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When silence goes viral, Africa sneezes! A perspective on Africa’s subdued research response to COVID-19 and a call for local scientific evidence

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A B S T R A C T

By mid-September 2020, over 1.33 million confirmed COVID-19 cases and 32 thousand deaths had been reported in Africa. Global research on COVID-19 went ‘viral’ with a record 3487 research contributions comprising of 2062 journal papers and 1425 preprints published within the first three months following the outbreak of COVID-19. Surprisingly, the silence of the African research community has been unprecedented – contributing a paltry 0.6% (22 contributions), a figure nearly matched by Colombia (18 publications). Until now, a comprehensive perspective on the reasons for this subdued research response, and COVID-19 themes critical to Africa has been missing. We posit that while a milieu of factors accounts for this silence, unprecedented research opportunities exist to support COVID-19 decision and policy formulation in Africa. The subdued response reflects weak research systems, characterized by deep-rooted challenges, including severe lack of research expertise, funding, and infrastructure, coupled with poor working conditions. Hence, Africa’s contribution to research on infectious diseases, including COVID-19, remains weak. Perceptions and attitudes among researchers and policy-makers on COVID-19, and the role of science in decision and policy-making also exist. Moreover, COVID-19 and earlier severe acute respiratory syndromes are considered as ‘imported diseases’ originating from outside Africa. Thus, notions may exist that the control methods will come from outside Africa through ‘technology-transfer’ or ‘capacity-building’. Yet local COVID-19 research is needed to address knowledge gaps, including; (1) potential novel transmission of SARS-CoV-2, (2) adaption of generic COVID-19 control measures to suit African settings, (3) occurrence and persistence of SARS-CoV-2 in solid waste, wastewaters, on-site sanitation systems, and drinking water, and (4) the ‘human factor’ including the role of gender, perceptions, myths, attitudes, and religious beliefs in the transmission and control of COVID-19. Therefore, there is a need to: (1) strengthen local research capacity and evaluation systems, (2) consider biosafety and ethical issues, (3) initiate cross-disciplinary research and global collaboration on COVID-19, and (4) integrate science communication in COVID-19 programs.

1. Introduction

The human coronavirus disease 2019 (COVID-19) first reported in Wuhan (China) towards the end of 2019, has evolved into a pandemic. At the time of writing (September 2020), COVID-19 cases have been reported in all the regions in Africa, including West Africa, East Africa, Central Africa, southern Africa, and North Africa (Africa CDC, 2020). Unlike selected developed countries in Europe where COVID-19 is slowing down, the pandemic curve in Africa continues on an upward trend. COVID-19 and its impacts transcend various facets of society, including business, international travel, public health, national security, food systems, livelihoods, information systems, governance, and democracy, among others. Due to chronic poverty, weak healthcare and social security systems coupled with a severe shortage of diagnostic equipment for mass clinical surveillance, Africa lacks the capacity to cope with mass outbreaks of COVID-19. Furthermore, contrary to the developed countries, Africa has unique and strong socio-cultural norms and practices, including gender disparities, religious practices, perceptions and myths, which could promote the transmission of COVID-19, and counteract current control measures.

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In other developing regions, such as South America, professional societies have also added their voice to the discourse on COVID-19 (Fiesco-Sepúlveda and Serrano-Bermúdez, 2020). This trend is even more evident in developed countries, where even country-specific studies exist (Pung et al., 2020). For example, in the UK, the Food Standards Agency published a review of the risks of food contamination with SARS-CoV-2 and the potential human health risks (Oakenfull and Wilson, 2020). One would also expect similar actions in the field of COVID-19 from the African countries and their associated university systems, including medical schools and professional medical bodies. Such professional bodies may include those specializing in public health and medical sciences (e.g., infectious diseases, respiratory diseases), civil and environmental engineering (e.g., water and wastewater engineers), commerce, and social and behavioral sciences, among others. Yet like their counterparts in the research community, African professional societies have largely remained silent. This is highly unexpected and disturbing, given the extent and magnitude of the health risks and potential knock-on effects of COVID-19 on African society.

The outbreak of COVID-19 nearly half a year ago witnessed an unprecedented research response in the history of research into human infections. As Nowakowska et al. (2020) highlighted in a bibliometric review, research on COVID-19 went ‘viral’ within the first three months of the outbreak covering the period January to March 2020. However, compared to other regions, including developing ones, the contribution of Africa to global research on COVID-19 has been very limited (Fig. 1). For example, results by Nowakowska et al. (2020) showed that authors affiliated with African scientific institutions contributed a paltry 0.5% of the total global research outputs, equivalent to 22 out of 3487 contributions. The lack of significant research on COVID-19 in Africa should be of great concern to the scientific community, the public, practitioners, decision and policy-makers, and local and international agencies to these issues. The objectives are as follows: (1) to discuss the unprecedented lack of research on COVID-19 in Africa and its implications, (2) to discuss the importance of African research on COVID-19, and (3) to highlight the critical research themes. Finally, the present perspective seeks to stimulate discussion and promote cross-disciplinary African research on COVID-19 and the need to allocate resources to support such studies.

2. Why is Africa’s research response to COVID-19 subdued?

2.1. Africa’s contribution to global research three months after the COVID-19 outbreak

COVID-19 continues to attract significant global research attention. As Nowakowska et al. (2020) pointed out, research on COVID-19 went ‘viral’ within the first three months of the outbreak covering the period January to March 2020. During that period, 2062 articles were published in 578 journals and 1425 pre-prints were posted on the four most frequently used online servers. Collectively, this gives a total of 3487 scientific contributions from 73 countries, corresponding to more than 1000 contributions per month, and nearly 48 papers for each of the 73 contributing countries, with China contributing the highest number of original papers (Fig. 1). The significant contribution of Chinese researchers is understandable and expected, given that the country served as the first COVID-19 epicenter before it spread to other south-east Asian countries, Oceania, Europe, North America, Latin America, and the Caribbean region, and then Africa. A high contribution was also seen from North America and European countries, particularly the United Kingdom, Italy, and Germany.

A closer examination of the results of Nowakowska et al. (2020) revealed interesting research trends in Africa. Africa contributed only 0.6% of the total global research output, equivalent to 22 contributions (Fig. 2). This is about three times lower than that of South America (1.7%), another developing region, which had the second-lowest

![Fig. 1. The contribution of Africa to the global research on SARS-CoV-2 (2019-nCoV) and COVID-19 published in English language during the three-month period (January and March, 2020). Based on Nowakowska et al. (2020).](image.png)
contributions. During the 3-month period, Africa published 22 scientific items in English language journals, comprising 13 articles and nine pre-prints (Fig. 2). The identified articles consist of 9 comments, three reviews and one perspective paper, thus the lack of original research manuscripts is apparent. The articles were limited to the following subjects: (1) epidemiology (69.2%), (2) prevention measures (23.1%), and (3) discrimination/politics (7.7%). The first two papers with corresponding authors affiliated in Africa were published on February 27, 2020. For comparison, the first peer-reviewed papers on COVID-19 were made available on January 14, 2020, while the first articles by Colombian authors began to emerge from February 8, 2020. The nine pre-prints published in the first 3-months of the outbreak constituted seven contributions that can be classified as original research as well as two reviews. Their subject matter was centered around three thematic topics: (1) epidemiology and mathematical modeling (44.4%), (2) treatment possibilities (33.4%) and bioinformatics (22.2%) (Fig. 3). The first pre-prints from African authors began to emerge as late as March 2, 2020—44 days after Chinese authors posted the first such item on the bioRxiv server.

Africa’s contributions were limited to just nine out of the 56 African countries (Fig. 4). South Africa, with five articles and three pre-prints, dominated the research contributions, followed by Nigeria with three articles and four pre-prints (Fig. 2). Collectively, South Africa and Nigeria accounted for 68% of the total contributions, corresponding to 36% (South Africa) and 32% (Nigeria) (Fig. 4). The remaining 32% was shared among Ethiopia, Mauritius, Tanzania, Uganda and Zambia which contributed one article each, while Senegal and Sudan contributed one pre-print each. These contributions were limited to just 9 out of 56 African countries, while no contributions were evident from the remaining 47 countries. The dominance of South Africa and Nigeria is not surprising. The analysis of citable research outputs from SCImago, covering the period 1996 to 2018, also showed that South Africa and Nigeria are ranked first and second, respectively. According to the Global Innovation Index (GII, 2019), South Africa is considered the most technologically advanced country in Africa, whereas Nigeria is making consistent progress in research productivity, particularly in life and health sciences (Odeyemi et al., 2019).

