Commentary

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Environmental health research challenges in Africa

Insights from symposia organized by the ISEE Africa Chapter at ISES-ISEE 2018

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Africa presents research challenges and opportunities for environmental health researchers. The African population is increasing rapidly with a rapid urban growth1, an increasing industrialization, a higher adoption of a wide variety of technologies and health interventions (e.g. more cars on one hand and higher vaccination rates on the other) and an intensive exploitation of environmental resources. Consequently, African countries are undergoing an epidemiologic transition from high endemic prevalence of communicable diseases to a double burden led by non-communicable diseases followed by communicable diseases. According to the United Nation[1] by 2070, the bulk of the world's population growth is predicted to take place in Africa. Of the additional 2.4 billion people projected between 2015 and 2050, 1.3 billion will be added in Africa. This transition presents increased health risks for Africans from increased use of pesticides, more exposure to heavy metals, and higher concentrations of other pollutants from cities.[2–4] Further, climate change is affecting the burdens of climate-sensitive health outcomes. Climate change projections and synergistic effects of heavy metals and pesticides pollutions suggest an increase of health risk in the coming decades without additional interventions,[5,6] in a global African context of weak availability of reliable/precise data on burden of health problems attributed to environmental health hazards.[4] Africans are particularly vulnerable to these risks,[7–9] mainly due to weak institutional, technical, and financial capacities of African countries to cope with the risks compared with developed countries.

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During the ISES-ISEE 2018 joint meeting in Ottawa, the ISEE Africa Chapter sponsored three symposia: *Climate Change, Air Pollution and Environmental Health* (two symposia), and *Exposure to Pesticides and Heavy Metals* (one symposium), focusing on Electronic Waste, Artisanal and Small-Scale Mining, and Indoor Residual Spraying.[10] The abstracts are available online at https://ehp.niehs.nih.gov/do/10.5555/cf321013-5720-41d4-8883-2a43ac2853de/full and synthesized in eTable 1 (http://links.lww.com/EE/A66). Twelve research projects were presented, covering seven African countries (Burkina Faso, Côte d'Ivoire, Ghana, Mauritania, South Africa, Uganda, and Zambia) and including researchers from 39 institutions from 16 countries working together in South–South or South–North/North–South partnerships. The disease outcomes being studied were diverse, from water- and vector-borne diseases (malaria, schistosomiasis, dengue) to non-communicable chronic diseases, mainly cardiovascular and pulmonary diseases (stroke, cardio-pulmonary failure, myocardial infarction, pneumonia, asthma) and children's neurodevelopmental disorders and immune function in relation to pesticide and heavy metals pollution.

The main lessons learnt from these presentations with relevance for research in Africa were (1) the value of intersectoral, institutional, and transdisciplinary collaboration among researchers and/or policy makers, (2) the critical importance of adaptation to climate change to advance resilience, (3) the high health burden of pesticide use and exposure to heavy metals, and (4) the continuing challenges to research funding. Although these lessons are not new for high-income countries, Africa presents a unique opportunity for furthering understanding of systems-based approaches to advance environmental health while also promoting sustainable and resilient development.

Need for a more intersectoral, institutional, and transdisciplinary collaboration among researchers and/or policy makers in Africa

Environmental health challenges in Africa are complex and require systems-based approaches to facilitate effective and efficient interventions in low-resource settings. Key examples of such challenges include high exposures to lead, mercury, and air pollutants; the large burden of health risks associated with indoor and outdoor burning of biomass and the significant proportion of urban children in many countries who suffer from lead poisoning.[11–13] Environmental exposures interact with nutritional deficiencies and a high burden of communicable diseases to create significant health challenges. These issues must be tackled jointly, requiring multifaceted frameworks that can deal with the associated complexities. Applying the approaches used in high-income countries to the realities of African countries will likely fail if local dynamics and holistic approaches to environmental health are not incorporated. The interplay of several nutritional, social, and behavioral risk factors concurrently with the environmental ones calls for more sophisticated models to

disentangle individual and combined risk factors, in addition to a better understanding of local beliefs, behaviors, and attitudes towards potential regulations.

Additionally, the multi-factorial nature of the health impacts of global socio-environmental change (climate change, rapid urbanization) calls for an increase in intersectoral institutional collaboration between health, environment, urban planning, and other sectors. The Libreville declaration on health and environment[14] may serve as a basis for increasing national inter-ministerial collaboration between health and environment sectors for research and development. This declaration, made in 2008 by African ministers responsible for health and the environment, commits and encourages African countries to develop or update national, sub regional, and regional frameworks in order to address more effectively the issue of environmental impacts on health, through integration of these links in policies, strategies, regulations, and national development plans.

Also, regional datasets are needed; these can be developed through South–South and North–South partnerships to increase data sharing for research and for adoption of effective management strategies at national and local scales. An urgent and immediate need is monitoring systems that allow for real-time information on a range of potential environmental hazards. These systems should be leveraged to create alerts, deliver customized and easily accessible health information for potentially affected populations, and form the basis for cohort studies of environmental exposures, which till date have been a major limitation for research from the region.[15] Smartphone applications may be an efficient way to increase awareness of health threats, provide real-time information about weather, concentrations of allergens like pollen, molds, and air pollutants, and to provide guidelines and measures to limit health impacts. African countries may strongly benefit from the rapid uptake and use of smartphones across the continent.

