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Review

Sources and routes of SARS-CoV-2 transmission in water systems in Africa: Are there any sustainable remedies?

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HIGHLIGHTS

• Pathways of SARS-CoV-2 transmission in water systems in Africa are discussed.
• Hospital sewage, human faeces, contaminated sewage, etc. may contain SARS-CoV-2.
• Sustainable remedial measures useful to developing countries are proposed.
• Ozonation, chlorination, UV irradiation, and NaClO can remove SARS-CoV-2 in water.

GRAPHICAL ABSTRACT

ABSTRACT

Governments across the globe are currently besieged with the novel coronavirus (COVID-19) pandemic caused by SARS-CoV-2. Although some countries have been largely affected by this pandemic, others are only slightly affected. In this regard, every government is taking precautionary measures to mitigate the adverse effects of COVID-19. SARS-CoV-2 has been detected in wastewater raising an alarm for Africa due to the poor water, sanitation, and hygiene (WASH) facilities. Also, most countries in Africa do not have resilient policies governing sanitation and water management systems, which expose them to higher risk levels for the transmission of SARS-CoV-2. Therefore, this study unearthed the likely sources and routes of SARS-CoV-2 transmission in water systems (mainly wastewater) in Africa through a holistic review of published works. This provided the opportunity to propose sustainable remedial measures, which can be extrapolated to most developing countries in the world. The principal sources and routes of potential transmission of SARS-CoV-2 in water systems are hospital sewage, waste from isolation and quarantine centres, faecal-oral transmission, contaminated surface and groundwater sources, and contaminated sewage. The envisioned overwhelming impact of these sources on the transmission of SARS-CoV-2 through water systems in Africa suggests that governments need to put stringent and sustainable measures to curtail the scourge. Hence, it is proposed that governments in Africa must put measures like improved WASH facilities and public awareness campaigns, suburbanization of wastewater treatment facilities, utilizing low-cost point-of-use water treatment systems, legally backed policy interventions, and Community-Led Total Sanitation (CLTS). SARS-CoV-2 in water systems can be inactivated and destroyed by integrating ozonation,
1. Introduction

The advent of the current novel coronavirus (COVID-19) pandemic caused by the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) has nearly wrecked the health systems in most countries even in developed countries but worst in most developing countries, especially in Africa. Although some countries have been largely affected by this pandemic, others are only slightly affected. Owing to this, every government is taking precautionary measures to mitigate the adverse effects of COVID-19. Some of the symptoms associated with COVID-19 include fever, cough, diarrhea, and breathing difficulties (WHO, 2020). The World Health Organization (WHO) has mentioned that the main routes of exposure of the virus to humans are inhalation of droplets generated when an infected person coughs, sneezes, or exhales (WHO, 2020). However, recent studies have shown that SARS-CoV-2 can be found in the faeces of infected symptomatic and asymptomatic patients (Foladori et al., 2020; Pan et al., 2020; Randazzo et al., 2020; Tang et al., 2020; Xiao et al., 2020; Zhang et al., 2020a). Clinical experiments and researches have also reported evidence of SARS-CoV-2 in urine samples of infected patients (Lescure et al., 2020; Ling et al., 2020), and hospital and urban sewage (Medema et al., 2020; Wu et al., 2020). It can be inferred from these studies that the water systems, especially municipal wastewater of areas hit hard by COVID-19 might contain the virus. Recently, SARS-CoV-2 has been detected in untreated wastewater in Australia, the Netherlands, USA, and France (Ahmed et al., 2020; Medema et al., 2020; Nemudryi et al., 2020; Wurtzer et al., 2020) corroborating the assumption that the virus could be detected in wastewater. This raises serious concerns for the water systems in developing economies like most African nations. Most countries in Africa do not have resilient policies governing sanitation and water management systems, which expose them to higher risk levels for the spread of COVID-19.