The collective contribution of the 56 African countries is also far lower than that of low and middle-income countries (Fig. 2). Specifically, Africa’s total of 22 contributions is nearly matched by that of Colombia (18 contributions), a single non-English speaking country.
from another developing region (Fig. 2). Furthermore, among the journal articles and preprints prepared by the authors affiliated with Colombian institutions, 50.0% were review papers, 27.9% were commentaries, 11.1% were meta-analyses, while original research and case reports constituted 5.6% each. This clearly demonstrates that in a developing region with limited financial and equipment resources there was still a capacity to contribute to the global COVID-19 research by providing comments, systematic reviews or meta-analyses – preparation of which does not require highly advanced research tools. Yet barring North Africa, and a few countries in West, Central and East Africa which speak French and Portuguese, the bulk of Africa uses English as the official language of communication. Moreover, Africa’s contribution is below that of Brazil and Iran with 50 and 30 contributions, respectively. One should note that contributions published in non-English languages such as French, Arabic and Portuguese were not included in the analysis. However, the bulk of indexed journals publishing scientific literature are in the English language (Ismail et al., 2009). The English language is also broadly considered as the international language of scientific research (King, 2004; Ismail et al., 2009). Hence, the bias introduced by the exclusion of non-English language publications could be negligible and less likely to change the trends evident in Fig. 1. Others may argue that African journals are not searchable via scholarly search engines, but there are very few journals published in Africa, while their quality of science and readership tends to be very poor. A significant fraction of African research is also published in predatory journals (Mouton and Valentine, 2017; Hedding, 2019; Tarkang and Bain, 2019), although the exact quantities are not known with certainty. Some estimates show that Africa and Asia account for 75% of the predatory journal authors (Shen and Bjork 2015). The question then arises, ‘Why is Africa’s contribution to global research on COVID-19 very limited, and even lower than that of other developing regions such as South America?’. This aspect has not been addressed in the existing literature on COVID-19. Here, a number of explanations are put forward to answer this pertinent question.

2.2. Africa’s research system and the COVID-19 research response as a nexus

2.2.1. The research system as an organizing framework

The quality and quantity of research that a region or nation generate is a reflection of the strength of the research system and the financial support it is receiving. In this context, the research system is conceptualized as consisting of the following: (1) scientists, including academics and students, (2) research infrastructure, including laboratories, equipment, and communication and information systems such as libraries, (3) the granting system or funders, and (4) evaluation systems, including the quality control/quality assurance, supportive policies, and incentives. Thus, the interactions among these various components or sub-systems control both the quality and quantity of research. This conceptualization is used as an organizing framework to discuss the potential reasons accounting for the subdued COVID-19 research in Africa. In fact, the limited African research on COVID-19 is not divorced from the generally low research output in other disciplines such as science, technology, engineering, and mathematics (STEM).

Here, we posit that Africa’s subdued research response to COVID-19 reflects a milieu of deep-seated problems that culminate in weak research systems. The lack of resources is often advanced as the most plausible reason to account for the limited research in Africa (Ngongalah et al., 2014; Bendada, 2019). While this is true to a certain extent, as discussed later, lack of resources alone cannot fully account for the limited research on COVID-19 in Africa. Note that, although the current discussion is limited to COVID-19, to a large extent, some of these reasons are generic, thus are also valid for other fields of research.

2.2.2. Unpacking the potential reasons behind Africa’s subdued research response

(1) Severe lack of competitive research funding

Despite several commitments and declarations made by African governments to fund research and technology development (Africa Union, 2014, 2020), the bulk of African countries lack a comprehensive research funding mechanism. Thus, barring South Africa, and probably a few countries in North Africa, the African countries lack competitive research grant systems. Estimates show that public funding of research accounts for a paltry 1% of the gross domestic product (GDP), averaging 0.38 in sub-Saharan Africa to about 0.61 in North Africa in 2017 (UNESCO, 2020). In 2017, South Africa had the highest research expenditure, equivalent to 0.88% of GDP. This low public support of research could be attributed to two factors: (1) limited budgets to support research due to low levels of economic development, and (2) limited importance placed on research by governments and policymakers as a fundable enterprise with the potential to generate goods and services. The issue of funding in Africa is more complex than just the limited availability of financial resources; it also includes a lack of proper financial accounting systems and transparency. This is because of rampant corruption and poor governance systems in Africa. Hence, the limited resources, as well as donations from the international community, are not used prudently and transparently. Thus, allegations of corruption and the abuse in-kind and financial resources, including donations meant for COVID-19, have been widely reported in the media in several African countries.

Due to a lack of sustainable research funding mechanisms, the bulk of the research in Africa is funded by external international agencies and governments who may even define the research focus and review and approve the research grants. Such funding mechanisms may not attract researchers to issues relevant to Africa, but to an agenda set by external agencies who may have their own ulterior motives for funding research. Recently, food security, climate change and its mitigation and HIV/AIDS have been trending as thematic research areas among the international funding agencies. While all of these areas are important, funding bias towards trending thematic topics could be detrimental to other emerging issues such as COVID-19. Thus, the lack of funding is probably considered as the most plausible reason accounting for the limited research in Africa.

Africa is one continent where research appears to receive very limited attention. Hence, policy and decision-makers rarely rely on scientific evidence or opinions in policy- and decision-making. Rather, policy and decision-making, including allocation of fiscal resources, seem to be motivated by political motives, including the drive to lure the electorate. Therefore, the allocation of scarce resources, including funding, equipment and personnel towards current mitigation measures takes precedence over the funding of research.

(2) Poor research infrastructure cannot support globally competitive research

Due to a lack of funding African countries have poor research infrastructure to conduct globally competitive research on COVID-19. Specifically, Africa lacks properly equipped research and teaching laboratories and communication and information facilities, including libraries and internet access. Access to literature, including recent subscription journals, is also very limited. Hence, researchers tend to rely on whatever free literature is available at their disposal. Advanced analytical methods and techniques such as RT-qPCR equipment critical for assaying for SARS-CoV-2 are not available at typical universities in Africa, including those offering postgraduate degree programs. Only a few universities may have access to these molecular tools and the capacity to operate them under appropriate biosafety measures. Where available, the equipment is often obsolete and uses archaic analytical
methods, including those with high detection limits or low sensitivity. Even in cases where such diagnostic instruments are available at universities with medical schools, under the current COVID-19 crisis, priority for the use of such equipment is likely to be given to clinical uses rather than research.

Analytical equipment, and laboratory supplies such as reagents are largely imported from developed countries, hence require foreign currency, which is often scarce. Several essential goods and services such as reliable water and power supplies, and internet connectivity, taken for granted in developed countries are not readily available at an affordable cost in Africa. Hence, barring South Africa, accredited laboratories with appropriate biosafety protocols and quality assurance and control systems are still very limited in Africa. Thus, given the poor research infrastructure, it is not surprising that Africa’s research on COVID-19 has remained subdued.

(3) Lack of capacity to attract and retain a critical mass of research expertise

Most African countries have marked low levels of economic development. Hence working conditions for essential research expertise are very poor. Accordingly, Africa lacks the capacity to attract and retain a critical mass of highly qualified and experienced scientists, technicians as well as postgraduate, postdoctoral and research fellows. As a result Africa experiences a significant “brain drain” across various research fields, and this is particularly apparent and severe in STEM, including medical or public health sciences. The drive to leave Africa is not only limited to experienced researchers and technicians but is equally very strong even among prospective undergraduate and postgraduate students. Hence, top-performing prospective undergraduates and postgraduates prioritize studying in developed countries rather than in Africa, in anticipation of living and working there afterwards. Moreover, the number of postgraduate research students (e.g., PhDs) and postdoctoral fellows at African universities is far smaller compared to a typical university in developed countries. Yet postgraduate research students and postdoctoral fellows are key in driving the research process, especially at universities. Moreover, because of low remuneration for teaching and research positions in Africa most experienced scientists often leave and take up administration positions. This creates a research vacuum often filled by early-career academics with MScs and PhDs. The official position in most African universities is that lecturers hold at least a Masters or PhD degree, and this is often a requirement for accreditation by regulatory authorities. However, in reality, due to a critical shortage of academics with MSc and PhD degrees in STEM, it is also not uncommon in Africa to have holders of a first degree BSc honors teaching a course at a university. To avoid damage to their reputation, and even deregistration of such degree programs, even in cases where this practice is prevalent, such universities will strongly refute such practices. In developed countries, such holders of first degree BSc honors often pursuing MSc or PhD degree programs will be employed as course teaching assistants responsible for the tutoring and grading of undergraduate students’ work under the close supervision of an experienced course coordinator/lecturer who will be a PhD holder. Early-career academics including holders of BSc honors and MSc degrees, and even recent PhD graduates have limited capacity to conduct and publish high-quality research on their own. Taken together, the critical mass of research expertise required to drive globally competitive research on COVID-19 and other thematic areas in STEM is missing in the majority of African countries.

