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Controlling and preventing climate-sensitive noncommunicable diseases in urban sub-Saharan Africa

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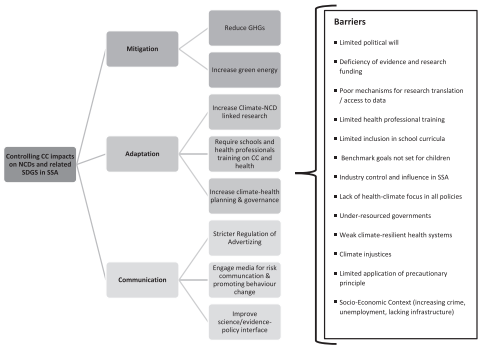
HIGHLIGHTS

- 80% of global NCDs deaths occur in LMICs, with a third of these occurring in SSA.
- The increasing disease burden of NCDs linked to increasing urbanization is highest in SSA.
- NCDs identified as climate-sensitive result in a disease risk magnification.
- Addressing climate-sensitive NCDs in SSA cities promotes achieving the SDGs.
- Urgent need for climate-sensitive NCD indicators in SSA policies, adaptation plans and SDG monitoring..

GRAPHICAL ABSTRACT



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ABSTRACT

Research continues to highlight the link between climate change and health outcomes. There is, however, limited evidence in research, policies and in the Sustainable Development Goals (SDGs) about the impact of environmental factors on noncommunicable diseases (NCDs) for people living in urban areas of sub-Saharan Africa (SSA). Important is that 80% of NCDs are taking place in low- and middle-income countries (LMICs) and linked to a third of the deaths in SSA. The question is, what would these statistics look like if environmental risk factors (e.g., pollution, chemicals) for NCDs, linked to climate change, were prevented and controlled. This article presents a framework for understanding climatic pathways' impacts on climate-sensitive NCDs and achieving the SDGs. It further explains how current global mitigation interventions in high income urban settings, with implied health co-benefits for NCD reduction (i.e., promoting use of less polluting vehicles, bicycles, walking, public transport, green spaces), experience major implementation challenges in SSA cities (i.e., too costly, lack of availability, poor road conditions, gender and cultural norms, security problems). Recommendations are made for applying this framework to control climate change impacts on NCDs and achieving the SDGs in SSA cities. These include, support for more research on the climate - NCD nexus, ensuring health professional training includes sustainable health education, and including a focus on climate change and health in primary and secondary school curricula. Further recommendations for addressing climate-sensitive NCDs and urban environmental health towards achieving and sustaining the SDGs, are linked to promoting climate-sensitive and health policies and governance, as well as controlling the influence of advertising. Lastly, improving communication of research findings for policy makers and the public in a manner for informed policy making, and how to comprehend this information to promote the reduction and prevention of NCDs in urban SSA, is key.
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1. Introduction

The literature on climate change and health continues to grow globally where the predominate focus has been on the health burden of temperature-related impacts. Despite this, research from low- and middle-income countries (LMICs) remains sparse. Striking is the limited data on the impact of climate change and related environmental risk factors on Noncommunicable Diseases (NCDs) even though NCDs are viewed by the World Health Organization (WHO) as a defining challenge for the 21st century (Chowdhury et al., 2018; Sharon Friel et al., 2011; Frumkin and Haines, 2019; Kula et al., 2013; WHO, 2014) and research on the link between climate change impacts on NCDs is increasing (Frumkin and Haines, 2019). Coupled with this is limited research on the health co-benefits of climate change mitigation measures linked to reducing the NCD burden relevant for LMICs contexts.

According to the WHO, around 70% of all deaths globally are linked to NCDs (particularly cardiovascular diseases, cancers, chronic respiratory diseases and diabetes). Of these deaths, 80% occur in LMICs and are responsible for a third of all the deaths in sub-Saharan Africa (SSA; World Health Organization, 2013a, 2013b; WHO, 2014; Marquez and Farrington, 2013). The documented increase of NCDs in SSA has been associated with changes in lifestyles linked to urbanization; SSA has an urban growth rate of 3.6% which in relation to the world average is double (Hobbs and Ramsay, 2015). After Asia, SSA is the next fastest urbanizing global region with unprecedented increases in pollution levels in cities. According to the literature, these pollution levels are linked to several NCDs (Amegah and Agyei-Mensah, 2017; Katoto et al., 2019; Landrigan et al., 2017). Many SSA cities do not have the infrastructure and health systems to manage the impact of increased urbanization on air quality, adequate housing, quality of food, lack of employment and human security in order to prevent and reduce NCDs (Hove et al., 2013). The economic, ecological, socio-cultural and political complexities in SSA are also intertwined with urbanization and the impacts of NCDs. This in turn has an impeding effect on achieving many of the Sustainable Development Goals (SDGs) by 2030.

An emerging concern with NCDs is the indication from research that some NCDs (e.g., acute and chronic respiratory diseases – e.g., allergies, asthma, chronic obstructive pulmonary disease, lung disease; type-2 diabetes; cardiovascular disease; cancers; mental disorders; injuries; malnutrition) are *climate-sensitive* or *climate-induced* – that is, symptoms of these diseases can be aggravated and exacerbated by climatic conditions such as temperature changes (Ariano et al., 2010; Colagiuri, 2013; Sharon Friel et al., 2011; Hayes et al., 2018; Kinney, 2008; Knowlton et al., 2004; Maxwell and Blashki, 2016; Parks et al., 2020; Wright et al., 2019). The burden of NCDs is growing in LMICs with increasing urbanization, faster in SSA than any other region, and these countries also carry the majority burden of pollution-related diseases (Sharon Friel et al., 2011; Fuller et al., 2018; Marquez and Farrington, 2013; Nojilana et al., 2016). Notable in SSA is the indication of an "epidemiologic transition" shifting the focus of disease burden from infectious diseases to NCDs and yet there is little empirical evidence of the role climate plays in this transition (Kula et al., 2013; Atiim and Elliott, 2016). Focus on the rise of NCDs in LMICs should not only look at the social determinants of urban health (particularly poverty related conditions), but also accelerate attention on the environmental determinants (including the role of climate on NCDs); since NCDs are strongly influenced by various environmental determinants of health (Prüss-Ustün et al., 2019). Despite there being many environmental hazards that impact on health, the focus of this article is on the relationship between NCDs and climate change in urban areas of SSA as a factor requiring more consideration and action to achieve the SDGs.