Hitherto, most Africans had two main misconceptions about COVID-19: the first was that, Africans were immune to the virus that started in Wuhan, China and spread to the rest of the world and the second was that the virus could not thrive in high temperature conditions in Africa. Unfortunately, these perceptions are flawed and have been proven scientifically coupled with the actual emergence of the virus in Africa. Africa recorded its first case of COVID-19 on 14 February 2020 in Egypt and since then, the disease has spread to all the 54 countries in the African continent with rapidly increasing infection rates (Emejulu et al., 2020). As at the time this review was conducted, a total of 578,734 people were infected with COVID-19 in the whole of Africa with South Africa alone recording 264,184 confirmed cases (Africa Centres for Disease Control and Prevention, 2020). The death toll of the continent as at 12 July 2020 was 12,996 with more than 280,000 recoveries (Africa Centres for Disease Control and Prevention, 2020). However, the WHO has projected a death toll of 199,000 for the entire African continent as a result of the COVID-19 pandemic (WHO, 2020). Accordingly, this projection is premised on the availability of robust healthcare systems to cater for vulnerable populations, general preparedness for the pandemic, ability to test, treat, isolate, and trace contacts and several other prompting factors. Similarly, Surgo Foundation (2020) recently designed a COVID-19 community vulnerability index across Africa (Fig. 1; http://surgofoundation.org/). The design of the index involved seven major themes spanning from age, epidemiological factors, strength of healthcare systems, fragility, population density, access to transportation and housing to socioeconomic factors. It is suggested that although Africa is not yet highly hit by COVID-19, most of the regions have high vulnerability manifested in their health, social and economic systems. The most vulnerable regions are in Madagascar, Democratic Republic of Congo, Ethiopia, Malawi, Uganda, Cameroon, and Mali (Fig. 1; http://surgofoundation.org/). Now, the fear that has grasped most governments and experts in Africa is that the continent is likely to be severely hit by the COVID-19 pandemic owing to the fragile health care systems and poor sanitary systems when compared to the rest of the world.

Wastewater management systems and sanitary systems in Africa currently are in critical conditions. It is very common to find pit latrines and groundwater sources, especially hand-dug wells in close proximity to each other. That notwithstanding, all African countries have policies regulating the siting of pit latrines in communities but these have been widely not adhered to in most countries. Such acts expose people to cross-contamination of the pit latrines with the groundwater sources. Consequently, if there are COVID-19 infected patients living in such communities that have their pit latrines closer to their drinking water sources, the risk of getting infected with the virus through oral ingestion of the virus-contaminated water is very high. Similar observations about water-borne diseases such as diarrhoea and gastroenteritis in Africa are very common (Oppong et al., 2020; Samie et al., 2020). Indiscriminate open defecation around surface and groundwater sources in Africa have also been reported in the literature (Elisante and Muzuka,
2016; Anornu et al., 2017; Back et al., 2018; Abanyie et al., 2020; Houéménou et al., 2020; Mutono et al., 2020; Owamah, 2020). Through open defecation, the carriers of the virus may unknowingly transmit it through their stool to drinking water sources, which can have a debilitating effect on consumers of such virus-contaminated water. There is also a high risk of exposure to the virus by people that use the same toilets (a common practice in Africa) because the virus may remain in the aerosol or droplet generated during the use of shared toilets built in small spaces without aeration.

On 2 July 2020, senior government medical officers reported in Ghana that the commonly known symptoms of cough, cold, fever, and breathlessness often exhibited by COVID-19 patients are not lately shown by COVID-19 patients. Now, COVID-19 patients show stomach upset, vomiting, and diarrhoea because the virus attacks the gastrointestinal tract rather than the previously known lungs attack. These are not well known symptoms of the virus and as such patients may not suspect these to be indicative of the fact they have come in contact with the virus. In addition, since these new symptoms of the virus are oblivious to most doctors, the virus could escalate at the community level. These symptoms are also akin to waterborne diseases and go to buttress the possibility of the virus being transmitted through the domestic usage of the virus contaminated water. Also, untreated wastewater is mostly discharged into the environment, which may interact with surface and groundwater resources, thereby contaminating these dwindling resources (Williams et al., 2019).

