COVID-19 PANDEMIC: WATER, SANITATION AND HYGIENE (WASH) AS A CRITICAL CONTROL MEASURE REMAINS A MAJOR CHALLENGE IN LOW-INCOME COUNTRIES

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Abstract

Severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2) is responsible for the deadly respiratory disease called coronavirus disease of 2019 (COVID-19), an ongoing global public health emergency that has been declared a pandemic by the World Health Organization. We review literature on the transmission and control of SARS-CoV-2 and discuss the challenges of focusing on water, sanitation and hygiene (WASH) as critical control measures in low-income countries. A significantly higher prevalence of SARS-CoV-2 infection and COVID-19 related deaths has been reported for the United States of America and other high-income countries in Europe and Asia, regardless of advanced medical facilities in those countries. In contrast, much lower COVID-19 related morbidity and mortality rates have been documented in many low-income countries, despite having comparatively higher socioeconomic burdens and suboptimal medical facilities. By September 29, 2020 over one million deaths have been reported. On the same day, the cumulative total of COVID-19 related morbidity for Africa was 35,954 with 3.5% of the global COVID-19 related deaths. We present arguments for the relatively low COVID-19 morbidity and mortality rates in many low-income countries and discuss the critical importance of WASH for preventing the spread of infectious diseases like COVID-19. We observe that the key recommendations put forward by the World Health Organization to effectively control the pandemic have been difficult to implement in low-income countries. We conclude that the pandemic reinforces previous pronouncements that adequate and effective WASH measures are crucial for public health and recommend closer coordination between public health and WASH sectors.

Keywords: COVID-19; low-income countries; SARS-CoV-2; WASH (Water, Sanitation and Hygiene)

1. INTRODUCTION

Coronavirus disease of 2019 (COVID-19), which was first detected in Wuhan (Hubei, China) in December 2019 has spread globally and declared a pandemic by WHO (Wu et al., 2020; Zhou et al., 2020; WHO, 2020). By November 2020, there were more than 51 million confirmed cases globally, with over 37 million recoveries and more than a million deaths, according to data compiled by John Hopkins University Coronavirus Resource Centre. The virus responsible for COVID-19 has been identified as Severe Acute Respiratory Syndrome Coronavirus-2 (SARS-CoV-2) (Gorbalenya et al., 2020; Li et al., 2020). SARS-CoV-2 belongs to the genus *Betacoronavirus* in the sub-family Orthocoronavirinae of the family Coronaviridae together with other three genera which include Alphacoronavirus, Gammacoronavirus, and Deltacoronavirus (Fehr and Perlman, 2015). Within the family *Coronaviridae*, in which SARS-CoV-2 clusters, there are other six viruses i.e., SARS-CoV-1 and MERS-CoV, which are known to cause severe human illnesses and 229E, OC43, NL63 and HKU1 strains, which cause mild symptoms (Cascella et al., 2020). The structure of coronavirus consists of enveloped viral particles with positive sense RNA strands ranging from 60 nm to 140 nm in diameter with spike-like projections on the surface, giving it a crown-like appearance under the electron microscope, hence the name coronavirus (Li, 2016).

Access to WASH is essential to protect human health during infectious disease outbreaks (Prüss-Ustün et al., 2014; Sophie et al., 2016; Chen et al., 2020). Hand hygiene, which is a critical component of the wider WASH framework is highly recommended by WHO as a critical control measure to contain SARS-CoV-2 transmission (Sophie et al., 2016; Guy et al., 2020: WHO/UNICEF, 2020). A simple WASH measure like proper hand washing with clean water and soap could interrupt the transmission of several disease-causing bacteria and viruses, thus reducing the general burden of disease. However, the WASH sector is typically least prioritized and underfunded in low-income countries despite its importance for economic growth and even more critically for the control of infectious diseases (Sophie et al., 2016; Roche and Cumming, 2017). Majority of the world's population lacking access to WASH facilities are in low-income countries, especially in rural settlements and unplanned urban population clusters. For instance, in 2017, nine out of ten of the 785 million people who still used limited services, unimproved sources or surface water lived in three regions: sub-Saharan Africa (400 million), Eastern and South-Eastern Asia (161 million), and Central and South Asia (145 million) (WHO/UNICEF, 2019). As the global spread of the pandemic became obvious in the first quarter of 2020, there was a sense of apprehension about what would happen when the pandemic gets to low-income countries (Blake, et al., 2020). The combination of poor WASH conditions and overstretched healthcare systems in those countries during a global public health emergency was a genuine reason for the apprehension.