(4) Poor working conditions account for the malaise and lack of motivation

With the exception of a few countries such as South Africa, most African academic institutions are characterized by poor working conditions including; (1) lack of supportive research policies and incentives, (2) very low remuneration, and (3) limited opportunities for career development and personal growth (Ahmed and Shifraw, 2019; Fussy, 2019). For example, anecdotal evidence shows that associate and full professors working full-time at some universities in the Southern African Development Community, a regional economic bloc consisting of 9 countries including South Africa earn an equivalent of less than USD 150 and USD 200 per month against a background of high inflation above 800% and the escalating cost of living. Although significant variations occur among countries, most African currencies are unstable against major international currencies such as the USD. Hence, besides being low in real USD terms, the salaries are highly fluctuating depending on the prevailing exchange rate. To draw a contrast with South Africa, reviewing a single master’s or PhD thesis from a South African university, which will take an estimated cumulative period of about two days, will earn an examiner between USD 250 andUSD 300, and as high as USD 900 per evaluated thesis. This is almost double or equivalent to a monthly salary of a lecturer or professor at a university in some other SADC countries. Therefore, it is not surprising that a significant brain drain in academic staff and scientists also occurs within Africa, with South Africa being the most preferred destination.

Due to poor working conditions, academics and researchers in most African countries undertake additional income-generating activities to supplement their low salaries. Based on the first author’s experience, it is not uncommon in African universities to find a lecturer/professor at a university doubling as a farmer, shop-owner, bar/restaurant owner, and even involved in cross-border trading. For example, in the faculties of law and medicine, lecturers and professors also operate private law practices and surgeries, respectively, and this appears normal in most African countries. In some cases, one lecturer may teach at more than three separate universities to raise additional income. The teaching loads at most African universities are also extremely high, and are probably among the highest in the world (Sawyerr, 2004), leaving very limited time for research. Given the demand and pressure from simultaneously balancing running private enterprises, university work, personal/family life, and heavy teaching loads, it is, therefore, not surprising that the research suffers. Anecdotal evidence also shows that, barring research conducted to earn qualifications, tenure, and promotion, very few researchers feel motivated to conduct and publish research. This is particularly the case when one is tenured or promoted to the highest academic grade (i.e., full professor). Poor working conditions also mean that Africa, unlike other regions, fails to attract and retain top research talent in various fields. These issues need attention if Africa aspires to develop world-class research systems as often highlighted in regional and continental declarations, government blueprints, and political sloganeering manifestos.

(5) The ‘human factor’: Perceptions and attitudes among researchers and policy-makers

A potentially under-estimated factor accounting for the limited research on COVID-19 is the role of perceptions and attitudes among the research community and even funders, collectively termed the ‘human factor’. To illustrate this, we highlight a few human factor issues that could contribute to low research on COVID-19.

(i) COVID-19 as an ‘imported disease’ warrants an ‘imported solution’

As discussed elsewhere in this paper, barring North Africa, the bulk of the research community in Africa lacks prior art in research and experience in human coronaviruses. Moreover, the current COVID-19 and previous human coronaviruses such as severe acute respiratory syndrome (SARS) and Middle East Respiratory Syndrome (MERS) are reported to have originated in Asia and the Middle East, while none of them have had their origins traced to Africa. Therefore, COVID-19 could be regarded as an ‘imported disease’ among the African research
community. Hence, such a perception coupled with the lack of prior research experience in human coronaviruses, could persuade the African research community to adopt the view that the solution to COVID-19, similar to the current control measures, will come from elsewhere. The notion that solutions to COVID-19 will come from elsewhere outside Africa has been highlighted and discussed in detail in an earlier perspective (Gwenzi, 2020a). In that perspective the current generic COVID-19 control and guidelines developed in developed nations (CDC, NHS, NIH) and by international agencies (WHO, UNICEF) could be regarded by the African research community as ‘global best practices’ on COVID-19 that are beyond reproach (Gwenzi, 2020a). This is partly understandable given the weak research systems in Africa compared to those in developed regions such as Europe and North America. This view is further strengthened by Africa’s over-reliance on external solutions and assistance, a phenomenon reflected in the widespread use of terms such ‘technology transfer’ and ‘capacity-building’ (Danquah, 2018; Jacobus et al., 2011; Smith 2005), which are discussed in the following section.

(ii) ‘Technology transfer’ and ‘capacity-building’ as dominant notions in Africa

As highlighted in the context of other challenges, such as clean water provision in Africa (Chicgoua, 2019), the notion that solutions to Africa’s problems come from elsewhere is not new, but could be even stronger in the case of COVID. This notion has also been further promoted by international development agencies and non-governmental organizations. This is aptly captured in the use of terms such as ‘technology transfer’ and ‘capacity-building’, two buzzwords which are often invoked in the discourse on the development of Africa. These terms insinuate that African communities lack the capacity to proffer solutions to their local problems unless the technology is transferred from elsewhere through capacity building. Anecdotal evidence shows that the preferential tendency to always seek external and international help at the expense of local expertise is also evident and strong even at policy and government level in Africa, and has been referred to in earlier studies as the ‘donor dependency syndrome’ (Awadari, 2020; Genger, 2020; Tshishonga, 2020). This notion creates and promotes the tendency for Africa to ‘wait’ for external solutions.

The discussion here is by no means intended to suggest that Africa does not need international assistance in the form of funding and/or expertise. Rather, we propose that Africa should take the lead in initiating, prioritizing and even funding research on COVID-19 to suit its socio-economic settings while the international communities play a supportive role. This is particularly the case given that several research thematic areas relevant to Africa could be of less importance in developing countries. A typical example is the potential human exposure and health risks associated with the possible transmission of SARS-CoV-2 through fecal contamination of drinking water via raw wastewater discharges and on-site sanitation systems (Guerrero-Latorre et al., 2020; Gwenzi, 2020a, b). Moreover, the potential of food cross-contamination via the vector-mediated transmission of SARS-CoV-2 (e.g., by houseflies) from fecal matter to human food has been discussed in recent papers (Gwenzi, 2020a, b; Heller et al., 2020). Hence, the novel transmission of SARS-CoV-2 via the fecal-oral route requires further investigation, especially in Africa and other low-income countries. Accordingly, such research themes are likely to receive less attention in developed countries but could be critical in preventing further spread of COVID-19 in Africa. Thus, the African research community should take a leading role in the attempt to tackle such thematic topics in collaboration with regional, continental and global partners.

(6) Africa has limited prior art and research experience with human coronaviruses

Besides North Africa, the bulk of African countries, especially sub-Saharan Africa, have limited exposure and experience with earlier coronavirus-associated diseases: SARS and Middle East Respiratory Syndrome (MERS). Specifically, in Africa, outbreaks of MERS were limited to North Africa due to its close proximity to and strong links with the Arabian Peninsula and the Middle East (Bleibtreu et al., 2020; Memish et al., 2020). Therefore, no prior art exists with respect to research and expertise in severe respiratory infections caused by the betacoronaviruses. Moreover, even in the cases of other viral infections such as the Ebola virus in Central and West Africa (Feldmann et al., 2020) and recurrent water-borne infections such as cholera and typhoid (Ahmed et al., 2011), Africa still relies to some extent on expatriates and international experts. Others may also argue that, compared to other regions such as Europe, south-east Asia, South America, and the Caribbean region, significant COVID-19 outbreaks in Africa occurred relatively late. However, a survey of recent global scholarly databases still shows that even after experiencing significant COVID-19 outbreaks, little has changed in terms of Africa’s research output (Gwenzi, 2020a). Unlike previous coronavirus-related infections, the current COVID-19 took Africa and its research and professional societies by surprise, when they least expected it.

(7) COVID-19 biohazards and unprecedented restrictions posed by national lockdowns

(i) Biohazards and biosafety issues

The modes of transmission and high virulence of SARS-CoV-2 pose significant biohazards to the research community and their immediate families. Therefore, the highly infectious nature of COVID-19 coupled with international and local media reports of health care workers contracting COVID-19 could have acted as a deterrent to the African research community. Thus, researchers might have prioritized their safety and that of their family members. This could be particularly true given the poor occupational health and safety standards such as the lack of personal protective equipment (PPE), and poor health systems lacking effective emergency response equipment such as ventilators.

(ii) Mass lockdowns and COVID-19 as a ‘surprise’

Moreover, in most African countries the mass national lockdowns and curfews, which were often enforced by the police and military, create severe restrictions to research. Mass lockdowns and the associated curfews often exempt those in critical services such as the healthcare industry and the security sector. Therefore, the research community, which is not classified under critical services, was not exempted. Moreover, given the public health concerns about COVID-19, the institutional and national approvals required to conduct research on COVID-19 could be tedious and time-consuming. Others may also argue that COVID-19 took the African research and professional community by surprise when they were least prepared.

While these reasons could have contributed to some extent, they cannot fully address the following questions: (1) How did other developing regions such as South America overcome such challenges to the extent that even a single country like Colombia can almost match Africa’s research outputs within the first three months of the outbreak? and (2) How does the African research community account for the lack of scientific opinions, viewpoints, and scanning and horizon scoping reviews which can even be accomplished under lockdowns? In fact, Africa still relies on external experts to tackle cholera and the Ebola virus (Ahmed et al., 2011; Geogalakis, 2020; Halabi et al., 2020). For example, a study using social network analysis of the Sierra Leone Ebola epidemic showed that United Kingdom biomedical scientists dominated the response network while Africans were almost entirely absent (Geogalakis, 2020). Similar cases have been reported for cholera outbreaks in African countries such as Zimbabwe (Ahmed et al., 2011). Hence, it is apparent that Africa’s subdued response to COVID-19 is not an isolated case, rather, this trend
transcends several other human diseases and disciplines. This further points to the inherently weak research systems characterized by deeply rooted challenges.

In summary, Africa’s subdued research response to COVID-19 points to weak research systems entailing complex interactions of deep-seated problems. Here, we used a systems framework to illustrate that the current scenario is not likely to change unless concerted efforts are made by African governments and their partners to address these challenges. The intricate linkages among the various factors imply that a holistic rather than a reductionist approach is required to address these deep-rooted problems. Therefore, providing competitive research grants without a corresponding effect to improve working conditions to attract and retain research expertise will not achieve the desired research outputs. Thus, unless measures are taken to address these challenges the current trend of low research productivity evident in COVID-19 is likely to persist in other disciplines as well.

The fact that Africa has weak research systems and low research productivity, even in critical areas relevant to its development, has been the subject of several studies (Contraria and Wang, 2020; Nakanjako et al., 2017; Wohlfuter, 2019). The data on Africa’s research response to COVID-19 presented in Fig. 1 aptly mirrors this trend. This glaring fact could be met with revulsion among African researchers and politicians alike, but it is a sad reality which should serve as a wake-up call to Africa could be met with revulsion among African researchers and politicians alike. COVID-19 presented in Fig. 1 aptly mirrors this trend. This glaring fact could be met with revulsion among African researchers and politicians alike, but it is a sad reality which should serve as a wake-up call to Africa’s researchers. Moreover, research productivity and quality, and their evaluation are quite complex subjects that depend on several factors and their interactions (Korytkowski and Kulczycki, 2019; Petersen et al., 2019). Hence, no single reason can fully explain the limited research on COVID-19 in Africa. The lack of funding resources may also account for the lack of original research, but cannot be advanced as a valid reason for the lack of other research contributions such as expert opinions, commentaries, viewpoints and reviews. One should note that the majority (72.1%) of all the journal articles published on COVID-19 within the first three months of the outbreak were commentaries and review papers (Nowakowska et al., 2020).

The relative significance of the various potential reasons highlighted here may vary considerably among countries and even individual researchers. Moreover, research productivity and quality, and their evaluation are quite complex subjects that depend on several factors and their interactions (Korytkowski and Kulczycki, 2019; Petersen et al., 2019). Hence, no single reason can fully explain the limited research on COVID-19 in Africa. This calls for systematic studies to understand the research systems in Africa and the reasons that account for the low productivity. Such studies may also need to draw comparisons with other developing regions such as South America, the Caribbean and south-east Asia, which are performing relatively better than Africa.

(8) Lack of robust research evaluation, and quality assurance and quality control systems

Robust research evaluation, and quality assurance and quality control (QA/QC) systems benchmarked against global best practices are critical for the advancement of research (Baker, 2016; Michener, 2018). Yet research evaluation and QA/QC are highly contentious and emotive issues among universities and even scientists, including those in Africa. However, a number of QA/QC questions arise with respect to Africa’s research systems: (1) Are research-based honors, masters, and PhD degrees at typical African universities equivalent to those at typical universities in developing and developed regions with higher research outputs? (2) Are the academic and research profiles of lecturers and professors at typical African universities equivalent to their counterparts in developed countries? and (3) Do the examination of research-based degrees, and assessment of an application for promotion in typical African universities conform to global best practices and benchmarks? These questions are critical, given the essential role of scientific expertise in the research process. Apart from data on global ranking of universities showing that African universities are

lowly ranked internationally, limited quantitative evidence exists to directly answer these questions. A more direct way to address these questions is to conduct a systematic comparative study of African universities with their counterparts elsewhere. Predictably, the results of such studies could be considered potentially controversial and attract rebuttals and even rejection among African universities and countries. This is understandable given that university education is now a multi-billion dollar business in Africa, and is even a symbol or epitome of a country’s research and knowledge system. Hence, any research evidence that could potentially damage the standing and reputation of the country’s university education system could potentially face strong resistance. Thus, one may speculate that few African universities will knowingly volunteer to participate in such comparative studies. Yet, if done fairly and in a transparent manner, such comparative studies, and evidence drawn therefrom could enable African universities and their research systems to draw key lessons and benchmark themselves again the global best. In our view, the starting point, which is based on the summary evidence on COVID-19 highlighted here, is that Africa should acknowledge that its research systems are weak, and that there is a need to address the underlying challenges in order for significant improvements to occur. Due to a lack of direct evidence, some insights and inferential evidence could be gleaned from the current authors’ collective professional experiences in southern Africa versus Australia and Europe. First, although variations exist among countries and even among universities within one country, research-based degrees in Africa are less intensive and rigorous than in developed countries. Secondly, PhD degrees in developed countries are more research-intensive and rigorous, invariably requiring at least three papers or their manuscript equivalent with potential for publication in peer-reviewed journals in order for the thesis to be submitted for examination. By contrast, the emphasis on research outputs is less in Africa, and even if such requirements exist, the quality of journals tends to be low. Studies indicate that even in South Africa or Nigeria, a high amount of the conducted research is published in so-called ‘predatory journals, which further undermines the trust in African science (Xia et al., 2015; Mouton and Valentine 2017). Therefore, only a small fraction of the research conducted at PhD level at a typical African university has the potential to be published in an indexed international journal. The examination of such PhD theses is often done among universities within a country or within Africa, while the use of external examiners from developing and developed regions such as North America, Europe and Asia is rare. The reasons for this trend are unclear, but some may argue that; (1) the use of in-country examiners could be necessitated by a lack of foreign currency to pay such external examiners from other countries, and (2) others may also argue that PhD theses in Africa require examiners with a fair understanding of the problems in Africa. However, this scenario creates a form of continental ‘academic in-breeding’ and raises questions as to whether or not such theses met global academic benchmarks. While these reasons could be valid in some cases, the need to adhere to global best practices in the training of research students and the awarding of research degrees should not be compromised for the sake of convenience.

The use of in-country, regional and continental assessors is not only limited to thesis examination but also to the promotion of academic staff at African universities. In this realm, the question of research quality also arises as evidenced by the limited contributions in indexed international journals. In most African countries, no ranking requirements exist for the journals in which one publishes. Here, the number of publications, which include articles and book chapters, appears to take precedence over quality, while in some cases even technical reports and manuals are considered for promotion. External assessors are often drawn from in-country or fellow African universities. In summary, the tendency to avoid examiners and assessors from developed countries with well-developed systems seems to be strong in most African countries. Proposals to benchmark African research, institutions and universities against global best practices are likely to be met with...
considerable resistance, with each country and institution defending its own system. Indirectly, this avoids scrutiny using global best practices, yet comprehensive quality control and evaluation systems are key to the development of research.

Several African countries, including South Africa, Kenya and Zimbabwe, among others, have regulatory systems and agencies mandated to ensure quality assurance and quality control in the higher and tertiary education sector that encompasses the universities (Garwe, 2014; Jonathan, 2000; Kiraka et al., 2020). In this respect, such countries will claim that their university systems conform to global best practices and standards. However, a closer examination of the regulatory systems will reveal a number of weaknesses and challenges constraining their regulatory functions. Firstly, due to rampant corruption in Africa (Glendinning et al., 2019; Nabaloh and Turyasingura, 2019; Mohamedbhai, 2015; Tefera and Aitbach, 2004), several malpractices involving the regulatory agencies and universities may occur, including the registration of universities failing to meet regulatory requirements. Secondly, similar to the research systems, the regulatory systems are weak and poorly enforced due to lack of resources including relevant expertise and experience. Hence, in some cases, regulatory agencies rely on staff from universities to implement the regulatory function. This creates a circularity problem and potential conflict of interest, whereby individuals play dual functions - first as the ‘regulator’ then as the ‘regulated’. This regulatory set up should not be confused with a peer evaluation process, where the peer review is independent of the system being evaluated. Such regulatory frameworks defeat the whole purpose of evaluation. Ideally, the regulatory system should be independent of the regulated institutions to ensure an impartial and objective evaluation. One option includes hiring an independent team of qualified and experienced international experts in research evaluation to conduct a comprehensive review of the university education and research system. The goal of such evaluations should be to benchmark Africa’s university education and research systems against global best practices. Yet most African countries and even some scholars (e.g., Kiraka et al., 2020) would probably argue for and prefer a regional or continental peer review process arguing that ‘African problems need African solutions’. However, a regional or continental peer review process undertaken by experts from equally weak African university and research systems may not yield the desired results. As discussed elsewhere in this paper, this simply promotes regional and continental ‘in-breeding’, thereby perpetuating the current system. In fact, the African peer review process, which is voluntary, is considered to have failed to address several issues in African politics and governance systems (Jordaan, 2006, 2007; Hammed and Kabo, 2013). Hence, prospects that an African peer review system will work as an effective evaluation mechanism for African university education and research systems are unlikely.

3. COVID-19 research in Africa: rationale and thematic areas

Here we argue that Africa’s unique socio-economic and cultural settings warrant customized research to address issues relevant to the continent. Specifically, Africa has marked chronic poverty, characterized by weak and poorly funded health care and social security systems, and high unemployment. Due to critical shortages of goods and services, such as housing, energy, sanitation, drinking water and food, overcrowding and queues are unavoidable (Gwenzi, 2020a,b). Africa experiences frequent political instabilities and humanitarian emergencies such as natural and man-made disasters. Moreover, a significant population of vulnerable people lacking formal employment and other essential services like housing and access to safe water, live in informal settlements, slums, squatter camps, and refugee camps (Gwenzi, 2020a,b). Strong cultural norms and practices, including gender disparities and gender-based violence also exist. The implementation of the current COVID-19 control measures based on social distancing, use of personal protective equipment and frequent hand washing has faced significant challenges and resistance even in developed countries. These challenges are even more severe in Africa in the light of chronic poverty and socio-cultural settings. Here, the critical thematic research areas and potential applications of local COVID-19 research are highlighted.

3.1. COVID-19 research thematic areas critical to Africa

Given the nature of the COVID-19 pandemic and its impacts, Africa’s research needs are potentially broad. Understandably, the thematic areas highlighted here should not be considered as exhaustive. Rather, these few thematic areas are meant to illustrate the need and potential utility of scientific evidence in understanding the transmission and control of COVID-19 in the African context.

(1) Occurrence and fate of SARS-CoV-2 in environmental media

Households with infected persons, healthcare facilities, quarantine centers and the funeral industry may generate solid wastes (e.g., used PPE) and wastewaters contaminated with SARS-CoV-2. Indeed, SARS-CoV-2 has been reported to persist for hours to weeks on potential solid waste materials, including metals, paper and plastics (Van Doremalen et al., 2020). Moreover, SARS-CoV-2 has been reported to be present in human feces (Wang et al., 2020) as well as in raw wastewaters, but these studies are limited to developed countries only (Ahmed et al., 2020; Randazzo et al., 2020). Given the lack of effective waste and wastewater treatment barriers in Africa, contamination of drinking water systems may also occur via raw wastewater discharges and on-site sanitation systems (Gwenzi, 2020b). Therefore, research is required to understand the occurrence, persistence and fate of SARS-CoV-2 in solid wastes, wastewater and drinking water systems under environmentally relevant conditions in Africa.

(2) Confronting the novel transmission hypotheses with field data

Respiratory droplets and direct contact with contaminated surfaces are considered as the predominant transmission routes for SARS-CoV-2. However, potential novel transmission through the fecal-oral route has been identified (Gwenzi, 2020b; Heller et al., 2020). This route consists of three potential sub-pathways: (1) ingestion of untreated contaminated drinking water, (2) cross-contamination of food along the farm-to-fork value-chain, and (3) vector-mediated transmission from fecal sources to human food (Gwenzi, 2020b; Heller et al., 2020). The research indicates that SARS-CoV-2 can infect the human digestive system and that viable virus is present in the human stool (Amirian, 2020). However, to date, fecal-oral transmission and its sub-pathways have remained a hypothesis which is yet to be confirmed through empirical research. The need to validate this hypothesis in Africa, that has been identified as an ideal region for such studies, has been discussed in an earlier paper (Gwenzi, 2020b).

Evidence also shows that fecal shedding of SARS-CoV-2 persists for a longer period, even after respiratory shedding has ceased (Ling et al., 2020). Yet to date, no studies have investigated fecal shedding of SARS-CoV-2 in symptomatic and non-symptomatic infected persons in Africa. Currently, inmates in quarantine centers are released based on the analysis of SARS-CoV-2 in respiratory swabs. One then wonders whether or not Africa is releasing infected people into society who will, in turn, further shed SARS-CoV-2 into the environment via feces and urine.

A significant population in Africa living in informal settlements often lack access to centralized municipal wastewater treatment systems. Hence, such communities depend on shared sanitation facilities, including pit latrines and septic tanks. The potential transmission of COVID-19 via shared sanitation systems, particularly among women, has been highlighted (Caruso and Freeman, 2020; Gwenzi, 2020b). COVID-19 transmission through shared sanitation facilities viaomite and aerosols requires further investigation (Jayaweera et al., 2020; Wang and Du, 2020).
Women are likely to be more exposed to COVID-19 via shared sanitation facilities than their male counterparts (Caruso and Freeman, 2020; Gwenzi, 2020a, b). In Africa, women also dominate in caring for sick family members, as healthcare workers, and as domestic workers involved in the cleaning of sanitation facilities and healthcare systems. However, data demonstrating that women are more exposed than men and hence are more affected are still lacking in the case of Africa. Instead, evidence drawn from developed regions shows that women are at a higher risk of exposure (Kocher et al., 2020), but once exposed, men are at a higher risk of severe infection and a fatal outcome of COVID-19 (Richardson et al., 2020). Thus, evidence is needed to understand the gendered aspects of the transmission and control of COVID. Such information is critical in developing gender-sensitive mitigation strategies.

(3) Counteracting myths, perceptions, and fake news through science communication

The emergence of COVID-19 has been accompanied by myths, misconceptions and even fake news, not only in Africa but globally (Shimizu, 2020). The resulting misinformation adds further complexity to an already complex crisis, culminating in public fear and panic. Therefore, proper communication of factual information based on current scientific evidence is critical in countering such information (Lancet, 2020). The lack of scientific evidence to counteract the misinformation creates an ideal environment for its persistence and propagation. In turn, such misinformation could be counter-productive to current and on-going control measures to prevent further transmission of COVID-19. Therefore, to avoid the propagation of misinformation and to strengthen the message on COVID-19 conveyed by public health authorities, the research community involved in relevant fields such as health sciences, medicine, environmental and public health, and biology should actively and continuously inform public opinion on COVID-19. While this is a common phenomenon in most regions, to a large extent, this has been lacking in Africa (Gwenzi, 2020a). For example, in a recent perspective paper targeting Africa, the lack of an African voice in the discourse on COVID-19 has been highlighted (Gwenzi, 2020a). Specifically, while learned and professional societies in other continents have added their voice to various aspects of COVID-19, this has not been the case in Africa. Similarly, while media reports involving interviews with scientists and experts on various aspects have been trending in both electronic and print media in several regions, including Europe, few such cases exist in Africa. Rather, media reports in Africa are dominated by the regurgitation of generic COVID-19 control measures with limited expert opinions. Scientific viewpoints could carry more weight in countering myths, misconceptions and misinformation than reports from media practitioners who may have limited educational background and scientific knowledge about COVID-19. Therefore, as experienced by the second author of this paper, the demand for comments on different aspects of COVID-19 in Poland has been massive. Specifically, the second author (P.R.) was asked to make nearly 60 media appearances between mid-March and August 2020. In turn, the first author’s (W.G.) experience in Zimbabwe has been that, like research outputs, scientific or expert opinions in both print and electronic media, have been missing. Yet the country boasts of nearly 12 state universities and more than 5 private universities as well as public and private research institutions. Thus, beyond adhering to the stipulated legal requirements for PPE, lockdowns and regular hand-washing, public understanding of COVID-19, its nature, transmission and control methods could be very limited. The messages conveyed to the public often lack a mechanistic explanation of how these various control methods function. Therefore, in Zimbabwe, it is not surprising to notice people in public not wearing face masks in an appropriate manner or not wearing them at all. Moreover, religious and family gatherings such as funerals have been limited to no more than 50 people, but the rationale for this figure is unclear. One even wonders, if the maximum size of the gathering (i.e., 50 in this case) also depends on the space available, or whether it is one of the global generic recommendations currently used without adapting it to local African settings. These issues highlight the need to integrate science and mass media because the scientific community has the most up-to-date scientific facts on COVID-19, while mass media experts have the skills to mass communicate. The need to integrate the two highlights the critical role of science communication, an emerging field that integrates the communication of scientific information on COVID-19 and mass communication via print and electronic media. Under the current COVID-19 crisis two options exist to achieve this: (1) the research community should actively seek to contribute scientific opinions and interviews in their areas of expertise to print and electronic media, both in the private and public sector, and/or (2) the private and public media should seek scientific opinion on aspects of COVID-19 that could be the source of myths, misconceptions and misinformation. In addition, cooperation and communication between universities and media outlets should be strengthened.