Overall, since most of the people living in Africa, especially those dwelling in rural and peri-urban settlements depend on surface and groundwater resources for their domestic water supply, the risk of contracting COVID-19 through SARS-CoV-2 contaminated water is very high and thus, the sources and routes of community spread of the virus, which is currently being reported must be critically re-examined. Therefore, this review examines the potential sources and routes of SARS-CoV-2 transmission in water systems in Africa with emphasis on wastewater management systems and proposes sustainable remedial measures to deal with the potential risk of community spread of SARS-CoV-2 via wastewater in Africa. Hence, the review will be a

Fig. 1. Africa COVID-19 community vulnerability index (http://surgofoundation.org/).
framework for African policymakers in dealing with the COVID-19 pandemic. It will also add to the pool of existing literature on the possible transmission of SARS-CoV-2 through wastewater.

2. State of water, sanitation and hygiene (WASH) systems in Africa

According to the WHO, as at 2017, about 2 billion people in the world are still living without basic sanitation facilities (WHO, 2019). Out of this, about 709 million people representing 35% of the total number are living in Africa. In contrast to the developed world, there is over-reliance on non-sewered wastewater and sanitation systems in Africa (Street et al., 2020). For instance, the first ten countries having the highest levels of open defection are all in sub-Saharan Africa (WHO, 2019; Street et al., 2020). Most of the people in these countries live in rural settlements. Accordingly, almost one in five people living in Africa use open defection as the mode of discharging human excreta and this may lead to disease outbreak (Saleem et al., 2019).

The sixth goal of the sustainable development goals (SDG 6) is aimed at achieving access to clean water and sanitation for all and elimination of open defection by 2030 (WHO, 2014). However, this goal is yet far from being achieved in Africa. For example, in Ghana, which is one of the biggest economies in West Africa, only 21% of the population has improved sanitation systems in place (Appiah-Effah et al., 2019), slightly below the improved basic sanitation coverage of 28% in sub-Saharan Africa (WHO, 2017). Elsewhere in South Africa, which happens to be one of the biggest economies in Africa, about 37% of the general public does not have a water-borne sewage system and thus, relies on bucket toilets, pit latrines, and chemical toilets as an alternative (Street et al., 2020). The same situation is common in most of the African countries. It is well documented in the literature that sub-Saharan Africa has most of its population sharing toilets vis-à-vis other nations in the world (Rheinländer et al., 2015). The situation is much worrying in the densely populated urban regions of sub-Saharan Africa, where public or shared toilets are common (Morella et al., 2008; Gudda et al., 2018) studied pit latrine faecal sludge accumulation in Nakuru, Kenya and pointed out that all the pit latrines in 100 households were communal and the average number of shared users of a pit latrine was 23 persons. There have not been any reported cases of SARS-CoV-2 transmission via faecal-oral or waterborne routes and due to quarantine or self-isolation of persons suspected to be infected with COVID-19, it is argued that infection through this route is unlikely (Amirian, 2020). Nevertheless, this might not hold for shared or communal spaces and the risk of faecal-oral transmission might be common in confined places of abode like hotels and places that are overcrowded (Wu et al., 2020).

Connection to wastewater treatment plants in Africa is mostly at the urban level. Even in some of the urban cities, they are limited and some exist but are dysfunctional. In most of the cities, there is poor management of industrial wastes. One would think that the capital cities where most of the industries and policy implementing bodies are found should have proper management strategies for industrial effluents. However, it is worrying that industrial wastes with potentially toxic substances and biologically unfit substances are directly drained into surface water sources without taking into account the potential environmental hazards these wastes can cause. For example, in Nigeria, which is considered as the giant of Africa with a population of over 200 million, most of the states such as Plateau, Niger, Kwa, Kogi, and Benue have dysfunctional wastewater treatment facilities while other states like Ondo, Imo, Bayelsa, Anambra, Akwa Ibom, and Abia do not have any treatment facilities at all (Adesogan, 2013; Adewumi and Oguntuase, 2016; Omole et al., 2019). With such, the wastewater in these states are directly discharged into surface water sources with no pre-treatment (Azzizullah et al., 2011; Aftal et al., 2019; Arslan et al., 2020). Also, in Ghana, the actual total waste production is not readily available. This stems from the fact that there is limited data on industrial and commercial wastewater production save for domestic wastewater. As at 2006, the total amount of wastewater produced in urban localities in Ghana was about 280 million m$^3$ (Agodzo et al., 2003). But with the influx of processing facilities within inland areas, it is projected that the amount of wastewater produced in urban Ghana will increase exponentially. According to Agodzo et al. (2003), urban wastewater production will reach about 1,452,383 m$^3$ per day by the end of 2020. Most of the wastewater generated in all the 16 regions of Ghana are left untreated mainly due to logistic constraints. Industries find it comfortable discharging their wastewater into surface water sources, which is totally unacceptable. The discharge of raw sewage into the surface water sources seriously calls for the investigation of contaminated surface water sources, which may give vital information regarding the distribution and existence of SARS-CoV-2 in the various countries.