Although all population groups living in urban areas of SSA are potentially at risk of increased NCD health outcomes that are amplified by climate change factors, of concern are vulnerable populations who are at a higher risk (e.g., children, outdoor workers, elderly, people with disabilities). Particularly, the argument is made that adaptation planning, strategies and policies for addressing climate-sensitive NCDs should have a predominant focus on children as the *benchmark*. That is, the goal for reducing climate-sensitive NCDs in SSA urban areas, as well as achieving the SDGs, should use children's health as the quantitative measure to assess the achievement of these goals (Ahmed et al., 2003; Clark et al., 2020). The reason for placing children's health as a quantifiable benchmark is related to their specific vulnerabilities and because other vulnerable population groups and the general population will be impacted by such plans, strategies and policies. SSA children, for example, living in urban areas are particularly vulnerable to the risks of developing an NCD given their increased exposures to NCDs inducing environmental factors (e.g., indoor and ambient air pollution, chemicals, nutrient poor food) during the *windows of vulnerability* (e.g., sensitivity) throughout their various development stages (Etzel and Landrigan, 2014; Landrigan et al., 2019; Suk et al., 2016). Since in SSA NCDs risks for younger children occur at a higher rate than in other regions, interventions in SSA to control the risks linked to NCDs should be targeted at, and for, children (Marquez and Farrington, 2013). According to the UNICEF Child Mortality Report 2018, SSA has the highest global preventable mortality rate for children under five (including deaths from non-infectious diseases such as diarrhoea; non-infectious diarrhoea is linked to unclean and unsafe water from extreme weather events; toxins from air pollution) and children between 9 and 14 years (including deaths from injuries such as drowning and road injuries linked to extreme weather events) (Gibbons, 2014; UNICEF, 2018). Gaining more attention in research is the trauma of displacement, family loss, hunger, and fear related to climate induced extreme weather events on children's mental health (e.g., post-traumatic stress disorder - PTSD) (Burke et al., 2018; Gibbons, 2014; Hayes et al., 2018; Kar et al., 2007; Sana and Khattak, 2014). Currently, there is limited research and inclusion in urban climate adaptation strategies addressing trauma experienced by children post extreme weather events who have, for example, lost a home, a parent, the ability to go to school or are living in increased poverty related conditions. Important, for example, is the recognition of the role mental health plays in sustainable development and the subsequent successful inclusion of mental health in the SDGs (Mills, 2018). For SSA countries that continue to experience impacts of, for example, extreme weather events, expanding the focus on mental health risk factors impacting on children, is key. By establishing indicators and benchmarking goals that focus on child specific protective measures, the intention is these measures protect across generations and other vulnerable population groups from climate change linked health impacts.

Another issue to take into account when discussing the impact, control and prevention of climate-sensitive NCDs in urban areas of SSA is that "intra-urban differentials" exist in countries and need to be addressed in any plans, policies or strategies (Bartlett et al., 2009). Infrastructure, for example, is one of these differentials (e.g., housing; health facilities; access to potable water, sanitation and electricity). Many SSA cities have, for example, large numbers of their populations (approximately 72%) living in informal settlements (e.g., slums, townships) where people live in make-shift shacks or other sub-standard housing vulnerable to floods and fires, have increasing exposures to heat, injuries and mould, as well as being subjected to water insecurity (Adams et al., 2019; Ramin, 2009). Although many outdoor workers in urban areas are at risk of increased impacts from climate change (e.g., construction workers, fire fighters, emergency-response workers, urban weed and pest control pesticide applicators, municipal workers, utility workers, refuse collectors, road workers, outdoor recreation workers, garden/park/city outdoor maintenance workers, disaster recovery workers), workers in the informal sector (e.g., vendors, hairdressers, welders), which is the largest unregulated worker sector in SSA, require particular inclusion in planning and strategies (Medina et al., 2017). Outdoor occupational exposures are multiple, such as exposures to UV radiation, increased air pollution, increased heat, chemicals, and pesticides. These, thus increase workers' risks of

developing NCDs such as chronic obstructive pulmonary disease (COPD), heat stroke, mental health effects, chemical and pesticide exposure-related cancers, respiratory conditions, biological hazards, and injuries (Levy et al., 2018; Modenese and Korpinen, 2018; Schulte et al., 2016).

In this article, an analysis is presented for assessing the key areas and factors for controlling and preventing climate-sensitive NCDs for urban populations living in SSA. Although not conclusive, problem areas, barriers, impacts on the SDGs and recommendations are provided to inform policy, adaptation strategies and future research.

2. Framing control and prevention of NCDs in SSA

A review of the literature relevant for controlling and preventing NCDs in SSA informed the development of an analytical framework presented in this article. The reviewed articles that presented research findings on environmental health, NCDs, climate-sensitive NCDs, urbanization and the SDGs in LMICs generally, but SSA specifically, were selected. The focus was on how the environment and climate change in urban SSA areas represents a major feature in population health and the development of NCDs. This framework provides an understanding of the climatic pathways impacts on climate-sensitive NCDS and the SDGs (Table 1). The framework also provides examples of the challenges faced in LMICs to implement global mitigation interventions with implied health co-benefits for NCD reduction (Table 2). It also provides recommendations while identifying the barriers for controlling climate-sensitive impacts on NCDs and achieving the SDGs in LMICs, especially SSA (Fig. 1). The tables and figure are intended to provide a framing for discussions and planning in urban areas to address climate change impacts.

2.1. Framework methodology

A review of the literature was conducted on identifying NCDs that are climate-sensitive and what pathways would potentially influence these health outcomes.

2.1.1. Table 1 methods

The development of Table 1 was an iterative process. The table began with the four key NCDs identified in the literature as both climate-sensitive and key NCDs in SSA (i.e., diabetes, cardiovascular diseases, cancer and chronic obstructive pulmonary disease). The pathways listed in Column 2 of Table 1 were identified based on key literature identified during the review that outlined direct and indirect effects from climate change, which could result in NCDs or amplify existing NCD conditions (Berry et al., 2010; De Blois et al., 2015; S. Friel et al., 2011; Frumkin and Haines, 2019; Kjellstrom et al., 2010; Watts et al., 2015). The following search domains were used: PubMed, Scopus and Google Scholar. Search terms used to identify pathways included “climate change pathways” and “noncommunicable diseases”. This table in no way purports to be exhaustive. Since the current research on climate pathways for NCDs is evolving and incomplete, some pathways may have been missed. The intention was to start developing a more comprehensive collection of NCDs beyond the key four that could be built upon in future research and provide a basis for climate-sensitive NCDs to feature more in prevention and control strategies, as well as national and international policies.

The citations to support the NCD and pathway were identified through two processes. First, the NCD being searched was linked to climate change (e.g., “obesity AND climate change”) in the three different search domains. NCDs were selected based on the literature cited in Table 1, as well as those considered a problem in urban areas of SSA, according to the literature. Again, the searches were repeated adding “sub-Saharan Africa”. Once the articles were identified, they were then reviewed for a clear link in the research between the NCD and a climate factor or a link between an NCD and an environmental factor identified in other research as having an interlinked relationship with climate change (e.g., air pollution). The NCD association to climate change had to be verifiable in a peer-reviewed research article to be included. Thus, most articles included make a clear link between climate change and the NCD in question. Column 4 in Table 1 illustrates potentially which SDGs might not achieve their goals and targets if the climate pathway for that NCD is not addressed. These were selected based on what was assessed as a clear direct link. Although arguments could be made for other SDGs to be listed but if the link was viewed by the author as indirect, then these were not included.