Given the lack of comprehensive COVID-19 surveillance and control systems in Africa, one may expect the disease to persist on the continent for a relatively long period. With the weak and poorly equipped health care systems in Africa the continent will largely rely on the prevention of further transmission. It is in this regard that timely communication of factual information is critical to counteract any myths, misconceptions and fake news. Therefore, research and its subsequent timely communication plays a crucial role in informing the public and clinical practice under the current COVID-19 crisis situation. Even without original data from Africa, the African research community is expected to be up-to-date with recent scientific developments on COVID-19 to offer a sound opinion on the topic. In this respect, the lack of financial resources, which is often cited as an excuse, will not be a constraint in the communication of science pertaining to COVID-19. In the long-term, the African academic community may also need to catch up with global trends by deliberately incorporating science communication in their STEM curricula.

(4) Understanding human health risks through quantitative microbial risk assessment

An increasing body of literature from developed countries exists on the occurrence and persistence of SARS-CoV-2 RNA in various environmental media, including wastewaters (Ahmed et al., 2020; Kitajima et al., 2020). However, the detection of SARS-CoV-2 RNA and even virions does not reflect viable and infective viruses and actual human health risks (Gwenzi, 2020b; Kitajima et al., 2020). This requires direct assessment in the cell line model and subsequent comprehensive health risk analysis using quantitative microbial risk assessment (QMRA) tools. Hence, in Africa, research investigating the occurrence of SARS-CoV-2 in various environmental compartments, including solid wastes, wastewater, on-site sanitation systems, and drinking water systems should be linked to QMRA. Unlike studies limited to the mere detection of SARS-CoV-2 RNA occurrence in the environment, QMRA estimates the human health risks by considering the various relevant factors (Kitajima et al., 2020). These factors include: (1) the nature and concentration of the biohazard (i.e., SARS-CoV-2), (2) degradation and fate processes, (3) human exposure pathways, and (4) modes of action once in the human body. Evidence-based on QMRA could potentially dispel or confirm some of the fears and concerns associated with the detection of SARS-CoV-2 in environmental media such as wastewaters.

(5) Wastewater-based epidemiology as a potential novel and low-cost COVID-19 surveillance tool

In the absence of comprehensive clinical surveillance, wastewater-based epidemiology (WBE) can provide insights into the prevalence of COVID-19 ahead of official confirmation of cases. Given the lack of diagnostic equipment in Africa, putative low-cost wastewater-based
epidemiology is a potential tool for COVID-19 surveillance in Africa. An increasing body of literature exists on WBE, highlighting its principles, advantages and potential limitations but this is limited to developed countries (Ahmed et al., 2020; Medema et al., 2020; Randazzo et al., 2020). Therefore, research is required in Africa to validate and conduct pilot applications of WBE under African settings. Such research should include both raw wastewater from centralized municipal wastewater systems, and on-site sanitation systems prevalent in Africa. Beyond COVID-19, WBE could also be critical in the surveillance of other human infections common in Africa, including cholera, typhoid and HIV/AIDS, among others.

(6) African plant biodiversity as a potential ‘Holy Grail’ of medicinal plants?

Africa has a rich ethnopharmacology coupled with a large plant biodiversity, including those with medicinal and therapeutic values (Malterud, 2017). Thus, the continent has a long history of using medicinal plants for the treatment of human and animal infections. Anecdotal evidence suggests that several medicinal plants and herbal medicines are currently used to treat COVID-19. However, scientific evidence on the nature, efficacy and active compounds of such medicinal plants is still lacking. Determining whether or not African plant biodiversity hosts medicinal plants and herbs with therapeutic effects against COVID-19 is a ‘holy grail’ for the public, the research community, policymakers and pharmaceutical companies. In this regard, it is the role of the African research community to investigate and provide scientific evidence on the potential opportunities offered by Africa’s medicinal plants. Notably, the proposal to investigate the medicinal and therapeutic effects of Africa’s plant diversity should not be misconstrued as a claim that Africa has a vaccine against SARS-CoV-2. However, the development and testing of vaccines derived from Africa’s rich biodiversity and ethnopharmacology should be a key component of future COVID-19 research in Africa.

(7) Potential SARS-CoV-2 environmental reservoirs and intermediate hosts

The issues of identifying the environmental reservoirs and intermediate hosts of SARS-CoV-2 remain unresolved. It is most plausible that it originated from bats with pangolins suggested as playing a role as intermediate species (Andersen et al., 2020; Lam et al., 2020). Research is needed in Africa to determine whether wild animals and (micro)biota could act as potential reservoirs and intermediate hosts of SARS-CoV-2. In Africa, as in south-east Asia, humans intimately interact with wild animals via livestock and consumption of wild animal products such as bush-meat, including ungulates, rodents, wild birds and insects. Therefore, understanding environmental reservoirs and an intermediate host may improve our understanding of how SARS-CoV-2 could jump from humans to wild animals and vice versa (i.e., host switching). There is also a need to continue the studies monitoring the betacoronavirus strains in bats and even edible rodents inhabiting Africa. An initial analysis documented their presence in different bat species. Furthermore, molecular analysis indicated that host switching (inter-genus transmission) for African betacoronaviruses is occurring at a similar rate as for Asian strains (Amphony et al., 2017). This, in turn, indicates that Africa is also at a higher risk for zoonotic emergence (although other factors are also needed for zoonotic emergence) (Halabowski and Rzymski, 2021; Johnson et al., 2015). One should also note that Africa is the only continent that lacks systematic studies on the occurrence of coronavirus strains belonging to genera other than betacoronavirus, e.g., delta- and gammacoronaviruses associated with birds (Wartecki and Rzymski, 2020).

(8) Estimating COVID-19 transmission dynamics

Africa lacks diagnostic testing equipment for comprehensive clinical testing of individuals. Therefore, given the poor coverage of clinical surveillance, current estimates of COVID-19 cases and deaths could grossly under-estimate the prevalence of COVID-19. This lack of clinical surveillance could be more pronounced in remote rural areas in Africa where the currently limited surveillance efforts in most African countries are confined to urban areas. This due to limited resources and the close proximity of people to each other in urban settings. In this regard, the current confirmed cases and deaths in Africa could represent only a ‘tip of the COVID-19 iceberg’. Asymptomatic and oligosymptomatic infected persons and several unreported cases likely to occur in remote rural areas of Africa could constitute the ‘submerged part of the pandemic’. However, controversy exists on whether or not Africa harbors a substantial number of undetected COVID-19 cases and deaths (Dyer, 2020). Estimates of the prevalence and transmission dynamics of COVID-19 are critical for decision-making and advance planning (e.g., procurement and deployment of resources). Therefore, biostatisticians, computer modelers and epidemiologists need to provide estimates of COVID-19 prevalence and transmission dynamics using models and existing knowledge on SARS-CoV-2. Such estimates are not expected to provide exact figures, but rather give the estimates lower and upper bounds, including assumptions inherent in the methods used in such estimations.

3.2. Potential applications of African COVID-19 research

(1) Validating hypotheses on the novel transmission of COVID-19

A number of research gaps and untested hypotheses relating to Africa and other developing countries still exist for COVID-19 (Section 3.2). These include the significance of the fecal-oral transmission, gendered perspectives on transmission and control and the role of the human factor in the control and transmission of COVID-19. Moreover, the transmission of COVID-19 through shared sanitation via fomite or contaminated inanimate surfaces and wastewater aerosols could be relevant in Africa but has received no research attention.

(2) Scientific evidence as a decision-support tool

The current COVID-19 control measures are too generic and often too rigid to fit into African settings (Caruso and Freeman, 2020). These aspects have been discussed in detail in an earlier paper (Gwenzi, 2020a). Thus, the examination of the current COVID-19 control measures raises the following questions pertinent to Africa and other low-income countries: (1) ‘How are vulnerable communities in Africa expected to observe social distancing when they share and queue for nearly all basic services including sanitation and water?’, and (2) ‘How are family members living in overcrowded and shared housing in informal settlements such slums, squatter camps, and refugee camps in disaster and war-prone Africa expected to adhere to social distancing in the case of one family member becoming infected with COVID-19?’. Moreover, ‘How are such communities expected to practice frequent hand washing when even clean drinking water is unavailable’? The majority of these challenges are not relevant to developed countries, where most of the scientific evidence that informs the mitigation measures is drawn from. Hence, no empirical evidence exists documenting how African communities in these environments cope with COVID-19. Thus, local evidence is required to internalize and refine the generic control measures to suit local conditions. This highlights the apparent need for local research initiated and led by African scientists with an intimate knowledge of the socio-economic and cultural settings in Africa.