Population growth in sub-Saharan Africa, particularly in urban areas is identified as the key factor accounting for the slow progress towards achieving the SDG (Adams et al., 2019). It is estimated that the urban population of sub-Saharan Africa will triple by the year 2050 (Dos Santos et al., 2017). Accordingly, 8 of the most rapidly growing countries in the world are in sub-Saharan Africa and the major cities there are estimated to have an annual growth of 4% within the next decade (Dos Santos et al., 2017). Majority of the population growth is in informal and peri-urban areas, which usually do not have basic amenities like water and sanitation, as a result, urban access to water has been impeded overtime. Current estimates reveal that approximately two-thirds of sub-Saharan Africa's urban residents live in informal settlements and only in Nairobi, Kenya, these areas contribute about 75% of urban growth (Dos Santos et al., 2017). The access to water by residents of these informal areas is really appalling when compared to the core urban areas, thus, rapid population growth will only compound the situation (Adams, 2018; Bain et al., 2018) revealed that during the period between 2000 and 2015, the annual rate of change of total population with access to basic drinking water amenities in sub-Saharan Africa was 57.6% and in North Africa, it was 90.6%. Moreover, the annual rate of change of total population with access to basic sanitation amenities in sub-Saharan Africa was reported as 28.1% and 86.1% in North Africa (Bain et al., 2018). In terms of hygiene, sub-Saharan Africa recorded a positive change of 15.4% whereas it was 76.3% in North Africa (Bain et al., 2018). Even with positive changes in hygiene, the records suggest that access to basic water, sanitation and hygiene amenities still remains very low in sub-Saharan Africa.

In addition, Nhamo et al. (2019), studied the chances of Africa to achieve the SDG 6 by 2030 using a composite index approach with three indicators of the SDG 6; proportion of the population using safely managed drinking water amenities, proportion of the population using safely managed sanitation amenities, and level of water stress. The results indicate that most of the countries are at various stages of achieving the targets set out in the SDG 6 (Table 1). The fact that many of the African countries show declining trends of WASH is a clue that it will be difficult for Africa to reach the SDG targets by 2030 (Nhamo et al., 2019).

3. Sources and routes of SARS-CoV-2 in water systems in Africa

There are several routes through which SARS-CoV-2 can enter the water systems, which can eventually lead to its transmission through the water medium (Fig. 2). Some of these routes include wastewater discharged from hospitals, government-approved quarantine and isolation centres (Wang et al., 2020a) and houses used as quarantine and isolation centres. Faecal contaminations can be transmitted through water supply network systems, which end up in contaminating the water (Arslan et al., 2020; Foladori et al., 2020). In Africa, domestic water supply is usually from surface and groundwater sources and these also serve as potential routes for transmission of SARS-CoV-2. For example, wastewater is often discharged directly into surface water sources without pre-treatment or proper treatment. If the wastewater discharged into the surface water sources contains fragments of SARS-CoV-2, which is the causative organism of COVID-19, then it is possible that
the water will be contaminated and there is a potential risk of community transmission since most rural dwellers in Africa rely on surface water sources for their domestic water supply. In the same way, groundwater sources can also serve as conduits for transmitting SARS-CoV-2 if the discharged wastewater that contains fragments of the virus is introduced into the aquifer. The virus contamination can as well occur during groundwater recharge. Generally, groundwater contains lesser microbial contaminants known as pathogens than surface water, but the biological integrity of groundwater cannot be underestimated (Alley and Alley, 2017). Majority of the waterborne diseases caused by human enteric viruses like rotavirus, enteric adenovirus, hepatitis A and E viruses, caliciviruses (norovirus and sapovirus), and astrovirus, that result in gastroenteritis, diarrhoea, conjunctivitis, hepatitis, aseptic meningitis, paralysis, encephalitis, myocarditis, insulin-dependent diabetes (Fong and Lipp, 2005; Gerba, 2009), and many more are related with contaminated groundwater (Craun et al., 2010). The disease outbreaks are mostly from wells (Borchardt et al., 2003; Fong et al., 2007; Committee on Environmental Health and Committee on Infectious Diseases, 2009) that supply water for businesses and domestic purposes. These wells do not always require any disinfection and are not periodically monitored for the microbial quality. Despite the fact that no study has yet documented evidence that SARS-CoV-2 is transmitted through drinking water, previous outbreaks of waterborne diseases resulting from faecal-oral transmission have been linked to cross-contamination emanating from poor water distribution networks, excessive network leakages, failure to disinfect water, and improper sewage disposal (Anakhasyan et al., 2012).