2.1.2. Table 2 methods

Since there was limited literature discussing mitigation measures in SSA urban cities and linking these to co-benefits of health, Table 2 is proposed as a thought starter for future research. The table provides examples of the thinking and concepts behind the framework to inform future research, as well as policy making and urban planning in SSA cities. This table is not intended to be comprehensive but rather suggests the need to include SSA (and other LMICs) in the mitigation and co-health benefits dialogue addressing the challenges that SSA cities face. The development of the table began with a general review of on mitigation strategies currently identified in the literature as having co-benefits to health. The mitigation strategy was then assessed for what intervention assumptions were linked to the strategy (e.g., reduce pollution by riding bicycles or walking instead of cars assumes that individuals have access to and can afford bicycles, roads exist that bicycles can be ridden on, that bicycle riding is culturally acceptable) and how these assumptions would play out in urban cities of SSA. For this process, the author relied on years of research and experience in SSA, as well as the literature. Column three, focuses on the driver that is needed for the mitigation intervention to happen. When determining the input required for the particular intervention to be implemented in SSA, the most important input (i.e., key actor) was put forward. For example, ‘self’ is not mentioned under public transportation because in many SSA countries public transport does not exist, is inefficient or is not safe for individuals to use. Thus, the decision as to whether to use public transport is not purely a ‘self’ decision but rather requires extensive external inputs before ‘self’ is a significant enough of a factor – as is recognized being the case in many high-income countries.

2.1.3. Fig. 1 methods

During the literature review for Tables 1 and 2, the author identified themes in the reviewed articles which mentioned a recommendation for or barrier to addressing climate change health impacts generally but also NCDs specifically. These themes were identified and analysed by using a qualitative content analysis approach. This is not an exhaustive list and should continue to be a work in progress, added to by future research. This list, however, provides a framework for informing current policy and adaptation strategy discussions for SSA countries; especially if strategies for SSA countries are informed by policies and strategies (i.e., used as examples and guidelines) developed for high income country cities.

3. Role of climate-sensitive NCDs in undermining the achievement of the SDGs

The SDGs have set the focus of the international agenda on acknowledging that there is an epidemiologic transition to NCDs, particularly in urban areas of LMICs, by the inclusion of these in the 2030 Agenda (Collins et al., 2019). While there is growing recognition of the scale of the problem with NCDs, particularly for urban dwellers, and the need to address these more at all levels, the role of climate-sensitive NCDs is missing. The concern is that if climate change's impacts on NCDs, as highlighted in Table 1, are not addressed in the global efforts to address NCDs, climate change could undermine achieving the SDGs. That is, the argument in this article is that climate change needs to be included as a

Table 1
Climatic pathways impacting on climate-sensitive NCDs and the SDGs.

Climate-sensitive NCDs	Climate factor/Pathway	References	SDG impacted/Undermined
Obesity (malnutrition)	Pollution[a]; heat stress – reduced physical activity and poor urban planning; food systems and nutrition insecurity (e.g., impacted by EWEs, lower yields, carbon fertilisation effects, increased carbon dioxide decrease in protein in crops);	(Meybeck et al., 2018; Swinburn et al., 2019; Wei et al., 2016)	SDG 3—Good health and well-being SDG 8—Decent work and economic growth SDG 11—Sustainable Cities and Communities SDG 13—Climate Action
Undernutrition (malnutrition)	Extreme weather events[b]; reduced food production and affordability of nutritious food; crop failure – pests, drought	(Lloyd et al., 2015; Serdeczny et al., 2017; Swinburn et al., 2019; Watts et al., 2018)	SDG 1—No poverty SDG 2—End hunger SDG 3 SDG 8 SDG 13
Type-2 Diabetes	Pollution; heat impact on insulin management and physical inactivity	(Blauw et al., 2017; Cook et al., 2011; Dain and Hadley, 2012; Deng et al., 2017; International Diabetes Federation, 2012; Lu et al., 2016; Rajagopalan and Brook, 2012; Yang et al., 2016)	SDG 3 SDG 8 SDG 11 SDG 13
Chronic obstructive pulmonary disease	Pollution; ozone exposure; desert storms; extreme weather events (e.g., fires)	(Bernstein and Rice, 2013; Friel et al., 2011)	SDG 3 SDG 8 SDG 11 SDG 13
Cardiovascular disease	Pollution; heat stress	(Cook et al., 2011; Cosselman et al., 2015; Du et al., 2016)	SDG 3 SDG 8 SDG 11 SDG 13
Ischaemic heart disease	Pollution; heat stress	(Cook et al., 2011; Cosselman et al., 2015)	SDG 3 SDG 8 SDG 11 SDG 13
Stroke	Pollution; heat stress	(Cook et al., 2011; Cosselman et al., 2015)	SDG 3 SDG 8 SDG 11 SDG 13
Asthma (allergic disease)	Pollution; higher ground-level ozone; longer pollen seasons; expansion of allergenic vegetation; Mould proliferation / fungal growth (flooding)	(Bouazza et al., 2017; Katelaris and Beggs, 2018; Landrigan et al., 2019; Olaniyan et al., 2017; Osborne et al., 2017; Salmond et al., 2016)	SDG 3 SDG 8 SDG 11 SDG 13
Rhinosinusitis and other allergic diseases (e.g., food allergies)	Pollution; Mould proliferation / fungal growth (flooding); increased pollen production (rising temperatures and carbon dioxide levels); increased carbon dioxide levels (food allergenicity); high winds (dust)	(D'Amato et al., 2014; Green et al., 2013; Katelaris and Beggs, 2018; Mady et al., 2017)	SDG 3 SDG 8 SDG 13
Eye Disorders (e.g., cataracts, macular degeneration, cornea cancer)	Depletion of stratospheric ozone	(World Health Organization, 2003)	SDG 3 SDG 8 SDG 13
Lung cancer	Pollution	(Eckel et al., 2016; Fuller et al., 2018; Lamichhane et al., 2017; Landrigan et al., 2017)	SDG 3 SDG 8 SDG 11 SDG 13
Skin cancer	Depletion of stratospheric ozone	(Bharath, 2009; Watts et al., 2018)	SDG 3 SDG 8 SDG 13
Other cancers (e.g., leukemia)	Pollution; increased exposure to chemicals from temperature increases volatilization & evaporation	(Filippini et al., 2015; Perera, 2017a)	SDG 3 SDG 8 SDG 11 SDG 13
Endocrine disruption	Increase pests & pesticide use; increase aflatoxin contamination; increase of chemical pollution in water/environment from extreme weather events	(Barata, 2017; Dang et al., 2017; Landrigan et al., 2019; Rother et al., 2020; Zinyemba et al., 2018)	SDG 2 SDG 3 SDG 6—Clean water and sanitation SDG 8 SDG 11 SDG 13
Neurodevelopmental diseases	Pollution Contaminated water	(Perera, 2017b)	SDG 1 SDG 3 SDG 8 SDG 11 SDG 13
Neurodegenerative diseases (e.g., dementia)	Heat stress; pollution	(Habibi et al., 2014; Killin et al., 2016)	SDG 3 SDG 8 SDG 11 SDG 13
Autoimmune diseases	Undernutrition; psychological stress (extreme weather events); ambient UV radiation	(Swaminathan et al., 2014)	SDG 3 SDG 8 SDG 13