In this article, we reviewed literature on SARS-CoV-2 transmission and control and discussed the challenges of focusing on WASH as a critical control measure in low-income countries with poor WASH conditions. In addition, we discussed the critical importance of water, sanitation, and hygiene for preventing infectious diseases and presented some arguments for the global disparities in COVID-19 related morbidity and mortality between low-income and high-income countries.

2. SARS-COV-2 TRANSMISSION, MORBIDITY AND MORTALITY

The exact animal reservoir of SARS-CoV-2 has not been ascertained fully but it is suspected to be from bats of the genus *Rhinolophus* as it shares 96% sequence similarity with Betacoronaviruses isolated from multiple species of bats from this genus (Han et al., 2019). The SARS-CoV-2 isolated from humans shared 92% sequence similarity with SARS-like viruses that were circulating in bats, and 90% of the SARS-like viruses from bats have been isolated from the *Rhinolophus* genus which is widely distributed across Asia, the Middle East, Africa and Europe (Csorba et al., 2003; Han et al., 2019). The comparatively strong genetic sequence similarity between SARS-CoV-2 and beta coronavirus isolated from bats (BatCoV RaTG13) suggests that ancestors of the former were circulating in bats in the Rhinolophus genus (Han et al., 2019; Zhou et al., 2020). Other studies have confirmed possible animal-to-human and human-to-human transmissions but the intermediate host for the transmission of SARS-CoV-2 is still not known with full certainty (Guo et al., 2020; Muhammad et al., 2020). Many respiratory infections have previously been linked to human interaction with wildlife and livestock but tracing a similar source of SARS-CoV-2 remains a big challenge (Han et al., 2019; Li et al., 2020).

COVID-19 is the third zoonotic coronavirus outbreak in the last two decades after SARS (Severe Acute Respiratory Syndrome) was reported in Singapore in 2003 and MERS (Middle East Respiratory Syndrome) in Saudi Arabia in 2012 (Yi et al., 2019; Xie & Chen, 2020). Like other coronavirus outbreaks, human-to-human transmission of SARS-CoV-2 occurs primarily when respiratory droplets containing the virus reaches the mucosa of the eyes, nose, and mouth (Lai et al., 2020). SARS-CoV-2 can spread quickly in healthcare facilities, public places and family settings when the recommended containment measures are not strictly followed (WHO, 2020). The virus spreads when people infected with the virus sneeze, cough on, or touch surfaces, or objects, such as tables, doorknobs and handrails (Chan et al. 2020; Kampf et al., 2020; Jin et al., 2020; Shen et al., 2020; WHO, 2020). Other people can be infected by touching contaminated surfaces, and touching their eyes, noses or mouths afterwards without cleaning their hands. Aerosol transmission may occur in indoor, crowded and poorly ventilated spaces such as restaurants, choir practice rooms, gyms, nightclubs, offices or places of worship where infected person(s) spend long periods of time with others (Jayaweera et al., 2020, Stadnytskyi et al.,2020; WHO, 2020).

Once the virus infects humans, it causes disease to varying degrees, from upper respiratory tract infections (URTIs) resembling the common cold, to lower respiratory tract infections (LRTIs) such as bronchitis, pneumonia, and even severe acute respiratory syndrome (SARS) (Corman et al., 2019; Schoeman and Fielding, 2019). Infected persons especially those with underlying health conditions are generally susceptible to SARS-CoV-2 within an incubation period of 2 to 14 days (Singhal, 2020). However, some SARS-CoV-2 infected persons do not show any symptoms and are likely to go unnoticed (Xu et al., 2020). Such individuals may trigger community spread of COVID-19 and are of public health interest to contain the pandemic (Bai et al., 2020; Gao 2020).