Although, SARS-CoV-2 may be transmitted in water through human stool, it is still not so clear how long it can survive in groundwater albeit limited researches have suggested that it can survive for weeks in groundwater (Gundy et al., 2009). In addition, waste such as surgical and nose masks, tissue papers, and personal protective equipment (PPE) discharged from hospitals without proper treatment into the water system can also lead to transmission of pathogens such as viruses (Kumar et al., 2020). This suggests that improper solid waste management practices in Africa could be one of the routes of SARS-CoV-2 transmission. In most African countries, it is now mandatory to wear face masks in public places due to the COVID-19 pandemic. Recently, Nziediewu and Chang (2020) stated that on daily basis, the total use of face masks in fifteen African countries is about 586,833,053. Governments of these countries are putting strict measures to contain and reduce the spread of COVID-19 but proper disposal of the PPE is being flouted. Hence, it is necessary to protect the water system routes to inhibit unforeseen contamination of these sources of water from SARS-CoV-2 and other pathogens. The SARS-CoV-2 and other pathogens can easily spread in countries having insufficient water supply amenities and the likelihood of infecting workers of wastewater treatment plants is high (Barcelo, 2020). Conversely, current studies have revealed that the presence of SARS-CoV-2 in wastewater is affected by temperature, UV ozone, and chlorine disinfectant (Hart and Halden, 2020; Rosa et al., 2020; Zhang et al., 2020b) and that SARS-CoV-2 has a half-life ranging from 4.8 to 7.2 h at 20 °C in wastewater (Carraturo et al., 2020; Hart and Halden, 2020; Robson, 2020).

Most African countries are logistically constrained such that they cannot adequately treat their wastewater to augment their fight against the virus. For instance, in Egypt and Tunisia, wastewater is not treated above secondary stage (Adegumi and Oguntuase, 2016). For that reason, their treatment systems heavily depend on natural systems like stabilization ponds raising the question of whether the natural conditions are adequate to kill the virus in the environment. Although the risk related with the existence of SARS-CoV-2 in surface water may be insignificant in other parts of the world, it is entirely different from Africa as a result of the poor sanitation and waste management practices.

4. Sustainable remedial measures of SARS-CoV-2 transmission in water systems in Africa

4.1. Improved WASH services and public awareness campaigns

Water, Sanitation and Hygiene, commonly known as WASH have been the focus of many researchers in Africa in recent times (Sanou et al., 2015; Elisante and Muzuka, 2016; Metwally et al., 2007; Adams, 2018; Back et al., 2018; Nhamo et al., 2019; Sunkari and Abu, 2019; Zango et al., 2019; Abanyie et al., 2020; Apanga et al., 2020; Mutono et al., 2020; Sunkari et al., 2020). Globally, it is well established that Water, Sanitation and Hygiene, commonly known as WASH have been the focus of many researchers in Africa in recent times (Sanou et al., 2015; Elisante and Muzuka, 2016; Metwally et al., 2007; Adams, 2018; Back et al., 2018; Nhamo et al., 2019; Sunkari and Abu, 2019; Zango et al., 2019; Abanyie et al., 2020; Apanga et al., 2020; Mutono et al., 2020; Sunkari et al., 2020). Globally, it is well established that WASH-related diseases have led to about 829,000 deaths in the world (Prüss-Ustün et al., 2019). The mortality rate in Africa alone as a result of WASH-related diseases is...
approximately four times that of the global rate. Despite the fact that there is currently no sufficient data linking the transmission of SARS-CoV-2 through WASH-related activities, the possible impact cannot be relegated to the background. The low rate of improved WASH activities in Africa is a good opportunity for the governments to partner with the private sector to deal with the situation. There is the need to provide efficient but cheap sanitation services to the citizenry, especially for the poorest of the poor. The best solution to this menace is the application of financial solutions to support the access of households to improved WASH amenities and to encourage WASH-related entrepreneurial activities. If governments provide easy access to funds by households and private individuals through microcredit, loans, and micro enterprise financing, this will facilitate the provision of WASH amenities for the poor. Another important measure for dealing with the possible transmission of SARS-CoV-2 through WASH-related activities is public awareness through regular behavioural change campaign to revolutionize the thinking of most Africans on myths associated with WASH activities. If all these measures are put in place in Africa, the likelihood for the transmission of SARS-CoV-2 and other human enteric viruses that may originate from the stool of infected persons will be very low.

4.2. Suburbanization of wastewater treatment facilities

Adequate and centralized wastewater treatment facilities are a major problem in Africa. As explained before, in most African countries, huge amount of the untreated wastewater generated is usually released directly into surface water sources. The adverse effects of this attitude on public health is unquestionable. It is even worrying to know that the quarantine and isolation centres of health care facilities used for testing and treating suspected and confirmed COVID-19 carriers have a common sewerage system with the coterminous communities and cities (Adelodun et al., 2020). This situation exposes the people to the situation and stop people from indiscriminately discharging wastewater into surface water bodies.

Wastewater generated in most industries in Africa, unfortunately do not pass through the entire cycle or pathway of wastewater flow (Fig. 3). Mostly after generation, due to financial or infrastructural challenges, the wastewater does not get treated but is discharged with no benefit (Fig. 3). However, with the needed finances and infrastructure in place, the wastewater generated must be properly treated and discharged or reused. Some of the ultimate uses of treated wastewater are for portable water supply, irrigation, and hydro energy (Fig. 3). Governments are overwhelmed with several equally important developmental works but there should be a willpower in dealing with the wastewater treatment issue in Africa. To augment the situation, the private sector should be motivated to focus on investing in waste-to-value projects in parts of Africa, where waste treatment or recycling facilities are absent. This will help improve the sanitary conditions around physical locations and also improve the health of the people.

4.3. Utilizing low-cost point-of-use water treatment systems

The most effective technology for virus removal from water systems is disinfection, which inactivates and destroys the virus (Pooli and Ng, 2018). It is worth mentioning that the development of low-cost point-of-use treatment devices that could completely kill and remove SARS-CoV-2 should be the focus of all countries. Similar viruses have been removed from water systems using cheaper low-cost point-of-use treatment devices such as zero-valent iron filter, iron-oxide biosand filter, nanocellulose-based filter, gravity-based ultrafilter, and many more (Bradley et al., 2011; Shi et al., 2012; Chaidez et al., 2016; Mautner, 2020). These devices can be effectively used for inactivating and destroying the SARS-CoV-2 genetic material, especially in Africa where there are no effective wastewater treatment systems.

Moreover, in view of the recent findings of researches that suggest that SARS-CoV-2 can be completely eliminated in water systems by the use of ozonation, chlorination, UV irradiation, and sodium hypochlorite (Rosa et al., 2020; Quevedo-león et al., 2020; Wang et al., 2020b), there is the need for African countries to start integrating them into their low-cost point-of-use treatment systems. The model for such an integration is schematically presented in Fig. 4. In this schematic diagram, it can be observed that when the different disinfection techniques are integrated and control measures are put in place to prevent the water from being re-contaminated, the integrity and reliability of the reclaimed water can be enhanced. Such an integrated approach of disinfecting contaminated water and wastewater can withstand influent flow and water quality fluxes.
4.4. Legally backed policy interventions