Table 1 (*continued*)

Climate-sensitive NCDs	Climate factor/Pathway	References	SDG impacted/Undermined
Renal diseases	Heat stress	(Barraclough et al., 2017; Glaser et al., 2016)	SDG 3 SDG 8 SDG 13
Non-infectious diseases (e.g., diarrhoea)	Contaminated water for extreme weather events; Heat induced vector population increases (e.g., filth flies)	(Barata, 2017; Sallam et al., 2017)	SDG 1 SDG 3 SDG 6 SDG 8 SDG 13
Mental health[c] & Wellbeing	Amplified NCDs; Extreme weather events; water insecurity	(Adams et al., 2019; Burke et al., 2018; Hayes et al., 2018; Hiscock et al., 2014; Padhy et al., 2015; Thomas et al., 2014; Watts et al., 2015; World Health Organization, 2012)	SDG 1 SDG 3 SDG 6 SDG 8 SDG 11 SDG 13
Injuries	Extreme weather events (e.g., physical trauma, drowning); water insecurity; heat impact on outdoor workers; heat impact on interpersonal violence, intergroup Violence, conflict and crime, and traffic accidents[d]	(Adams et al., 2019; Godsmark et al., 2019; Leard and Roth, 2015; Mares and Moffett, 2016; Marquez and Farrington, 2013)	SDG 1 SDG 3 SDG 6 SDG 8 SDG 11 SDG 13
Snake bites	Increased snake migration & pattern change (urban areas) due to drought, heat waves, floods & wildfires.	(Ediriweera et al., 2018; Longbottom et al., 2018; Phillips et al., 2018; World Health Organization, 2019)	SDG 3 SDG 13

[a] Pollution includes indoor and outdoor ambient air, and chemical contamination/exposures.
[b] Extreme weather events refer to resulting floods, fires, landslides and massive storms from amplification of climate variability.
[c] Mental health refers to posttraumatic stress disorder, anxiety and depression.
[d] Traffic accidents include accidents with vehicles, pedestrians, bicyclists, and motorcyclists.

modifiable risk factor for NCDs (Stein et al., 2019). Perhaps the next United Nations member states' high-level meeting on NCDs could consider including climate as a risk factor in the current five-by-five approach to tackling NCDs which would expand on the five current disease types listed (Mensah and Mayosi, 2013; Stein et al., 2019).

Sustainability in these goals is crucial in that the SDGs are not just to be achieved but rather the global progress of achieving these needs to have supported and put in national mechanisms for sustained health and well-being beyond 2030. The SDGs targets, however, will be challenging to achieve, let alone be sustained beyond 2030, if the issue of climate change's impact on NCDs is not addressed in multiple national SDG relevant policies and strategies, and particularly in national climate change adaptation and mitigation strategies. This is because health impacts and the economic costs, both visible and hidden, linked to the burden of disease from NCDs in relation to environmental factors in SSA are significant (Bickler et al., 2018; Prüss-Ustün et al., 2019). As Haines and Landrigan (2018) rightly point out, a major oversight of the *Lancet* Taskforce on NCDs and economics (paper 1) on NCD prevention and management to advance the SDGs, was the omission of the significant role environmental factors play in the development of NCDs and the need to control these (Haines and Landrigan, 2018; Nugent et al., 2018). They subsequently argue for a stronger concerted effort to include pollution control, including climate mitigation, for preventing and controlling NCDs. As shown in Table 1, pollution (including indoor and ambient air quality, as well as chemical pollution) is a significant, and often neglected, climate pathway for climate-sensitive NCDs (Landrigan et al., 2019; Noyes and Lema, 2015; Prüss-Ustün et al., 2019). As highlighted in the *Lancet* Commission on Pollution and Health, chemical pollution is underestimated as a contributor to the burden of ill-health as a "causative agent" of several NCDs, as well as the role of climate change in promoting chemical exposures and health risks (Landrigan et al., 2017). Although the indicators for monitoring the achievement of SDG Goal 3 Target 3.4 refers to NCDs, including mental health, reference to the reduction of risk factors are missing, particularly to environmental factors such as pollution and climate change.

Table 1 presents an extensive, not exhaustive, list of climate-sensitive NCDs identified in the literature that are of concern in SSA with potential climate pathways listed and the SDGs indicated that are impacted by not addressing these climate pathways for that NCD. The lightly shaded rows in Table 1 represent the four main NCDs that are climate-sensitive. What is clear is that the range of NCDs vulnerable to varying climate conditions goes far beyond the four key NCDs. Therefore, if these are not included in current SDGs, adaptation, as well as NCD prevention strategies, the health risks and burden in SSA urban populations could be compounded as climate impacts from drought, floods, extreme weather conditions and wildfires increase in these countries.

For example, Target 2.4 of SDG Goal 2 states that *by 2030, ensure sustainable food production systems and implement resilient agricultural practices that increase productivity and production, that help maintain ecosystems, that strengthen capacity for adaptation to climate change, extreme weather, drought, flooding and other disasters and that progressively improve land and soil quality* (Nations, U., Affairs, D. of E. and S, 2020). Cancers and diseases related to endocrine disruption could increase as a result of the impact of pesticide use aimed at increasing food production (Dang et al., 2017). Furthermore, with the temperature changes, pests are now appearing in areas where they were previously not present, as climatic conditions were not conducive for their survival. Given that pests and pest generations are increasing with temperature increases the result is more frequent use of pesticides and use of 'cocktails of pesticides' to address these pest infestations and pesticide resistance, resulting in increased pesticide exposures (Dhang, 2017; Zinyemba et al., 2018).

4. Controlling and preventing NCDs - focus on health co-benefits and achieving the SDGs in SSA

NCDs prevention has focused mostly on shared risk factors which have concentrated predominately on tobacco use, unhealthy diets, physical inactivity and alcohol use (WHO, 2014). It is argued, however, that the risk factors linked to climate change's ability to amplify NCDs be included in this list (e.g., air pollution, extreme weather events, high temperatures). What is needed is additional and further research identifying and testing interventions that would address controlling and preventing climate-sensitive NCDs in various urban settings in SSA. The WHO has estimated that by removing or preventing the major risk factors, around three-quarters of heart diseases, stroke and type-2 diabetes and 40% of cancers would be abated (WHO, 2014). The

Table 2
Global mitigation examples with health co-benefits of NCD reduction and implementation challenges for SSA countries.

