learning rate and progressive image resizing that performed better than COVID-Net in diagnosing COVID-19 [106]. A system has been developed called COVID_MTNet by applying improved Inception Recurrent Residual Neural Network and NABLA-3 network models for detection and localization of regions of interests from both x-ray images and chest CT scan [107]. Another study used AI-based classifiers for predicting the outcome of RT-PCR results of COVID-19 cases using 16 simple parameters derived from complete blood profile [108]. This may find application in reducing the number of RT-PCR tests in resource-poor settings.

AI in reducing the burden from medical practitioners and healthcare staff

AI-based triage systems developed can assist in reducing the work burden of medical staff and healthcare workers by automating several processes such as imparting training to practitioners, determination of the mode of treatment and care by analyzing clinical data using the pattern recognition approaches, digitalization of patient's reports and also by offering solutions that minimize their contact with the patients [102]. AI can be used for classification of patients based on the severity of symptoms, genetic disposition and clinical reports in different categories like mild, moderate and severe, so that different approaches can be adopted for handling the patients in the most effective manner [109]. AI in telemedicine can also be

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used to eliminate the need of frequent and unnecessary hospital visits by distant monitoring of cases and recording of patient's data in asymptomatic cases or patients with mild symptoms. AI-based medical chatbots can also be used for consultations, thereby reducing the physical crowding of hospitals as well as the spread of infection and thus increasing the efficient operation of critical care services [104]. Chatbots like Clara from the Centre for Disease Control and Zini, are providing essential support to patients in remote settings [101]. A forecasting algorithm has predicted the mortality risk of patients by machine learning methods using extracted features derived from the data of other patients as training dataset [107]. A similar approach has been used to predict the possibility of developing acute respiratory distress syndrome. Service robots and anthropomorphic robots with AI core can be used for the delivery of essential services and routine tasks like cleaning, disinfecting and monitoring in hospital settings [106]].

AI in protein structure prediction

AI is applicable in predicting the structure of important proteins necessary for virus entry and replication and providing useful information that can support the drug development in a very short time. AlphaFold algorithm of Google Deep mind employed deep residual networks (DRN) called ResNets for predicting protein structures of membrane protein, protein 3a, nsp2, nsp4, nsp6 and papain-like C-terminal domain of SARS-CoV-2, which can give huge impetus to drug discovery programs [103-105]]. DeepTracer, a program based on customized deep convolutional neural network, has been used to derive protein complex structure of SARS-CoV-2 from high-resolution cryoelectron microscopy density maps and amino acid sequence [107]].

AI in development of therapeutics and vaccines

AI techniques improve and complement traditional technologies by reducing the time required in bringing a drug from discovery to the market by speeding up lead discovery, virtual screening and validation processes by a huge margin [33, 71]. AI can also enhance the acceleration process by deriving useful data for drug repurposing or drug repositioning through screening properties of already approved and validated drugs based on molecular descriptors and properties, which may not be possible for a human expert. Benevolent AI used machine learning methods to accelerate its drug discovery program and identified baricitinib as a potential drug against COVID-19 [109]. In silico Medicine has also identified several small molecules against COVID-19 using AI [13, 95]. Another study combined virtual screening and supervised learning to identify potential drugs against COVID-19 and some have adopted an integrative network-based systems pharmacological methodology for finding potential drugs for SARS-CoV-2 from the already existing repertoire of drug molecules and drug combinations [102]. Several other AI-based initiatives include inclProject IDentif.AI (identifying infectious disease combination therapy with artificial intelligence) [108], and PolypharmDB have been successful in identifying candidates against COVID-19. Many machine learning approaches and deep learning-based applications are now being used for making progress in the drug discovery process [108]. In the development of vaccine, AI is making a great contribution more than mankind has witnessed before in the race for the discovery of a vaccine against COVID-19 and has accelerated significantly by exploiting the power of AI. There has been possible prediction of vaccine candidates for COVID-19 using the Vaxign reverse vaccinology-machine learning platform that relied on supervised classification models [107]

PERSPECTIVE OF GAIN-OF-FUNCTION RESEARCH

Gain-of-function research refers to the serial passaging of microorganisms to increase their transmissibility, virulence, immunogenicity, and host tropism through the application of selective pressure to a culture [111]. This is performed in a research context to understand the way in which a pathogen can adapt to environmental pressures, making it possible for better planning of disease control measures, and potential vaccines and therapies to be explored. Gene editing technology such as CRISPR may be utilized in combination with selective serial passaging to investigate the role of specific genes on protein expression and ultimate organism function [111]. CRISPR technology, which is a simple yet powerful tool for editing genomes has allowed researchers to easily alter DNA sequences and modify gene function. Its many potential applications include correcting genetic defects, treating and preventing the spread of diseases and improving crops [111]

Applications of gain-of-function research

Gain-of-function studies are mostly applied in virology and have revealed many details regarding the biological mechanisms behind virus transmission and replication. The high replication and mutation rate of viruses commonly leads to escape mutants, lineages that have acquired changes to their genome that lessen or eliminate the affinity of natural or vaccine-induced antibodies towards the virus, while not notably lowering survival [112]. Most of the mutations a virus may acquire are deleterious to virus function, though in some cases mutation can both enhance virulence and allow better immune escape. For example, early studies regarding the E484K mutation of the spike protein of severe acute resSARS-CoV-2 suggest that affinity towards the ACE2 receptor, the target of the virus, is enhanced, while neutralization by serum antibodies sourced from patients having recovered from wild type SARS-CoV-2 are evaded more effectively [17, 85].