The current times require policy interventions that have legal support to direct the attitude of people living in Africa. Even with the advent of the COVID-19 pandemic, some people living in Africa believe COVID-19 is a western disease and that the confirmed cases in their countries are only political gimmicks of their governments who they think largely depend on the western world. In these abnormal times, surface water sources such as streams and rivers, which hitherto were used as domestic water supply sources in some villages have to be protected from encroachment by the rural people. In this regard, governments have to find alternative ways of meeting the water supply needs of rural people.
By doing so, sanctions can be meted out to violators. At this critical point in time, wastewater should be treated before discharge into the environment. Hence, there must be stringent measures regulating wastewater treatment and culprits should be punishable by law. Employees in wastewater treatment facilities must thus take maximum precaution to prevent themselves from possible infection. At least, it is encouraging that some African countries like Ghana, Nigeria, Cameroon, South Africa, Angola, Benin, Burkina Faso, Equatorial Guinea, Ethiopia, Gabon, Guinea, Kenya, Liberia, Rwanda, DR Congo, Sierra Leone, Zambia, and Morocco, have already put law-supported punitive measures in place for people who do not wear masks in public places in the wake of the COVID-19 pandemic. This sets the basis for others to follow suit if only they want to fight the COVID-19 pandemic. However, the safety protocols provided by the WHO and Ministries in charge of Health in all countries should be strictly adhered to and people who violate them in public places should be sanctioned.

4.5. Community-led total sanitation (CLTS)

This is an innovative way of allowing communities to initiate their own actions towards addressing their own problems. The aim is to help improve WASH practices and it is currently being implemented in many developing countries through the guidance and support of non-governmental organizations. In Africa, it is difficult for governments to be able to spearhead every developmental project. This calls for active participation of community members themselves and important stakeholders in society. One of the primary targets of the CLTs in the COVID-19 pandemic should be complete eradication of open defecation in Africa. Through this approach, communities can be technically and financially supported to carry out their own assessment of open defecation and then initiate actions to become open defecation-free. Merely providing access to toilet facilities will not always guarantee their use since previous approaches to curtail sanitation problems only set high standards with subsidies as incentives to rural people. Overtime, this never became sustainable due to the uneven adoption and partial use of the toilet facilities. Moreover, it has made rural dwellers over reliant on subsidies, which are not also regular. In this regard, faecal-oral transmission through open defecation persisted leading to the spread of waterborne diseases. So instead of merely providing the ‘hardware’ for WASH practices, there is the need for behavioural change to ensure sustainable improvement and this can only be done through CLTs. Investing in community mobilisation should be at the heart of the CLTs programs such that the focus on toilet construction for individual households will be shifted to making sure villages and communities are actually open defecation-free. Through awareness creation with the message that the continuous practice of open defecation by even the minority in the community will expose everyone to the risk of diseases, CLTs will prompt the community’s crave for collective change, will push people into taking actions and development of innovative ideas, will provide mutual support and proffer suitable local solutions to local problems, which in the end will lead to complete ownership and sustainability.

5. Conclusion

The impact of the COVID-19 pandemic is currently felt everywhere in the world and in all aspects of the economy. The impact is even envisioned to be more severe in the developing world like Africa, which is still struggling to meet the basic necessities of life for the people living there. Since most of the people living in Africa, especially those dwelling in rural and peri-urban settlements depend on surface and groundwater resources for their domestic water supply, the risk of contracting COVID-19 through SARS-CoV-2 contaminated water from wastewater systems is very high. Hospital sewage, waste from isolation and quarantine centres, contaminated surface and groundwater sources, faecal-oral transmission, and contaminated sewage are identified as the potential sources and routes of SARS-CoV-2 transmission in water systems in Africa. These can be effectively addressed by improved Water, Sanitation and Hygiene (WASH) services and public awareness campaigns, sub-urbanization of wastewater treatment facilities, utilizing low-cost point-of-use water treatment systems, legally backed policy interventions, and Community-Led Total Sanitation (CLTS). Apart from preventing water from being contaminated with SARS-CoV-2 through these proposed sustainable measures, they can be effectively used to deal with waterborne microorganisms that are causing several diseases and deaths in Africa.

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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