(3) Dispelling myths, perceptions and misconceptions through science

Scientific evidence can also be used to dispel counter-productive
myths, attitudes and perceptions. Due to strong cultural and religious beliefs in Africa, several myths, perceptions, attitudes and misconceptions exist among the public and even political leaders. For instance, anecdotal evidence shows that there is a myth that black Africans are genetically resistant to COVID-19 compared to other racial groups in Africa. Anecdotal evidence and media reports show that the following myths and misconceptions exist in Africa, among others:

(i) ‘Black Africans are genetically resistant to COVID-19 compared to other racial groups’ (Anadolu Agency, 2020).
(ii) ‘SARS-CoV-2 in Africa is relatively weaker than the one reported in other regions such Asia, Europe and South America’ (The Herald, 2020).
(iii) ‘Imported and donated diagnostic testing equipment and personal protective equipment are the sources of, and spread COVID-19 in Africa’.

The first two myths or misconceptions seem to be motivated by the delayed outbreaks and relatively low COVID-19 cases and fatalities currently reported in Africa compared to other regions such as Europe, Asia, North America and South America. It is also plausible that a notion that black people are immune to SARS-CoV-2 infection has arisen from the news that an individual of Cameroonian-origin, who represented an initial group of COVID-19 cases in China, has responded well to treatment (Padayachee and du Toit, 2020). This misinformation brought back memories of the yellow fever epidemic of 1793, during which 400 blacks lost their lives due to false susceptibility claims (Hogarth, 2019). The third myth could be attributed to malfunctioning diagnostic equipment and/or human error during the operation of the equipment. Although no scientific evidence is proffered to substantiate these claims, media reports show that some political leaders in Africa have been propagating the same myths and misconceptions (Al-Jazeera, 2020). In this regard, science should play its role in verifying and dispelling myths and misconceptions from facts to avoid conspiracy theories and propagation of myths and misconceptions. Yet systematic studies investigating the ‘human factor’ in the transmission and control of COVID-19 is still missing. Without local scientific evidence, such myths could be propagated and promote transmission. The lack of local African scientific evidence on critical issues may lead to a loss of confidence and distrust in the relevance of current control measures. Moreover, the lack of relevant local scientific evidence to support decision and policy-making may create an information void. Consequently, a risk exists that unproven conspiracy theories, myths, and cultural and religious beliefs may fill such information voids. In several fledgling democracies and authoritarian regimes in Africa, politicians could seize such opportunities to politicize COVID-19 and suppress dissent, and civil, human and democratic rights. Such a scenario could be retrogressive and counter-productive to the current fight against COVID-19.

(4) Validating novel local knowledge systems and coping mechanisms

Infectious diseases are not entirely new in the history of Africa, as evidenced by historical outbreaks of smallpox and other infectious diseases (Baker et al., 2017). Therefore, local communities who are severely challenged to implement the recommended control measures could also develop and adopt their own coping strategies. This raises three questions, (i) ‘What role could be played by local knowledge systems in the control of COVID-19 and building resilience against its societal impacts?’ (ii) ‘How are the poor and vulnerable communities in Africa coping and adapting to COVID-19, and are there broader lessons to learn for Africa for future outbreaks of similar infections?’ and (iii) ‘What role could herbal medicines and home remedies play in mitigating COVID-19 in low-income settings and what is the extent of the practice of these local knowledge systems?’.

(5) Validation and application of novel surveillance tools

Africa lacks resources for comprehensive mass clinical testing of individuals due to a shortage of diagnostic equipment, financial resources and expertise. This calls for novel surveillance methods as an alternative to clinical testing of individuals. WBE is one such potential low-cost and promising tool. WBE utility has been demonstrated in the case of several viral diseases as discussed in earlier reviews (Xagoraraki and O’Brien, 2020; McCall et al., 2020). WBE detects COVID-19 in advance by about a week, unlike clinical surveillance of individuals (Randazzo et al., 2020). This approach seems to be ideal in Africa given its putative low cost and low equipment requirements. Yet to date, no studies exist on WBE in Africa, while a substantial literature exists in developing countries. Once WBE is validated for COVID-19, scope exists to extend the tool to other co-morbidities prevalent in Africa including cholera and typhoid.

(6) Africa’s inability to control COVID-19 is a potential global health concern

The low amount of COVID-19 research in Africa and its putative inability to effectively respond to, and control the transmission of COVID-19 should not be considered as a problem limited to Africa. Rather, this should be perceived as a potential global health concern. This is because, without effective control or vaccine, COVID-19 could become deeply rooted in Africa for a prolonged period. In turn, Africa may serve as a potential global reservoir of SARS-CoV-2 for years to come. Moreover, prolonged human exposure to SARS-CoV-2 may lead to the development of herd immunity. Hence, local populations may harbor SARS-CoV-2 but they will be asymptomatic or oligosymptomatic. Without effective surveillance and control systems the fate of COVID-19 in Africa is unclear. Hence, whether or not the African population will develop a natural herd immunity over time, and the extent to which such immunity will protect the local population that remains is difficult to predict. Furthermore, whether or not the prolonged occurrence of COVID-19 in Africa may also increase the likelihood of SARS-CoV-2 jumping from humans to wild hosts such as African bats is not currently known. However, as a global pandemic, and considering global connectivity via international travel, COVID-19 cannot be effectively controlled if the global community ignores Africa’s plight. Hence, Africa’s subdued research response to COVID-19 should be of concern not only to Africa but also to the international and global research community, warranting urgent attention.

4. Future perspectives: looking ahead in Africa

In view of the foregoing discussion, the following future research perspectives need attention in Africa.

(1) A strong local scientific evidence base is critical in the fight against COVID-19

Several knowledge gaps unique to Africa still exist on the transmission and control of COVID-19 (Section 3). A strong local scientific evidence base is critical in addressing these knowledge gaps and would provide key information for decision and policy-making. The capacity of the research system to respond to human health threats, including COVID-19, should not be under-estimated. It should be emphasized that our current understanding of the transmission of COVID-19 and its control via social-distancing, use of PPE and frequent hand washing are a culmination of scientific research. The unprecedented scientific response witnessed within just three months following the outbreak of COVID-19 clearly demonstrates the immense capabilities of modern science to react swiftly to emerging global health threats even under extremely challenging conditions (Nowakowska et al., 2020). Therefore, resources allocated to research, if used prudently and transparently,
should not be considered as a potential waste of scarce resources. A local scientific evidence base also builds confidence and trust among the stakeholders, including the public, researchers, practitioners and decision and policy-makers. Yet currently, research on COVID-19 has received cursory attention with respect to the allocation of resources. The bulk of resources, including funding, expertise and diagnostic equipment, are channelled towards the control of further transmission of COVID-19. While this is understandable, African governments and their international partners, including donor agencies, should equally consider allocation of a portion of the resources towards research. The question is not whether or not COVID-19 research in Africa warrants funding, but rather, how to strike a balance in the allocation of scarce resources between research on one hand, and control efforts on the other.

(1) The African research community should take the lead

The focal niche areas and knowledge gaps highlighted in the current perspective provide a starting point for COVID-19 research in Africa. The next step should entail the African research community taking the lead in initiating and implementing research on the various facets of COVID-19. The preliminary research may involve well-conceptualized and thought out papers in the form of perspectives, opinions, viewpoints, scoping reviews and horizon scans. Scoping reviews, horizon scans and meta-analyses are particularly important in defining the importance of a research field, its current status and the direction it should take in the future, including outlining important research thematic areas and knowledge gaps. It is envisaged that such well-conceived preliminary research will act as a launchpad and springboard for large funded projects and even attract collaborators and funders. Lacking such preliminary research, and commitment to conduct such research, Africa could be considered as a ‘greenfield’ with regard to COVID-19 research. Hence, considering that the global research and grant systems have become highly competitive, without demonstrated local research evidence Africa could be considered unattractive and a high risk to both collaborators and funders alike.

(1) The need to cross traditional disciplinary boundaries

The multi-faceted nature of COVID-19 and its impacts requires effective collaboration and coordination beyond the traditional disciplines in medical sciences and public health such as epidemiology. As Daughton (2020) rightly pointed out, research on COVID-19 should transcend traditionally disparate disciplines to gain a comprehensive understanding of its transmission, control and potential impacts. Thus, multi-disciplinary research should include the following expertise: (1) analytical and immune-chemists, and biochemistry, (2) public health, environmental and civil engineers, (3) utility operators and managers including those involved in waste, wastewater and drinking water systems, (3) computer modelers with expertise in systems and quantitative risk analysis, (4) mathematicians and (bio)statisticians, (5) clinical scientists and pharmacologists, (6) infectious disease specialists and public health experts, including epidemiologists, (7) environmental and human microbiologists including virologists, (8) behavioral and social scientists, including psychologists, social workers and sociologists, (9) science communication experts including mass media experts with experience in communicating complexity and risks, and (10) public health practitioners and decision and policy-makers.