Two main challenges need to be addressed. First, obtaining regular air pollution and other environmental assessments is needed in African countries. Despite the availability of extrapolations from satellite data with respect to optical density, air quality and weather conditions, significant work is needed to validate observations using monitors and appropriate models. Such environmental models may also help predict environmental factors and concentrations at a finer spatial scale. Second, limited efforts are being made in knowledge dissemination, training, and capacity building. These will be key to developing and efficiently using these new systems and technologies at individual, family, and community levels.

Climate change adaptation in Africa

Africa is particularly vulnerable to climate change because of higher exposure and vulnerability. Most of Africa's population rely on climate-sensitive resources and rain-fed agricultural systems for livelihoods[16] and will likely suffer a disproportionate share of the adverse effects of climate change, regardless of its comparatively limited role in bringing it about. Literature on the health risks of and adaptation to climate change is more limited in Africa than in other regions.[17,18] In addition to basic research, progress in the skill of real-time weather forecasting in high-income countries needs to be extended to Africa, including understanding how changing weather patterns affect air quality (e.g., the concentration of pollen and fine particles [PM2.5]) and affect vector-borne and water-related disease transmission.[4,7,18] Further, the frequency, intensity, and duration of many of extreme weather and climate events are projected to increase, with consequences for injuries, illnesses, and deaths.[7,18] A warming climate is expected to bring more frequent heatwaves and other extreme weather events that can interact with air pollution to further increase health risks.[5,7]

Pesticides-use and exposure to heavy metals in Africa

Pesticides are widely used worldwide for control of pests, including insects, rodents, and unwanted plants. The use of pesticides, such as dichlorodiphenyltrichloroethane (DDT) and pyrethroids for control of various pathogens and vector-borne diseases, is widespread in Africa, especially in Malaria-endemic regions. Despite the usefulness of these control measures, there is currently strong evidence supporting adverse health effects related to pesticide exposure, including neurological, endocrine, reproductive, and carcinogenic effects.[2,6,19] Many pesticide families have been banned or phased out in industrial countries, but the control of vector-borne diseases in Africa represents a challenge to establish such regulations. According to a recent UN report, the potential cost of pesticide-related illnesses in sub-Saharan Africa between 2005 and 2020 could reach $90 billions.[20] We propose here that environmental health studies in Malaria-endemic regions should include cost–benefit analyses of the use of DDT spraying and pyrethroid treated bed nets for Malaria control. Such studies will unravel the usefulness and health costs related to these practices, and allow for better informed decisions in regard to the use of these chemicals.

Both natural and anthropogenic activities are sources of heavy metal pollution. Exposures in Africa present a challenging picture with an even more complex picture of exposure sources. These arise from artisanal and small-scale gold mining activities, unregulated processing of the E-waste from high-income countries that often ends up in low- and middle-income countries, use of leaded petrol until recently, airborne dust, arbitrary dumping, and burning of toxic wastes. These exposure sources are enhanced by the profile of exposed populations that include working children and women in uncontrolled environments. This complexity is enhanced by a rapid urbanization and lack of construction guidelines in regard to materials. The levels of exposures to heavy metals in Africa have been shown to be extremely high in some studied communities, with levels in the soil, drinking water, and air almost 1000 times higher than the permissible level.[21] Similar high exposures have been found in pregnant women and children.[22,23] The global burden of exposure to heavy metals in Africa is still unknown and may cost hundreds of billions of dollars yearly. For instance, exposure to lead alone have been shown to cost about 4% of Africa's gross domestic product (~$140 billions).[24] There is a need to increase regulation and sensitization and capacity building of populations and communities for better use of pesticides. At the country level, regular processing of E-waste and formal registration of gold mining enterprises would lead to better control of environmental contamination and protection of workers' health. Pollution and disease related to pesticides and metals can affect water supplies, food security, human productivity, and health systems in significant ways, hampering efforts towards the United Nations Sustainable Development Goals.[20]

Research funding challenges in Africa

Science is required to inform policies to protect vulnerable populations in Africa. Increased research funding is an urgent priority. African nations lag far behind in the share of gross domestic product (GDP) allocated to funding research compared with industrialized countries that have more resources. European countries, United States, Japan, Korea, and China invest more than 2% of their GDP into research and development, and all other developed countries invest at least 1% of GDP. On the other hand, in the Lagos Plan of Action for the Economic Development of Africa (1980–2010), African Heads of States and Governments pledged to allocate at least 1% of their GDP annually to science and technology.[25] However, hardly any African government met this target in 2016. There is a need for advocacy for greater investments in research to support sustainable and resilient development in Africa,

considering environmental health research equally critical to research on some other infectious diseases.

In conclusion, the African continent is facing multiple significant environmental health challenges, including from rapid urbanization; air, soil, and water pollution; and climate change. These environmental factors will be at the origin of new cases of communicable and non-communicable diseases. The potential interactions between communicable disease and environmental hazards and/or how these may configure risk of non-communicable diseases in later life, constitutes a field where the African situation has the potential to be highly informative. In the long-term, this could be achieved by introducing the exposome concept taking the interactions among environmental factors and the human body into account through lifespan. Decision-makers, communities, and citizens need scientific insights into the magnitude of the resultant population health consequences, and the policies and activities that could be used to avert them. Addressing the challenges identified at the ISES-ISEE 2018 conference would increase the likelihood of achieving the United Nations Sustainable Development Goals.

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For more information on ISEE Africa Chapter, please visit https://www.iseepi.org/Public/Chapters/Africa/Public/Regional_Chapters/Africa.aspx?

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