The FDA requires that animal testing be performed for vaccines before human trials can go ahead. However, as viral tropism towards the model species is unlikely to exist already, in cases where human viruses are under investigation, the strains that are able to infect the model species need to be generated. This can be achieved by using gain-of-function research where the virus is passaged through the animal, allowing molecular determinants of transmissibility to be identified, and vaccines under investigation to be tested [113].

Controversy surrounding gain-of-function research for COVID-19.

Reports by some group of researchers was published in 2012 to show Airborne Transmission of Influenza A/H5N1 Virus Between Ferrets. The group had genetically modified the A/

H5N1 virus by site-directed mutagenesis and serial passages in ferrets, creating a strain that was airborne transmissible in ferrets [114]. This demonstrated that it was possible for the avian influenza virus to become airborne and that the strain was sensitive to certain antiviral drugs, though raised many concerns regarding the ethics and safety of creating such a virus. The possibility of accidental or intentional malicious release of such a virus caused the USA administration under Barack Obama to halt funding for gain-of-function research relating to influenza, SARS, or MERS in 2014, though this decision has since been overturned [115].

The use of low-pathogenic strains for gain-of-function research, or specifically only performing loss of function research, where the function of genes is investigated by their removal, has been proposed due to the safety concerns associated with generating enhanced virulence pathogens. However, the kinetics of replication and tropism are not necessarily well replicated in low-pathogenic strains, while loss of function research alone often does not provide sufficient data. Farther removed alternatives such as single-protein or replication-incompetent virus in vitro studies, in silico modeling, or long-term genetic sequence comparison of samples collected from patients are under increasingly intense investigation to replace gain-of-function research.

The gain-of-function research can highlight possible mutations that may take place in currently known viruses and allow better community surveillance, identifying when such mutations arise and allowing vaccines to be prepared in advance of such an outbreak. However, the mutations a virus may acquire naturally are widely varied, and not guaranteed to present in the same way as those developed by serial passages in a laboratory. Similarly, the cost and time associated with vaccine development and storage means that preparatory stockpiling of vaccines is also unlikely to become a real benefit of gain-of-function research. Additionally, inter-tropic research such as the above-mentioned work on ferrets may not be applicable to viruses in humans as the way in which a mutation alters the interaction of a virus with its environment may differ between hosts. On the other hand, this type of research provided the only means of conclusively demonstrating the possibility that H5N1 had the capacity to transfer between mammals and become airborne.

The scientific community are unanimously calling for transparency and safety accreditation for any laboratories performing gain-of-function research on highly pathogenic organisms. This is particularly important with regards to public relations and opinion in the wake of the COVID-19 pandemic, where public mistrust of science has been thrust into the spotlight surrounding unfounded conspiracy theories concerning the origin of SARS-CoV-2. Regardless of the true origin of SARS-CoV-2, the pandemic has demonstrated that global infrastructure is largely unprepared for such an outbreak, and many scientists argue that gain-of-function research could have predicted and allowed the world to better prepare for the outbreak.

Conclusion

Coronavirus has increased fear among the world population which has directly affected all dimensions of people's socio-cultural activities. COVID-19 disease has directly affected the economy, education, cultural activities, religious activities, faith, and psychology of the people. It has enhanced the gap between rich and poor people, haves and the have- not, domestic violence, frustration, and suicide rates. It has weakened the bond between the people within the community reducing significantly the spirit of socio-cultural cross fertilization. In the current situation, there is the need to for us to focus on personal safety, complete social responsibility, and develop knowledge and skills both on indigenous and modern medicine to manage, cure and protect ourselves from the virus based on their ecological environment. Diseases like COVID-19 has not appeared in an alternate time and space to be used as a tool to grasp the power but the situation calls for total humanitarian action and unity on a global scale. With fears of a new recession and financial collapse, times like these call for resilient and strong leadership in healthcare, business, government and wider society. Immediate relief measures need to be stepped up, implemented and adjusted for African sub-Saharan African countries. A medium and long-term plan needs to be put in place to re-balance and re-energize the economy of sub-Saharan African states following this crisis. A broad socioeconomic development plan including sector by sector plans and an ecosystem that encourages entrepreneurship is also needed, so that those with robust and sustainable business models can flourish. It is prudent that governments and financial institutions constantly re-assess and re-evaluate the state of their nation in order to ensure proper implementation of emergency action plans. Research capacity building in cutting edge technology like new generation sequencing, artificial intelligence and gain of function research should be encouraged in sub Saharan African countries to compete for research grant funding at global stage, even if it is through a North-South collaboration platform.

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