(1) Biosafety, research and professional ethics as cornerstones

SARS-CoV-2, the etiologic agent of COVID-19 and infectious materials (biological samples) pose a significant biohazard. These biohazards and bio-risks could be particularly significant in Africa due to a lack of certified research and private analytical laboratories. Hence, research and university laboratories involved in research entailing SARS-CoV-2 may need to be certified to at least biosafety level 2 (Won et al., 2020). Such laboratories will need strict biosafety protocols during sample collection, pre-treatment, analysis and subsequent disposal of samples. Bioethics, including the need for consent approvals among vulnerable communities, are cornerstones of scientific research.

Research ethics are also paramount in Africa, a region often associated with poor quality research, including publishing in predatory journals. Indeed, concerns have been raised about the quality of research from Africa with respect to originality/novelty. This is particularly important, given that even in developed regions, research on COVID-19 has not been without problems, as discussed in earlier reviews (Rzymski et al., 2020). Several recent high-profile retractions in top journals such as Nature, New England Journal of Medicine or The Lancet, among others, clearly illustrate the gravity of this point. The risks and dangers posed by poor quality research are immense and far-reaching and have been discussed in earlier papers on COVID-19 (Nowakowska et al., 2020; Rzymski et al., 2020). These include; (1) misdirection, and propagation of misleading findings, (2) diversion and waste of scarce resources and research efforts, and (3) mistrust and loss of public confidence in science. The tendency to make short-cuts in the research process, rushing peer-review or massively post the manuscripts in the form of non-peer-reviewed pre-prints could be particularly high during emergencies such as COVID-19. Therefore, these aspects warrant serious attention as Africa and its global partners initiate and implement research on COVID-19.

(5) The need for effective research evaluation and quality assurance and control systems

The dominance of South Africa is particularly interesting and could probably serve as an example of a functional research system in Africa. Specifically, unlike most African countries, the South African research systems have competitive research grant systems coordinated by the National Research Foundation (NRFs) (NRF, 2020). This is in addition to several other international, public and private grants. Unlike other African countries, the South African NRF’s Incentive Funding for Rated Researchers Programme benchmarks a scientist’s research outputs including publications over a period of eight years (Hedding, 2019). In this regard, scientists are ranked into various categories depending on their level of career development based on the quality and quantity of research outputs. The South African research system also has a monetary incentive system, where scientists are awarded a payout for each publication in accredited journals. Indeed, concerns have been raised about the quality of research identified by the South Africa’s Department of Higher Education and Training (DHET) (Hedding, 2019). To our knowledge, we are unaware of any other African country with a similar research evaluation system. However, a monetary incentive system has its limitations - the system can be ‘gamed’ by unscrupulous scientists and turned into an ‘incoming generation venture’, which could, in turn, promote unethical and unprofessional conduct at the expense of quality research. The limitations associated with the use of monetary incentives to promote research has been discussed in detail in earlier papers (e.g., Abritis et al., 2017; Hedding, 2019). However, several global benchmarks and best practices exist for promoting research, especially in developed countries. Thus, African countries may need to build on and adapt such systems to suit their needs and socio-economic settings.

(6) The need for global research collaboration in COVID-19

On its own, Africa has limited capacity to conduct comprehensive research to address the various gaps highlighted. Therefore, global research collaborations are critical to overcoming the research constraints pervasive in Africa. Such collaborations may entail (1) joint research grant proposals and implementation of research projects, (2) capacity building at national and regional levels in COVID-19 research through training of researchers, postgraduate students, technicians and
are regarded as ‘imported diseases’ or ‘capacity-building’ will come from elsewhere outside Africa through ‘technology-transfer’ region, and (3) opportunities to overcome current constraints through scientific evidence base, (2) potential thematic research areas critical to the collaboration on a subject of mutual interest, (2) prospects for Africa to immense research opportunities with respect to the following: (1) global settings and recommendations. Citizen science, an emerging paradigm, may also assist in science community, behavioral scientists, policy-makers, and mass media experts. In this respect, effective science communication systems are required to ensure that a consistent scientific message is conveyed to the audience and end-users without overwhelming them. Effective science communication systems require strong interactions among the research community, behavioral scientists, policy-makers, and mass media experts. In summary, there is no doubt that COVID-19 presents a significant health threat to Africa and the rest of the world. Yet on a relatively positive note, the several knowledge gaps highlighted here also present immense research opportunities with respect to the following: (1) global collaboration on a subject of mutual interest, (2) prospects for Africa to develop its research systems. Thus, the current perspective seeks to stimulate debate and challenge the African research community to contribute significantly towards research on COVID-19 beyond the current subdued level. To this end, a detailed framework is provided, including: (1) the motivation for Africa to develop a strong local scientific evidence base, (2) potential thematic research areas critical to the region, and (3) opportunities to overcome current constraints through global collaborations, and future perspectives.

5. Concluding remarks and outlook

The current paper presents a nuanced perspective on the subdued African research response to COVID-19 and the specific relevant niches where African research focuses in the light of the rising infection and death rates. To date, Africa has made a paltry contribution to global research on COVID-19, which during the first three months of scientific response to its outbreak, was the lowest among all the continents. Weak research systems, characterized by a severe lack of expertise, funding and infrastructure, including analytical equipment, account for the lack of a strong scientific evidence base on infectious respiratory diseases such as COVID-19 and others. Potential perceptions and attitudes among researchers, practitioners and policy-makers towards COVID-19 and the role of science in decision and policy-making were discussed. Specifically, severe respiratory coronaviral infections, including COVID-19, are regarded as ‘imported diseases’ originating from outside Africa, thus a notion could exist that COVID-19 control and treatment methods will come from elsewhere outside Africa through ‘technology-transfer’ or ‘capacity-building’. A weak scientific evidence base to support decision and policy-making adds to a milieu of several other challenges currently experienced in the fight against COVID-19. These challenges include chronic poverty, poor coping capacity attributed to weak health care and social security systems, and the severe shortages of diagnostic testing infrastructure for clinical surveillance of individuals. Furthermore, effective waste, wastewater and drinking water treatment systems are often lacking, inefficient and overloaded. In turn, the lack of effective barriers implies that the novel fecal-oral transmission of COVID-19 via drinking water, vectors and food cross-contamination cannot be totally discounted in Africa. The role of the ‘human factor’ including; unique socio-cultural norms and practices, gender disparities, social status such as vulnerable communities, and perceptions and myths on the transmission and control of COVID-19 remain under-studied. The focal African research niches in COVID-19 were presented, including (1) potential novel transmission of COVID-19, (2) the need to internalize and adapt generic COVID-19 control measures to suit African settings, (3) context-specific research on the occurrence and survival of COVID-19 in wastes, wastewater and drinking water systems, (4) gendered perspectives on the transmission and control of COVID-19 among vulnerable communities, (5) validation and application of wastewater-based epidemiology as a decision support tool, and (6) understanding the role of the ‘human factor’, including perceptions, myths, attitudes and religious beliefs in the transmission and control of COVID-19. These issues are context-specific, while others are unique to Africa, hence are overlooked and considered less relevant in research conducted in developing regions. Thus, current and future research on COVID has limited capacity to address these issues unless the African research and professional communities take the lead in spearheading such research. In such research endeavors, research and professional ethics should be of paramount importance and quality rather than quantity should be a key milestone in such scientific efforts. This is because research on COVID-19 has not been without problems, as evidenced by several high-profile retractions. The need for collaboration in such research efforts was highlighted to overcome the research constraints pervasive in Africa. Failure by the African research and professional communities to fill this void may result in loss of confidence and distrust in current control measures. Consequently, unproven conspiracy theories and cultural and religious personal beliefs and myths may fill such information voids. Furthermore, in several fledgling democracies and authoritarian regimes in Africa, politicians could seize such opportunities by to politicize COVID-19 and suppress dissent and civil, human and democratic rights. Such a scenario could be retrogressively counter-productive to the current fight against COVID-19. Overall, by bringing these issues to the fore, this perspective is a call to duty for the African research and professional community to provide the much-needed scientific evidence to support decision and policy formulation in the fight against COVID-19. One should bear in mind that while COVID-19 is still with us, new similar pandemics may occur in the future. Therefore it is not too late for the African research and professional communities to introspect and take the lead in COVID-19 research relevant to Africa.

CRediT author statement

Willis Gwenzi: Conceptualization, Methodology, Investigation, Formal analysis, Visualization, Writing – original draft, review, editing, & finalization. Piotr Rzymski: Methodology, Investigation, Formal analysis, Visualization, Writing – original draft, review & editing.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.
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