



The changing landscape of public health in sub-Saharan Africa: Control and prevention of communicable diseases needs rethinking

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How to cite this article:

Mboera, L.E.G., Mfinanga, S.G., Karimuribo, E.D., Rumisha, S.F. & Sindato, C., 2014, 'The changing landscape of public health in sub-Saharan Africa: Control and prevention of communicable diseases needs rethinking', *Onderstepoort Journal of Veterinary Research* 81(2) Art. #734, 6 pages. <http://dx.doi.org/10.4102/ojvr.v81i2.734>

Note:

Proceedings of the 2nd One Health Conference in Africa. Jointly organised by the Southern African Centre for Infectious Disease Surveillance and the Tanzania National Institute for Medical Research, held at the Snow Crest Hotel in Arusha, Tanzania from 16th to 19th April 2013: <http://www.sacids.org/kms/frontend/index.php?m=119>.

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In sub-Saharan Africa, communicable diseases (CDs) are the leading public health problems and major causes of morbidity and mortality. CDs result in significant individual suffering, disrupting daily life, threatening livelihoods and causing one-third of the years lost to illness or death worldwide. This paper aims to analyse the current strategies in the control and prevention of CDs in sub-Saharan Africa and proposes an ecohealth approach in relation to current changing epidemiological profiles. Whilst in recent years the burden of HIV and AIDS, tuberculosis and malaria have helped to mobilise large amounts of funding and expertise to help address them, many CDs, particularly those affecting the poor, have been neglected. People living in rural areas are also likely to be politically marginalised and living in degraded environments. They often lack assets, knowledge and opportunities to gain access to health care or protect themselves from infections. New diseases are also emerging at unprecedented rates and require attention. Many CDs are rooted in environmental and livelihood conditions and mediated by social and individual determinants. It is now increasingly recognised that a much broader, coordinated and multi-sectoral ecohealth approach is required to address CDs in sub-Saharan Africa. An ecohealth approach has been shown to be more robust in public health interventions than the traditional medical approach. The approach helps to generate an understanding of ecosystem factors that influence the emergence and spread of both old and new diseases, considers temporal and spatial dimensions of disease infection and allows systems thinking. In conclusion, establishing intersectoral and multisectoral linkages is important to facilitate joint efforts to address CDs at the national, district and community levels.

Introduction

A communicable disease (CD) is an illness due to a specific infectious agent or its toxic product that arises through transmission of that agent or its products from an infected person, animal or inanimate reservoir (e.g. from a food source or contaminated water) to a susceptible host. CDs comprise clinically evident illness resulting from the infection, presence and growth of pathogenic biological agents in an individual host organism. They can be spread by direct contact with an infected person or animal, through ingestion of contaminated food or water, by disease vectors or by contact with contaminated surroundings like animal droppings or contaminated air. Demographic and environmental factors such as population growth, increased urbanisation and alteration of habitats of disease vectors may promote the spread of infectious diseases (Saker *et al.* 2004).

Whilst health systems face an increasing burden from chronic non-CDs, CDs continue to be the single most important contributor to the burden of disease in developing countries. CDs have remained leading causes of morbidity and mortality in sub-Saharan Africa for various reasons, including human sociocultural factors, inequity, weak health systems, limited national budgets and poor governance and accountability. Others include antimicrobial drug and insecticide resistance, environmental changes that favour vector population increase and demographic factors such as land use patterns, significant human migration and displacements. Population growth and migration, environmental change, transformation of landscape and globalisation of trade and economies have changed the kinds of health challenges faced by populations around the world. Despite substantial gains in socio-economic development around the world, and enormous advances in sanitation and medical knowledge and technologies, many CDs continue to pose an unacceptable burden to people in developing countries. A further threat is posed to people all around the world by the emergence of new infectious diseases, most of them zoonotic in nature, which appear to be on the rise (Jones *et al.* 2008).

About 60.0% of all infectious pathogens of humans originate from animals, although many of these are totally adapted to their new host and no longer require a non-human animal host for

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persistence. Various publications suggest between 60.0% and 75.0% of new or emerging infectious diseases of humans in the last half century originated from animals, of which about 71.0% of these were of wildlife origin (Jones *et al.* 2008). Important zoonoses that have posed health threats in Africa include: avian influenza, Ebola, Marburg, Lassa fever, Rift Valley fever, new arenavirus (Lujo) outbreak, anthrax, plague, human African trypanosomiasis, bovine brucellosis, bovine tuberculosis, porcine cysticercosis and rabies. It has been estimated that over half (54.3%) of emerging infectious disease events are caused by bacteria or rickettsia, reflecting a large number of drug-resistant microbes (Jones *et al.* 2008). The drivers of many emerging disease are mostly related to human behaviour, livelihoods, environmental and ecological factors. The main risk factors for human and animal epidemic diseases revolve around systems of governance; movement of humans, animals and commodities; and human behaviour (Rweyemamu, Otim-Nape & Serwadda 2006).

Communicable diseases, ecosystems and livelihoods

The persistency of most CDs and the emergence of zoonoses are complex and multifactorial, driven by factors which include evolving ecology, microbial adaptation, human demographics and behaviour, international travel and trade, agricultural practices, technology and industry. The persistence or re-emergence of infectious diseases, and the emergence of some new ones, may be indicative of wider problems affecting the dynamics of socio-ecological systems. Ecosystem health examines changes in the biological, physical, social and economic environments and relates these changes to impacts upon human health. Major CDs that are endemic in Africa constitute a high risk for health and livelihoods and future marginalisation of Africa through trade restrictions and sociopolitical impacts. In general in Africa CDs constitute a disproportionately higher burden level than in the rest of the world, with 72% of the disease burden attributable to poverty, interactions between socio-economic opportunities and the health of animals, people and ecosystems.

It is estimated that about 40% of the burden of disease in sub-Saharan Africa is environmentally determined (Smith, Corvalan & Kjellstrom 1999). Another important aspect of health is climate change and variability which is reported to have impacted more heavily in Africa than most other parts of the world. Generally, vulnerability of individuals and communities to CDs is influenced by multiple factors (environmental, economic and socio-ecological) in addition to host and causative agent factors (Weiss & McMichael 2004; Wilson 1995). Vulnerability is also tightly linked to inequity with respect to access to resources, decision-making power and capacity to cope. The continued prevalence of illness and vulnerability itself stems in part from the continued inequality within and between households, communities and countries. Inequality affects vulnerability directly by constraining the options available to communities, households and

individuals when faced with external shocks, and indirectly through its various links to poverty.

Complex health problems such as CDs are difficult to solve without understanding socio-economic and environmental contexts. It has already been recognised that socio-economic and environmental factors affect health, exposure to illness, risk for illness-producing behaviours, and the household or community response to the respective health problem. The modelling of human health from the perspective of its interaction with the environment was initially highlighted by the experience of the biomedical world and the spread of infectious diseases. Yet the world is subject to the influences of many complex factors that can undermine the health of human beings and that cannot be controlled by a biomedical approach alone.

A new approach to human health constitutes a bridge between public health, a strategy for integrated management of the environment and an ecosystem approach to promoting human health. The ecosystem approach to human health offers an unequalled opportunity to promote human health through an enlightened approach to management of the ecosystem. Ecosystem management relates to natural and environmental resources, but also should take into account the many human components as well as the socio-economic and cultural factors relevant to the living environment. The ecosystem approach to human health is also dependent on a participatory and transdisciplinary research methodology that remains sensitive to the needs and aspirations of different social groups, including the differences between genders. This means that the ecosystem approach to human health promotes a holistic view of human health, livelihoods and environmental sustainability (Charron 2012).

In the context of ecosystems, health is a positive characteristic of human communities. It implies both the availability of and accessibility to resources. Specific positive outcomes include food security, good nutrition, low levels of disease, reproductive capacity, a sense of well-being and access to knowledge (Waltner-Toews & Kay 2002). This means that health is a social construct negotiated in the context of a better understanding of the constraints and opportunities provided by the ecosystems of which people forms an integral part. Despite this understanding, for a number of years, conventional CDs research and control has tended to choose specific outcomes and view them as the result of a linear chain of events. It is envisaged that a more complex and realistic view requires identification of certain kinds of livelihood factors, which, although they are possible determinants of communicable disease transmission, also generate money to improve the well-being of the population. Considering this view, resolution of health-related issues (including CDs, education, nutrition and livelihoods) requires going beyond traditional health sector concerns and paying attention to the ecological and socio-economic context. Thus, it is not surprising to find out that programmes that are entirely unrelated to the conventional health sector, such as



agriculture, water and infrastructure development projects, have a major, usually contradictory, effect on human health. It has been argued that conventional programmes aimed at creating environments that promote health are simplistic and if they achieve their goals they do so by accident rather than by design.

Most CDs represent complex, multidimensional health problems with a host of interacting variables ranging from the parasite, vector, human host and local health-delivery systems to land use and climate change. A sound understanding of the nature and dynamics of certain ecosystem variables and their relationship to CDs transmission is a necessary step in identifying and addressing interventions that may reduce diseases whilst increasing household productivity.

Vulnerability to communicable diseases

Large groups of people continue to be vulnerable to CDs due to poverty, absence of adequate infrastructure, lack of access to health services, and degraded living environments. Similar to adaptations that people make to their changing environment, infectious disease agents also adjust to their changing surroundings. The pathogens that cause disease are in a state of perpetual adaptation, which can lead to the emergence of 'new' diseases or the spread of known diseases to previously unaffected areas. Diseases that experience a marked change in distribution, incidence and/or behaviour are often referred to as 'emerging or re-emerging diseases'. Factors that lead to the adaptation of infectious agents are complex and dynamic, ranging from deforestation, irrigation, species competition, and human and animal migration patterns to drug resistance and changing vector lifecycle due to climate variability (McMichael *et al.* 1996; Patz *et al.* 2005)

Understanding the determinants of health, beyond exposure to parasites and viruses, is fundamental to understanding how communities and individuals adapt to avoid risk and illness. Factors such as the ability to mitigate increased vulnerability associated with illness, access to timely diagnosis and care, and access to adequate nutrition all play a role in managing vulnerability and disease progression. These factors are in turn affected by behavioural and societal norms, such as the ability to control resources needed for health-seeking and protection behaviour and the perception that specific symptoms merit an immediate investment of time and resources (Jones & Williams 2004).

Climate change or variability and communicable diseases

There is a close link between local climate and the occurrence or severity of CDs. The effects of climate change and variability on ecosystem health are multiple and include interrelated environmental factors, food security factors, health factors, socio-economic factors and governance factors. The impacts of climate change are global, affecting mostly people from developing countries who depend most directly on their

ecosystems for survival and, because of poverty, have the least capacity to adapt to the rapid changes that are affecting their environment. The major impacts of climate change include severe floods, frequent and prolonged droughts, reduced water supply, decline in both crop and livestock yields, culminating in food shortages and health disorders.

The impact of climate change and variability on health and livelihoods varies between different ecological patterns. Populations in the drylands are likely to face decreased water availability, with implications for the consumption of safe food and disease profiles. Climate changes have been implicated in contributing to the spread of CDs, especially vector-borne diseases. The risk of CDs may increase due to changes and survival of pathogens, population movements, vector dynamics and changes in the natural ecosystems. Such changes include deforestation, agriculture and animal husbandry, water development projects, urbanisation, loss of biodiversity, introduction of alien species, and climate change.

There are many factors that affect vulnerability and how households manage their health and well-being in relation to climate change. The resilience of many ecosystems is likely to be exceeded by an unprecedented combination of disturbances associated with climate change and other drivers such as land use change and overexploitation of resources. Understanding how different factors influence access to resources and the social structures that govern behaviour is essential in appreciating health problems and their prevention, especially in view of a changing climate.

Drylands in sub-Saharan Africa are under constant threat from multiple stresses and challenges, which occur as a result of a complex interplay of natural and human-induced processes. People in the semiarid and arid areas of Tanzania suffer from poverty, food insecurity, ecological fragility and social vulnerability as well as CDs. Increasingly, scarce water sources concentrate people and animals in specific locations which can be hotspots for CD transmission.

Over many years, communities in sub-Saharan Africa have lived with variability in rainfall and frequent droughts using a range of coping strategies. Adaptation to climate variability has been a survival strategy that has been well refined over time. However, increasing variability and frequency of unusual weather events place the livelihoods of those most vulnerable to climate change at risk.

Challenges in the control of communicable diseases

Appropriate technical solutions exist to detect and treat most of the high impact CDs, whether through chemotherapy, chemoprophylaxis or applying better management practices. Poor execution or inability to apply management practices and known solutions for causes of the underlying poverty, capacity, infrastructure, knowledge and policy has prevented health services in countries in sub-Saharan Africa



to control CDs. The absence of effective health systems and weak disease surveillance in the region means that at best there is syndromic information on disease with little specific local knowledge. This means that some diseases are probably over-reported and many others under-reported. Pharmaceutical costs are likely to remain high given the reluctance of commercial pharmaceutical companies to invest in accessible, affordable products for use in animals to prevent or reduce the risk of zoonotic infection, since these are of little commercial value. This is in addition to weak community infrastructure (housing, animal facilities, waste systems, water supplies), poor nutrition and poor hygienic practices mostly due to lack of basic facilities and weak or remote health services. Education and awareness can also play a part – although there is no evidence that this in itself is a basic constraint, it will help in specific interventions and improved practices. Given the basic living conditions, exposure to the environment and reliance on animals for survival and daily food, poor communities are at risk from zoonosis, with a disproportionate number of women and children exposed through their particular domestic roles in animal management.

There is a general consensus that sub-Saharan Africa is lagging behind in the implementation of the UN Millennium Development Goals (MDGs). Considering that four of the eight MDGs are linked directly to CDs whilst the other four are linked indirectly, the continuing burden of CDs in Africa contributes to the slow progress with regard to the MDGs and in general result in undernutrition (Waage *et al.* 2010). Underlying trends to this disease status are increasing natural and man-made shocks and emergencies which further increase vulnerability of African communities (Ndiyoi, Rweyemamu & Meadows 2006).

Studies on future risk of CD have led to the realisation that such diseases are and will continue to be a formidable challenge to human welfare and economic development in sub-Saharan Africa over the next two decades, thereby impeding the region's ability to meet the targets of the MDGs (Brownlie *et al.* 2005, 2006; FAO/OIE/WHO 2008; