Commentary
Air Pollution in Africa in the time of COVID-19: the air we breathe indoors and outdoors

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https://doi.org/10.17159/caj/2020/30/1.8227

The first COVID-19 case was announced in Nairobi, Kenya, on the 12th March 2020. The Ministry of Health in Kenya swiftly advised physical distancing, suspended public gatherings and interschool activities, and imposed travel restrictions. In addition, the Ministry advised regularly and thoroughly washing hands with soap and water or using alcohol-based hand sanitizer. The Ministry also warned against misinformation; a call echoed by the United Nations Secretary General who cautioned against "a dangerous epidemic of misinformation" (UN News, 2020), as people searched for facts and answers which could save their lives. The coronavirus outbreak has seen these measures escalated to lockdown for many African countries including South Africa, Rwanda, and Uganda, which have been in lockdown since the end of March (Dunford et al., 2020). Other countries across the globe have also implemented different lockdown measures.

As much as the media celebrated reduction in air pollution with lockdown measures in place as a small silver lining amidst the COVID-19 pandemic, it seemed like indoor air quality was the elephant in the room given the directives for people to stay at home to curb spread of infection. This is especially so as African countries have a health and environment burden due to the increasing outdoor air pollution, but it is the indoor air pollution that has a bigger burden on premature mortality and morbidities. Exposure to indoor and outdoor air pollution is estimated to be responsible for 404,000 and 258,000 premature deaths in Africa per year, respectively (GBD, 2017). Air pollution (both indoor and outdoor) accounts for over 14% of all non-communicable diseases (NCDs), a far greater share than the contribution of other key risks factors including alcohol, diet and high sodium intake (GBD, 2017). This exceeds mortality due to unsafe water, sanitation, and childhood malnutrition in Africa (Rees et al., 2019). Furthermore, there is added risk because NCDs, which are pre-existing conditions that increase the risk of death for COVID-19, are the diseases associated with the increase in exposure to air pollution. Preliminary results find that among the U.S. population, an increase of only 1 µg/m^3 in $PM_{2.5}$ in the long-term is associated with a 15% increase in the COVID-19 death rate (Wu et al., 2020). In Europe, early results show COVID-19 fatalities were greatest in the regions with the highest long-term exposure (Conticini et al., 2020). Therefore, in Africa, COVID-19 fatalities and air pollution are likely to further overstrain health systems which already suffer from a disproportionate burden of communicable diseases like malaria, cholera, Ebola, and dengue fever.

More than 900 million people in Africa rely on polluting energy sources for cooking, and 600 million are without access to electricity (IEA (International Energy Agency), 2019). This means, during the COVID-19 period, millions of households in Africa are exposed to high levels of air pollution as they cook, heat and use light inside their houses. The exposure to air pollution from the burning of wood, charcoal and kerosene in these households is exacerbated by many millions living in small congested spaces, poor ventilation and building materials that increase the pollution load. These living conditions are encountered globally in informal settlements, where close to one billion people are estimated to live (Corburn et al., 2020). Furthermore, in the poorer households, most families will use whatever is available for fuel: scrap tires, plastic waste, cloth rags and other unconventional materials (Muindi et al., 2016). A study in Nairobi in an informal settlement showed the levels of fine particulate matter communities were exposed as they went about their daily activities were approximately 3 to 4-fold the World Health Organization (WHO) Air Quality Guidelines for outdoor air quality (West et al., 2020). When the indoor and outdoor air pollution mean values were compared, indoor air pollution concentrations far surpassed the outdoor air pollution values. Thus, during the COVID-19 period where most households are required to be indoors, it is most likely indoor air pollution exposure will increase, adding to the underlying vulnerabilities of people already exposed to long term high levels of outdoor air pollution. Moreover, air pollution exposure is unevenly distributed and inherently unjust in Africa as poor communities are most likely exposed to higher levels because their houses and workplaces are close to major roadways, industrial parks and waste dumps (Rooney et al., 2012; Egondi et al., 2016). This is compounded by poor health access and nutrition. As parts of Africa transition towards colder weather and as households face economic hardship, there may be more use of dirty fuels further worsening indoor pollution.

The traffic in most cities in Africa during the COVID-19 shutdown has reduced, such that the easing of congestion is seen to be like the traffic thinning during the festive period where most city dwellers decamp to the rural area for short periods. The question of the cleaner air in African cities however is most

likely more complex than the optimistic reports of clean skies and fresh air in cities: New York (Mcshane, 2020), Los Angeles (Kann, 2020), London (Edwards, 2020), Milan (Buonocore, 2020), Wuhan(World Economic Forum, 2020), Beijing, Bogota (Petersen et al., 2020) and New Delhi (Gettleman, 2020). The ease in which the evidence could be provided on the declining levels of outdoor air pollution in cities in the U.S, Europe and Asia, may not be for African cities. This may be because there is a dearth of ground air quality monitoring in African cities. Less than 10 countries in the African region have ground-based city level data on air pollution including PM_{10} and $PM_{2.5}$, representing only 0.5% of cities in the region(WHO, 2018) . But among the cities with data, 90% of them exceed the WHO guidelines for PM. There is also limited air pollution epidemiological studies conducted in Africa (Coker and Kizito, 2018). Furthermore, epidemiological studies obtained in developed countries may not be extrapolated with complete confidence to African countries (Wichmann, 2005). Thus, it is clear there an air pollution problem in Africa, but we need to build the evidence base (Wichmann, 2016).

Globally, outdoor air pollution has declined in 27 countries in the first two weeks of lockdown: nitrogen dioxide (NO_2) by 29%, Ozone (O_3) by 11%, and fine particulate matter ($PM_{2.5}$) by 9% (Venter et al., 2020). This decline has been attributed to lower emissions from transport and industry related activities. Scientists have cautioned for these studies to be interpreted against the seasonal meteorological variation (Carslaw, 2020; McNeill, 2020; Young, 2020). However, these analyses are often not possible in Africa where the limited ground air quality monitoring is often sparse, short term, piecemeal and where most of these campaigns are to test new technologies, and thus the scarce resources are not often targeted towards the local problems but rather at the external project priorities.

Amid the COVID-19 pandemic the potential for innovation in Africa has come to the fore, new ways to tackle hygiene in a water scarce environment for example comes to mind. A recent invention by Kenyan youths for example, mounts a mobile wash facility on a bodaboda (motorcycles commonly used for goods and passenger transport) that dispenses soap, water and masks, and recycles the water used; this is all assembled using recycled material (Shiundu, 2020). Leveraging these kinds of efforts to tackle air pollution challenges may be the targeted interventions African governments need. However, the rollback or the loosening of air quality limits during the pandemic (McNeill, 2020) or after in some parts of the world is action African governments can ill afford. Whilst indoors, households are advised to reduce indoor air pollution by increasing ventilation by opening windows, doors and if undertaking activities such as cooking, heating or lighting leaving these open for as long as possible. Furthermore, the relief packages considered for the vulnerable members of the communities in Africa may consider clean fuels as part of the package to alleviate exposure due to burning of dirty fuels. Additionally, as evidence on spread of COVID-19 in Africa is built there is a need for the modelling to consider environmental factors including air quality as well as trends in fuel usage.

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