Currently, both morbidity and mortality rates from COVID-19 remain relatively low in many low-income countries compared to some high-income countries (Fig. 1). A significantly higher prevalence of SARS-CoV-2 infection and COVID-19 related deaths has been observed in many high-income countries like the United States of America, and other countries in Europe and Asia regardless of advanced medical facilities in these countries. It is still not fully understood why morbidity and mortality remain relatively low (Figure 1, D) in many low-income countries, although COVID-19 risk has been diametrically associated with certain demographic characteristics such as household size, age structure, level of income and social/economic status (Walker et al., 2020). On 29 September 2020, the world passed the grim milestone of one million reported deaths. On the same day, the total mortality count for Africa was 35,954 (Marsh and Alobo, 2020). Africa accounts for 17% of the global population but only 3.5% of the reported global COVID-19 deaths. There has been much discussion on what could be responsible for the relatively lower morbidity and mortality rates in sub-Saharan Africa. Factors such as limited travel, inadequate COVID-19 testing capacities and widespread challenges with data collection have been mentioned (Marsh and Alobo, 2020). But decisive and timely measures (like the early lockdown) that were put in place by many governments in the region, borne from experience with previous outbreaks like Ebola, may have contributed to fewer confirmed cases and deaths compared to other regions (Gaye et al., 2020). In addition, Marsh and Alobo, 2020 argued that the age structure in Africa (dominated by a much younger population) explains a very large part of the apparent difference and suggested that some of the remaining gap is probably due to underreporting of events. However, there are a number of other plausible explanations. These range from climatic differences, pre-existing immunity, genetic factors, and behavioural differences among cultures and regions (Doshi, 2020; Maecenas et. Al., 2020; Marsh and Alobo, 2020; Tso et al., 2020; Urashima et. al., 2020; Zeberg and Pääbo, 2020). One hypothesis is that the population in sub-Saharan Africa could have been previously exposed to other coronaviruses prior to the COVID-19 pandemic. This may have resulted in some degree of cross-protection against SARS-CoV-2 infection and pathogenesis. In a recent study, a significantly higher prevalence of SARS-CoV-2 serological cross-reactivity was detected in blood samples from sub-Saharan Africa compared to USA, Europe, and Asia (Tso et al., 2020). The authors suggested that prior exposure to common human coronaviruses may be the reason behind the low susceptibility in sub-Saharan Africa. Clearly there is no single reason for the observed differences in COVID-19 related morbidity and mortality rates, but a combination of the factors discussed above could help in our understanding as more studies are undertaken and reported.

3. SARS-COV-2 CONTROL UNDER POOR WASH CONDITIONS

A major challenge for the control of SARS-CoV-2 transmission has been the lack of effective drugs or vaccine (Qu et al., 2020). Like SARS and MERS, there is still no specific licensed antiviral treatment for COVID-19. Clinical management of COVID-19 patients has been mainly supportive to manage symptoms. However, some treatment medications or procedures are under investigation and positive results from various vaccine trials indicates that the virus can be stopped. For example, by December 2020, three of the six vaccine candidates supported by the U.S. Government have reported promising data with high efficacy with emergency use authorization for two vaccines being issued already. Nevertheless, the path ahead is still very uncertain considering the costs and huge logistics needed to produce, distribute, and administer vaccines. According to WHO, $4.3 billion is needed immediately to lay the groundwork for mass procurement and delivery of vaccines and a further $23.9 billion is required for 2021 (Address to the First High-Level Session of the U.N. General Assembly on the Pandemic on December 4 2020 by WHO Director-General Tedros Adhanom Ghebreyesus).