Interventions	Positive health outcome	Challenges implementing in SSA	Self or external input required	SDGs relevant for addressing SSA implementation challenges
Less polluting vehicles (e.g., cars, trucks, motorcycles, boats, trains)	Reduced NCDs	Costly; availability in LMIC	Self; External – industry; government	SDG 3; 9 - industry, innovation &infrastructure; 11; 13
Cycling	Reduced NCDs	Costly; high theft risk; poor road conditions; lack of cycle lanes; high road traffic injuries; gender and cultural issues preventing women from cycling	Self; External – government	SDG 3; 11; 13; 15 – gender equality
Walking[a]	Reduced NCDs	Long distances to work; dangerous particularly for women & children; lack of time given long travelling time to work/school	Self	SDG 3; 11; 13; 15; 16 – peace, justice & strong institutions
Public transport	Reduced NCDs	Limited; security problems; expensive	External – government infrastructure and IGO[b] funding	SDG 9; 11; 13; 17 – partnership for the goals
Community walking groups	Reduced NCDs	Requires buy-in; time-consuming; limited time available; require lead agency;	External – community health workers; NGOs; faith-based organizations	SDG 3; 11; 13
Renewable energy, improved indoor (cleaner) cooking facilities and improved housing	Improved air quality which reduces linked NCDs; reduced vector borne diseases (rats; housing)	Dependent on resources, political will and an effective driver, cost of liquefied petroleum gas, access to sustainable solutions	External – government and industry	SDG 3; 7- affordable & clean energy; 9; 13; 17
Green spaces	Reduce urban heat island effect; reduce air pollution; flood management	Land pressure in LMIC for housing	External – government; private planners and developers	SDG 3; 11; 13
Urban greening	Reduced exposure to allergenic pollen, air pollution & temperature extremes	Lack of resources	External- government; private planners and developers	SDG 3; 11; 13; 15 – life on land
Education programmes (for general public, schools and health professionals)	Reduced NCDs	Lack of involvement of the education sector with the health sector in health communication through schools & to the general public; medical curriculum lacking focus on environmental health & climate change	External – media, health sector, ministries of Education; universities	SDG 3; 4 – quality education; 13
Urban promotion of healthier diets (focus on reducing meat consumption)	Reduced obesity & diabetes	Meat culturally strong part of meals; vegetable consumption constrained by access and willingness to eat; high cost of "healthy foods"	Self; external – government; food industry	SDG 3; 11; 12 – sustainable consumption & production; 13
Waste management and recycling	Reduced NCDs	Lack of solid waste systems in urban areas especially informal settlements; lack of recycling facilities; lack of public information on recycling and health link	External – government; private sector initiatives	SDG 3; 9; 12; 13; 17

[a] In many SSA individuals walk for their main mode of transport. This intervention refers to areas where physical inactivity is a problem and walking is not a regular mode of transport.
[b] IGO refers to Intergovernmental Organizations such as United Nations, World Bank, etc.

question needs to be asked as to what these statistics would look like if risk factors for NCDs linked to climate were prevented? Also, to what extent would the SDGs be more achievable?

Climate change mitigation and adaption interventions have been heralded in the literature as an opportunity for co-benefits, particularly health benefits linked to NCDs. The problem is that many of the interventions recommended are relevant for high income countries and are likely to encounter difficulties when implemented in SSA, as illustrated in Table 2 (Prüss-Ustün et al., 2019; Watts et al., 2018). Furthermore, SSA countries, except for South Africa which is one of five top emitting LMICs, have had the lowest per capita contributions to green-house gas emissions impacting on climate change, although this may be changing and thus mitigation measures in SSA could have limited impact (Hogarth et al., 2015; Kula et al., 2013; Sarkodie and Strezov, 2019). It is, therefore, crucial to identify interventions with co-benefits for health relevant for SSA urban contexts, as well as addressing the challenges highlighted in Table 2. Hence, Table 2 highlights the 'actor' that needs to take the lead in implementing the intervention to reduce the climate impact and increase the co-benefit to health. In the case of 'self', an individual must show self-efficacy in relation to their motivation to implement the intervention and to execute the behaviour change. Self-efficacy (regulation) is also seen as resilience to managing climate shocks. As highlighted by the challenges for implementation in Table 2, often this self-efficacy is impeded by the social, economic and political environment within which the person is operating (e.g., cost of a bicycle being prohibitive in relation to annual wages, roads being non-bike friendly in terms of poor road surface and lack of dedicated bicycle lanes, high rate of bicycle theft given their economic value). The literature is clear that the advantages provided by health co-benefits mitigation interventions are important to highlight as an opportunity, despite climate change's negative impacts. These advantages also provide an opportunity to illustrate the positive aspects for people who are climate-sceptics (Bain et al., 2015; Smith et al., 2018). This research has highlighted that it is important to address the implementation challenges of interventions in urban areas of SSA countries for co-benefits to be achieved.

It is argued in this article that given the resource constraints and problems in SSA urban areas (outlined in Table 2), prevention measures should shift from being solely the responsibility of the individual to societal and government levels (Norman et al., 2013). Where responsibility is apportioned to individuals living in SSA urban areas, there needs to be a clear indication that individuals in varying socio-economic categories have the means to implement the intervention and that government or other support is provided to ensure this. Since controlling and preventing climate-sensitive NCDs in SSA, as well as other LMICs, requires a multi-stranded approach, Fig. 1 presents these as well as key barriers that need to be addressed. These key interventions are briefly discussed in Sections 4.1 to 4.6 and should be framed as targets or indicators for achieving NCD reduction in SSA. The opportunities for achieving the main SDGs undermined by climate-sensitive NCDs are