Until that time when effective treatment and universal vaccination is possible, the underlying health and immunity status of exposed population and the measures recommended by WHO to prevent SARS-CoV-2 transmission will play a critical role in containing the pandemic (Mohamed and Josef, 2020; WHO, 2020; Xu et al., 2020). Current WHO recommendations on preventing the transmission of SARS-CoV-2 promote good hygiene, especially regular hand washing with clean water and soap (WHO, 2020). In addition, WHO recommends social distancing practices, wearing of face mask in public places and situations where social distancing is not possible, and the use of personal protective equipment by frontline health service providers (WHO, 2020). Wearing of masks prevents the wearer from transmitting SARS-CoV-2 to others and the practice may provide some protection to the wearer (Howard et al., 2020). Given that transmission of SARS-CoV-2 can occur through contaminated surfaces and contaminated hands, proper hand hygiene is extremely important to stop transmission.

Hand hygiene is well known to interrupt transmission of other viruses and bacteria causing common colds, flu, and pneumonia such as rhinoviruses, coronavirus, influenza A or B virus, arainfluenza virus, respiratory syncytial virus, adenovirus, enterovirus, *Chlamydia pneumoniae*, *Haemophilus influenzae, Streptococcus pneumoniae*, *Mycoplasma pneumoniae* (Mäkelä et al., 1998; Prüss-Ustün et al., 2014; Chen et al., 2020; Hopman, 2020; Zunyou and Jennifer, 2020). Handwashing with soap is a cost-effective public health intervention in reducing diarrhea disease burden, costing US$3.35 per disability-adjusted life year (DALY) averted (Cairncross and Valdamanis, 2006). The duration of survival of human coronaviruses in general depends on several factors, including the type of surface, temperature, relative humidity, and the specific strain of the virus (Kampf et al., 2020). SARS-CoV-2 is an enveloped virus with a fragile outer membrane. Hence, it is less stable in the environment, although like SARS-CoV-1, it can persist on aerosols and other similar surfaces (van Doremalen et al., 2020). The virus is susceptible to detergents and oxidants, such as chlorine and it is reported to be inactivated significantly faster than non-enveloped waterborne human enteric viruses (Salido et l., 2020; WHO/UNICEF, 2020).

Therefore, WHO has put hand hygiene as a key pillar for stopping the transmission of SARS-CoV-2. However, access to adequate WASH facilities is a challenge in low-income countries, especially in rural areas and low-income urban settlements (Donde et al., 2013; Jeuland et al.2013; Behnke et al., 2018; Gudda et al., 2019; Kumwenda, 2019; Owassa et al., 2020; Robert et al., 2013; TEARFUND 2007). Furthermore, the promotion of other COVID-19 control measures such as social distancing, self-isolation and avoidance of public places has been more challenging in low-income countries given that people from different households in rural areas and densely populated urban clusters use the same water points and share bathrooms and pit latrines, which are often in poor conditions (Guy et al., 2020). Organizations like World Vision have continued to work with local institutions such as schools and universities to improve the WASH conditions during the pandemic. However, implementing and sustaining even a basic hand washing facility with soap is still difficult to achieve in many parts of Africa, Asia and South America. It is estimated that universal access to WASH services to achieve SDG 6 targets by 2030 would require an estimated 0.13 to 1% of the gross regional product (GRP) of low income and middle-income counties in Southern Asia and sub-Saharan Africa (Hutton and Varughese, 2016). This will be difficult to achieve from public funds which are now constrained by additional and urgent budgetary needs like containing COVID-19. Therefore, external development assistance would be required to support the WASH sector at a critical time when resources are being channeled towards the global fight against the pandemic. A rational allocation of resources to respond to the pandemic could include the WASH sector, which is typically least prioritized and underfunded in low-income countries.

Waterborne transmission for SARS-CoV-2 has been ruled out, but some particles of SARS-CoV-2 have been detected in faeces and urine of COVID-19 patients, as well as in the wastewater streams of urban areas where COVID-19 outbreaks have occurred (Chavarria-Miró et al., 2020; Haramoto et al., 2020; Medema et al., 2020; Thompson et al., 2020; Wu et al., 2020; Xu et al., 2020; Zhou et al., 2020). In addition, a surrogate human coronavirus has been reported to survive for several days in tap water and sewage at 4°C - 25°C (Ahmed et al., 2020). Although there is currently no evidence for SARS-CoV-2 transmission via drinking water, wastewater or through the faecal-oral route, these findings nevertheless, highlight the need for adequate WASH services and care in handling human excreta and wastes especially from healthcare facilities handling COVID-19 patients. Furthermore, the discovery of SARS-CoV-2 viral particles in wastewater has emerged as a potential effective approach for identifying and tracing the spread of the virus (Thompson et al., 2020). Initial results and analysis indicate that monitoring wastewater influents at community or municipality scale may provide insights into how widespread the outbreak has occurred in certain population clusters, especially in communities where mass testing of the entire population may be difficult to achieve (Mallapaty, 2020). Such analysis could reveal the true scale of a COVID-19 outbreak that is associated with a particular population cluster (Medema et al., 2020; Thompson et al., 2020). The approach could be helpful in low-income countries with limited resources to undertake mass COVID-19 testing and tracing.

Some additional challenges have since emerged with regards to meeting the required standards for disposal and management of wastes from healthcare facilities handing COVID-19 patients. Management of healthcare wastes following standard procedures is a challenge in most low-income countries and this increases the potential for SARS-CoV-2 transmission (Nzediegwu and Chang, 2020; Rhee, 2020). A major concern includes proper management of the Personal Protective Equipment (PPE) used to protect frontline health workers and handling biocidal agents used to fumigate surfaces at healthcare facilities handling COVID-19 patients. Several countries have thus far instituted policies to ensure sustainable management of waste while protecting the safety of waste handlers (Sarkodie and Owusu, 2020). However, most countries have proceeded with the establishment of testing/treatment centers and isolation facilities with little or no attention towards establishment of safe disposal facilities for the infectious waste generated (Ugom, 2020). Strict sanitation procedures are to be followed when handling wastes from confirmed COVID -19 patients. Such wastes should be handled with care and treated as biohazards (WHO/UNICEF, 2020). It is required to provide separate flush toilets or latrines that should be cleaned and disinfected at least twice daily by a trained cleaner wearing appropriate PPE (Rhee, 2020). Toilets should be flushed with the lids down to avoid droplets splattering around, as well as to prevent aerosols from being generated (Johnson et al., 2013; Gudda et al., 2019). Furthermore, the plumbing system should be well maintained to avoid leakages and prevent aerosolized droplets from entering the plumbing or ventilation systems (Rhee, 2020). When pit latrines are used, care must be taken to prevent contamination of the environment with excreta, including groundwater (Gudda et al., 2019).

4. CONCLUSIONS AND RECOMMENDATIONS

The COVID-19 pandemic underscores the critical importance of WASH for preventing infectious diseases and reinforces previous pronouncements that adequate WASH is crucial for public health. However, key WASH recommendations put forward by WHO to effectively contain the pandemic has been difficult to undertake in low-income countries.

- WASH policy and action can be transformed and scaled more quickly through appropriate political involvement to address current needs while preparing for future public health emergencies. This would require high-level political attention and closer coordination between public health and WASH sectors at the level of implementation.
- WASH is central to the COVID-19 response and recovery strategy. Sufficient funding is necessary to provide and maintain adequate WASH services and support countrywide advocacy programmes on science-based messaging. This will ensure that WHO recommendations on regular handwashing with clean water and soap are achieved universally.

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CONTRIBUTIONS

Each author listed equally participated actively in the design of the study, as well as in the collection, review, and analysis of literature. They undertook drafting and writing of the manuscript in equal measure and approved the submission of the manuscript in its current format.