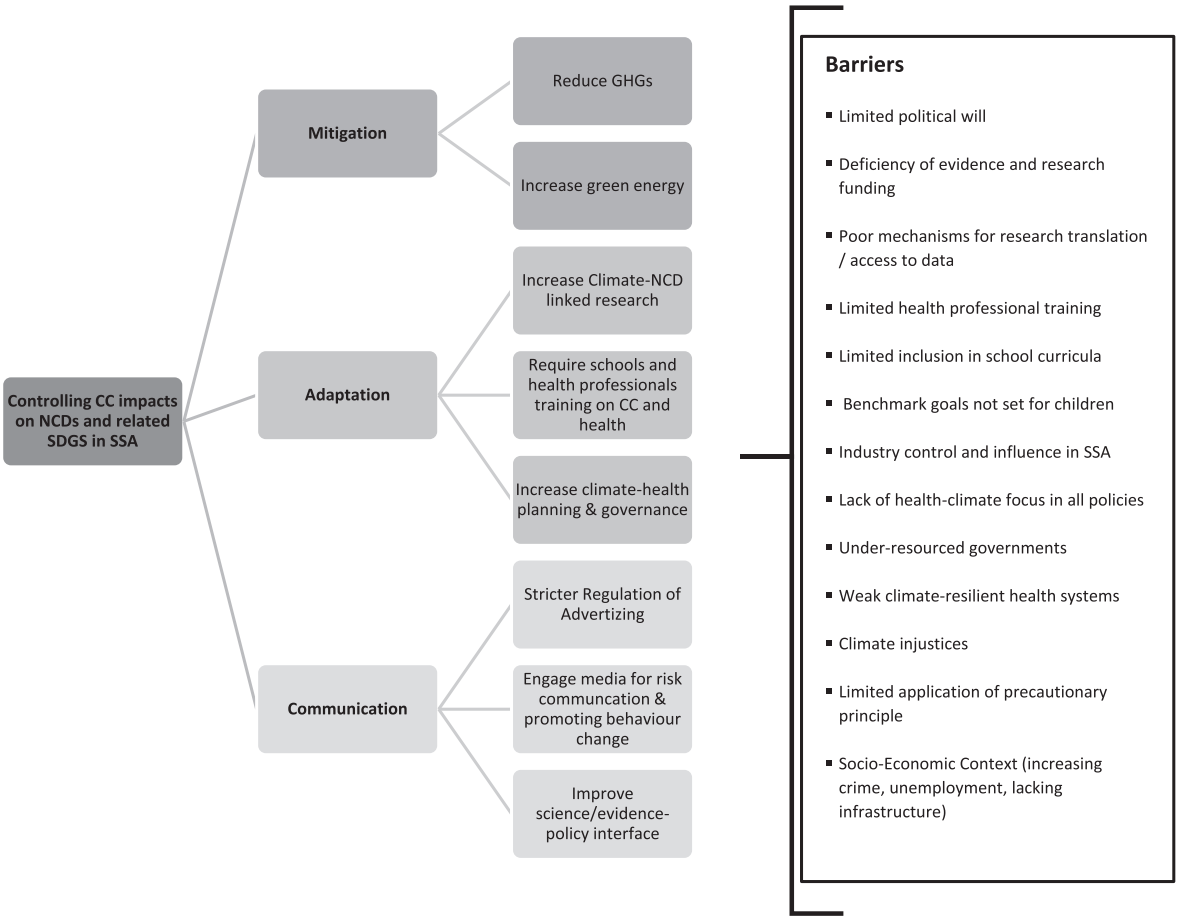

Fig. 1. Recommendations and barriers for controlling climate-sensitive NCDs in SSA urban areas.

highlighted in Table 1, namely SDG 3—Good Health and Well-being; SDG 8—Decent Work and Economic Growth; SDG 11—Sustainable Cities and Communities; and SDG 13—Climate Action. Nunes et al. (2016) aptly point out in detail the multiple differing government sectors that need to engage to address the various SDGs (Nunes et al., 2016).

Sections 4.1 to 4.6 provide an analysis of the adaption and communication recommendations (indicated in brackets after each heading) to control and prevent climate impacts on NCDs in SSA specifically, and LMICs generally, as illustrated in Fig. 1. Mitigation is not discussed as Table 2 illustrated the problems that should be addressed at the government level and incorporated into the regular work of many government departments (e.g., transport, agriculture, health environment, public works, social development).

4.1. Climate and NCD research (adaptation)

Currently, research on NCDs is predominately linked to four NCDs which are seen as making up 80% of the global burden of disease, Table 1, however, illustrates that there are multiple NCDs which are climate-sensitive beyond these four. In order to make a shift to controlling and preventing the impact of climate on NCDs in SSA, a key first step is for climate change to be referred to (i.e., "framed") as a public health issue and as an NCD risk factor (Maibach et al., 2010; Shea et al., 2018; Watts et al., 2017). Maibach et al. (2010) have argued that having public health messaging that focuses on the co-benefits of greenhouse gas emissions on health (particularly NCDs) garners more success in implementing change than highlighting the negative consequences (Maibach et al., 2010). This supports the current need for more research on health co-benefits linked to mitigation measures that are relevant for African countries, given the issues highlighted in Table 2. Global research on the link between the broad range of NCDs and climate change is limited (e.g., beyond the cardiovascular disease and climate link), particularly for SSA where NCDs are a high health burden in urban areas. WHO supports extensive work on NCDs, particularly the collection of data through the Global Health Observatory (https://www.who.int/gho/ncd/en/), yet data on climate-sensitive NCDs are missing. This is an area that could be expanded on. A brief discussion on relevant surveillance and monitoring indicators is discussed in Section 4.3.

Of concern is the limited research focusing on the impact of climate variability risks on children's health in general, as they are at a higher risk of developing NCDs. In particular, an emerging concern is in relation to climate change affecting the mental health of children. For example, understanding the effect childhood exposures to and survival of an extreme weather event will have on their mental health in the future (Kar et al., 2007; Sana and Khattak, 2014).

4.2. Education and training (adaptation)

For behaviour change to occur at the individual level, as well as collectively as a society, access to scientific information, comprehension of this scientific information, and a sense of self-efficacy are required. Of course, underlying these factors is whether they impact on climate denialism or not. Who is providing the information (and the trust of this source) and the format play a key role (Rother, 2018b; Rother, 2014; Breakwell, 2000). Currently, the media is a key source of climate information for the general public and many policy makers (Stecula and Merkley, 2019). Access to scientific data in a comprehensible manner for individuals is limited. Therefore, when reviewing climate-sensitive NCD controlling and preventing strategies, education and

training (including informal channels of information such as the media) must form an integral component of these strategies. Furthermore, education and training on the relationship between climate change and health should traverse many different fields and curricula from primary education to tertiary education for health professionals, urban planners, engineers, and business degrees, to name a few (Shaman and Knowlton, 2018). This is evident in the broad spectrum of disciplines and specializations required for implementing interventions that will mitigate climate change, which are needed for adaptation interventions implementation and in order to address the relevant SDGs highlighted in Tables 1 and 2. Prevention and control of NCDs goes beyond being a health issue. With the NCD link to urbanization, the built environment, chemicals and agriculture (Frumkin and Haines, 2019), training on climate-sensitive NCDs needs to transverse the curriculum of other disciplines for sustainable problem-solving, solutions and prevention (e.g., urban planners, architects, sociologists, chemists, engineers, agronomists, biologists, anthropologists). SDG Target 13.3 and indicator 13.3.1 refer to improving education and curricula at primary, secondary and tertiary levels for mitigation, adaptation and early warning, which should include specifically a focus on the health and climate nexus.

4.2.1. Primary and secondary school education

It is important to promote this inclusion of the relationship between climate change and health in primary and secondary school curricula globally. The global *Youth for Climate Action* movement has highlighted both the instrumental role of the youth in preventing and controlling climate change impacts on the environment, as well as the need for access to evidence and information on the impact of climate change on health and particularly NCDs. Furthermore, social movements raise the question of maintaining the momentum and consistency of access to information, highlighting the importance of a formal process to bring climate change and health into the school curricula. This would also provide a way of highlighting mitigation and adaptation co-benefits to health in relation to the reduction and prevention of NCDs in SSA. Although a literature review assessing inclusion of climate change and health in primary and secondary school education curricula was not conducted, the indication from the review for this article is that NCDs and the link with climate change, as well as prevention measures, are not currently included.

4.2.2. Health professionals

Health professionals (medical doctors, nurses, physiotherapists, audiologists, etc.) are managing patients who have health issues related to environmental exposures, as well as climate-sensitive NCDs, often incorrectly diagnosing and missing prevention opportunities. These professionals are key to identifying climate-sensitive NCDs, treating these, as well as a key role player in prevention. For African SSA health professionals to effectively implement this role, the relevance of their medical training is crucial. The dearth in climate change and sustainable health training for health professionals is an adaptation failure globally for health systems, including in SSA. There are efforts globally to highlight the need to include climate change in medical education, with guidance provided on curricula development (Bell, 2010; Maxwell and Blashki, 2016; Tun, 2019). This is also considering the role health professionals play and the respect/trust they hold in communities, especially regarding the information and advice they provide. Thus, they play a key role in preventing and controlling climate-sensitive NCDs.

Globally, there is an awareness and some efforts being made to promote training of health professionals, which includes eco-health literacy and environmental sustainable healthcare education, as well as a focus linked to environmental health and climate change (Musaeus et al., 2018; Walpole et al., 2019, 2017). The Global Consortium on Climate and Health Education (GCCHE), for example, is a global network of health professions concentrating on sharing practices (Shaman and Knowlton, 2018; Shea et al., 2018), but the shift to include this focus in medical training in SSA is limited (Walpole et al., 2017).

4.3. Climate-sensitive and health linked policies and governance (adaptation)

In order for climate impacts on NCDs to be prevented, reduced and managed, there is a need to re-evaluate governance for health in an era of climate change at the local (i.e., sub-national), national, regional and international levels (Godsmark et al., 2019; Hancock et al., 2016; Shea et al., 2018). The challenge is to include climate change and NCD issues in existing policies and strategies, but what will be the catalyst to ensure this occurs? Particularly as a key barrier is the limited understanding of the climate-health nexus and training linked to this in most disciplines (Shea et al., 2018).

A "climate-health in all policies", building on the WHO's "health in all policies" approach, should be implemented to ensure that sectors whose actions will impact on NCDs are included as well – such as environment, social development, housing, children's welfare, agriculture, etc. (Garland and Rother, 2017; Godsmark et al., 2019). Health systems, furthermore, in SSA should be adapted and strengthened specifically for managing climate risks, incorporating research findings and for better communication to the public. Resilient health systems are more likely to have adaptive capacity for dealing with the impact of increasing climate-sensitive NCDs (Cing et al., 2015). The health sector needs to lead in ensuring that solutions to reduce NCDs and improve healthy lifestyles are in all relevant sector policies such as urban planning, air pollution control, chemicals risk management, education, and transportation to name a few. A first step is to review what environmental health programmes, policies and departments are in place in SSA countries, and if these are overseen and run by individuals with environmental health expertise. There needs to be a "driver" ensuring that the climate health interface generally and climate-sensitive NCDs specifically are included in relevant policies within and outside of the health sector.

What is recommended is that researchers, intergovernmental organizations (e.g., WHO, UNEP) and government officials (at regional, national and sub-national levels) develop indicators (i.e., measurements) for climate-sensitive NCDs that could be used to collect surveillance data and identify future climate-sensitive NCD health burdens for prevention and control measures to be implemented. Although WHO has developed "A Prioritized Research Agenda for Prevention and Control of Noncommunicable Diseases" and supports collecting relevant NCD data for policy making, the highlighting of climate-sensitive NCDs are missing from the agenda (World Health Organization, 2011). New Zealand has a website presenting information on climate-sensitive disease indicators, but the most prominent NCDs are not featured assuming that surveillance indicators are missing for these (http://www.ehinz.ac.nz/indicators/climate-change/climate-change-is-a-health-issue/#diseases). Hambling and colleagues present a review of several frameworks for developing Environmental Health Indicators for assessing the impacts of climate change on health identifying the WHO Driving Force-Pressure-State-Exposure-Effect-Action (DPSEEA) as the most useful (Hambling et al., 2011). This model has also been used to illustrate the ways in which the changing environment influences the risk of NCDs (Frumkin and Haines, 2019). Within the DPSEEA model, the driving forces and pressures are viewed as prevention indicators, whereas the state, exposure and effects are seen as corrective or curative indicators (Briggs, 2003). The *Lancet* Countdown 2018 report presents data from the Global Burden of Disease Study 2016 for an indicator on *global health trends in climate-sensitive diseases* (indicator 1.7) which is useful for picking up global trends such increasing mortality from malignant skin melanoma and dengue fever (Watts et al., 2018), more nuanced indicators would be useful for climate-sensitive NCDs in SSA (see examples in Box 1). These indicators should also be based on and constructed to reflect human rights and climate justice in, but not limited to, SSA countries. The inclusion of these indicators in SSA national and sub-national policies also promotes SDG 13 on climate action and target 13.2 to *integrate climate change measures into national polices, strategies and planning.*

Adaptation strategies would be more effective if structured to take into account a life course approach to addressing climate-sensitive NCDs since NCDs impact children more and more and not just adults (Mikkelsen et al., 2019).

4.4. The role of advertising and industry (communication)

A "low-hanging fruit" to bring attention to the NCD climate interrelationship to the public, as well as to promote positive changes to urban dwellers health, is for governments in SSA to monitor the effect of and control industry advertising. Research has shown that advertising and various industries (e.g., sugar, tobacco) play a role in contributing to the growing health burden from NCDs (Delobelle et al., 2015). Industry's accountability and role in prevention measures, therefore, should form a stronger part of government's prevention initiatives. Advertising, especially targeted at children, needs more scrutiny and government control (Clark et al., 2020; Gostin, 2014; Spires et al., 2016). If NCDs in SSA are to be reduced and prevented, then the role of advertising requires more scrutiny, stringent review and control. More research should highlight the various impacts of industry advertising on NCDs.. Governments in SSA could mobilize and require industry to provide advertising platforms and space for broadcasting to the public the linkage between environmental risk factors, as well as the amplification role of climate change, to bring health and well-being into the commercial world's engagement with environmental sustainability (Jones et al., 2018). Of course, the issue of advertising is just one impact of industry in limiting effective prevention and control of NCDs in urban areas of SSA. Issues of ineffective self-regulation measures, pharmaceutical companies push of NCD control through drugs rather than prevention, conflicts of interest, and weak government regulation of companies also have a significant impact (Swinburn et al., 2019). The subtle messaging and framing of the industry's role in NCDs health burden and the link with undermining achieving some of the SDGs needs to be addressed (Clark et al., 2020; Jones et al., 2018).

4.5. Climate-NCDs risk and health communication (***communication***)

Several SSA countries have climate change and health communication strategies being supported by the WHO through Clim-Health Africa (www.climhealthafrica.org). These are, however, not easily accessed in order to evaluate the focus of these strategies. The emphasis seems to be on climate adaptation measures more generally. As more SSA countries develop climate change communication strategies, with the support of WHO or as part of their adaptation plans, this will provide an opportunity to specifically include plans and strategies for preventing and controlling climate-sensitive NCDs. It is unrealistic to expect national and sub-national government sectors to be well-versed and experienced in risk and health communications (Colagiuri et al., 2015; Lozon, 2018). Therefore, guidance and research on communications strategies to incorporate into adaptation strategies should be forthcoming to SSA governments. A particular focus should be on climate-sensitive NCDs prevention and control. For example, current climate change warning systems should not be limited to extreme weather events and high temperatures, but also include information on increased pollen and mould spore dispersal locations, poor air quality linked to climate change and relevant exposure prevention strategies (Koh, 2016). More research is needed to identify mechanisms that can be used in the various countries in SSA to improve risk and health communication. Some suggestions are the use of policy briefs, social media, m-Health, faith based organizations and other community trusted networks, to mention a few (Rother, 2014;Whitmee et al., 2015).

4.6. Research and knowledge translation (***communication***)

Interventions to mitigate the amplification of NCDs in SSA, as well as to promote achieving relevant goals and targets of the SDGs require multiple approaches. One crucial aspect of communication is both the transferring of knowledge as well as allowing for comprehension and engagement with this knowledge for policy makers and the public. The challenge is the production and funding of more research on climate-sensitive NCDs. Although research findings intend to provide more certainty, even when direct attribution of a health effect to climate change is not always clear, there is an opportunity to promote increased engagement with policy makers and the public to understand what the current research results mean for their health. That is, providing access to data and findings is not enough (*right-to-know*), rather mechanisms are needed to promote engagement with and comprehension of the data (*right-to-comprehend*) (Rother, 2018b; Rother, 2014).

One key issue is that researchers translate their findings for both communities and policy makers so that these results and insights play a role in local, national and international adaptation strategies (Colagiuri et al., 2015; Rother, 2014; Rother et al., 2020). To effectively address the reduction of climate-sensitive NCDs, academics and decision makers play a role in leading multi-stakeholder teams that include health professionals, urban planners, local officials (e.g., working on sanitation, housing, pest management, social development), and education officials (Rother et al., 2020).

Researchers have a responsibility of making their study findings available to their study participants, as well as the broader community. The use of technology to present findings to research participants and the public in SSA should be expanded as, for the most part, the public is connected through mobile phone technology (Sandberg et al., 2016).

Improved science and policy interface through research translation would aid in addressing many of the barriers identified in Fig. 1. The challenge is finding viable mechanisms for this engagement with SSA country government officials. The onus should be on the researchers to package findings into a format that is understandable and accessible. Research funders and ethics committees, as well as university promotion criteria, could assist in identifying suitable mechanisms by requiring this as an output of research.

5. Barriers for prevention and controlling of climate-sensitive NCDs

Fig. 1 presented several barriers which need to be acknowledged and addressed across sectors, policies and initiatives for the effective control and prevention of climate-sensitive NCDs in urban SSA.

Box 1
Examples of climate-sensitive NCD indicators for SSA policies and surveillance

- Country trends of climate-sensitive NCDs listed in Table 1 in cities
- Number and type of NCD outcomes attributed to climate change
- Climate-sensitive NDCs included in national and sub-national adaptation strategies
- Number of medical doctors trained in environmental health, climate change and sustainable health care
- Number of national medical schools including training on climate-sensitive NCDs, environmental exposure history taking and climate change in mainstream medical curricula
- Climate change adaptation strategies addressing children's vulnerabilities to climate-sensitive NCDs in cities
- Climate change adaptation strategies addressing other vulnerable populations in cities including outdoor workers
- Number of primary and secondary school curricula including environmental health and climate change information and prevention measures

Section 4 and Table 2 addressed some of these. Section 5 presents a brief discussion of the barriers not addressed in Section 4.

First is the issue of limited understanding of the climate-health nexus by key stakeholders and actors, generally and in relation to NCDs more specifically (Rother et al., 2020; Shea et al., 2018). The World Health Organization, for example, conducts extensive work on NCDs with a strong focus on prevention and control yet this focus has limited acknowledgement of the impact of climate change on NCDs, as well as strategies targeting climate impacts. Juma and colleagues report on the findings from the first African NCDs research conference in 2017 which has little reference to the role of urban environmental health and NCDs, as well as the SDGs, and no mention of the impact of climate on NCDs (Juma et al., 2019). What is of concern is that unless the focus shifts to assess the NCDs burden from climate change, interventions may not be effective or adequately targeted, or undermined by unplanned for disasters and climate-induced health risks. Mechanisms should be put in place to ensure that the findings that are available in relation to climate factors amplifying the burden of disease from NCDs (Frumkin and Haines, 2019), are presented to and accessible by relevant government sectors in SSA countries, to promote evidence-based policy making. This could be in the form of policy briefs, UN guideline documents, the media, or presentations at high-level meetings. The role of the media should not be underestimated as an opportunity to deliver information to policy makers, particularly on high risk health impacts to their populations.

As NCD burdens in urban areas continue to be amplified by climate change impacts, there is a need for further discussion on how the precautionary principle (PP) should be applied to reduce these impacts in SSA. Although evidence-based policy making is desired, the prevention of health risks for SSA populations needs to take precedent with what data is available; even where scientific uncertainty exists. The literature linked to applying the PP for climate change and health risks is rather outdated. A call to researchers is, therefore, encouraged to provide a critique and analysis for implementing the PP in SSA to reduce climate-sensitive NCDs in urban areas (Quiggin, 2007; World Health Organization, 2003).

As highlighted by the WHO, for SSA, financing prevention and control of climate-sensitive NCDs is critical (World Health Organization, 2013b). A key element is the use of evidence-based policy making as an impetus for buy-in with importance for controlling climate-sensitive NCDs, as well as identifying creative financing mechanisms. Given that research and government funding for NCD prevention and intervention development (as well as evaluation) is limited, it could be strategic to access funding from funding agencies through climate change and health avenues (Allen, 2017). The disease profile of the distribution of climate-sensitive NCDs by cause of death in SSA urban areas is currently unclear. More research, therefore, is needed to track hot spots in SSA cities.

6. Conclusion

Since climate change has a magnifying effect potential on a vast number of NCDs experienced by populations living in urban areas of SSA countries, it is paramount that environmental health features more prominently in mitigation, adaptation and communication strategies. Furthermore, the NCD burden focus needs to expand, for example, to cover environmental risk factors such as indoor and ambient air pollution, extreme weather events, and chemical pollution. There is no one approach that is most effective to prevent and control climate-sensitive NCDs prominent in SSA urban areas, rather a multi-stranded approach involving multiple sectors is required. Simultaneously, underlying barriers to achieve and implement measures will need to be addressed nationally, regionally and internationally for achieving and sustaining the SDGs. Strategic drivers (i.e., stakeholders, role players, activists) promoting the importance of controlling and preventing climate-sensitive NCDs in urban SSA environments have an opportunity to gain momentum by illustrating the link to achieving the SDGs. The framework presented in this paper provides a guide for multisectoral management and prevention approaches to support health professionals, urban planners, risk managers and decision makers. It particularly highlights the need to bring climate-sensitive NCDs and risk factors to the forefront of national and international agendas to protect the health of urban dwellers in SSA and that of future generations.

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