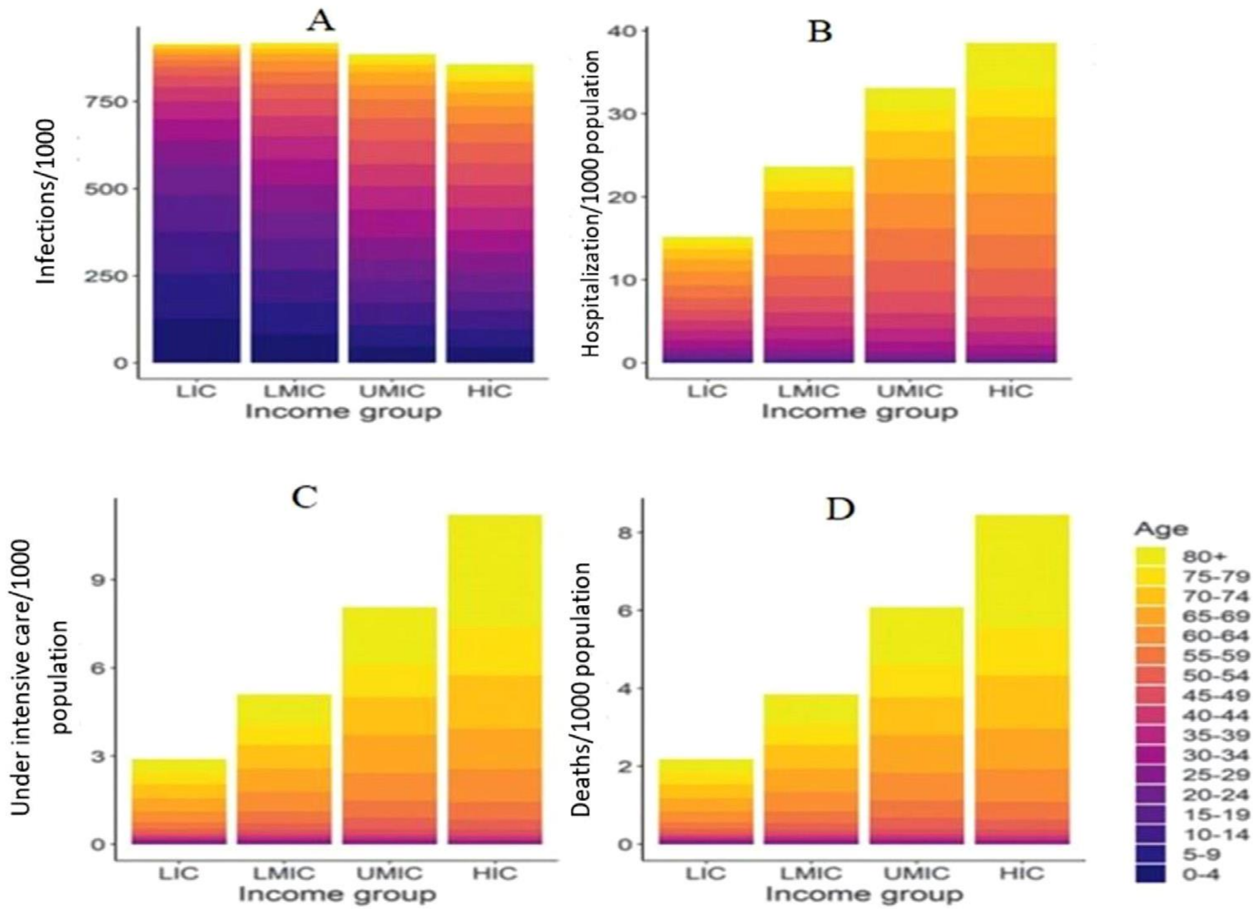

Figure Legend

Figure 1: Global status of COVID-19 pandemic for different countries categorized into income levels and age groups. (Produced by author based on July 2020 data compiled by Johns Hopkins University). A: Number of infections per 1000 population; B: Number of infected patients requiring hospitalization per 1000 population; C: Number of infected patients requiring intensive care per 1000 population; D: Number of deaths experienced per 1000 population; LIC: Low-income countries; LMIC: Lower middle-income countries, UMIC: Upper middle-income countries; HIC: High income countries)

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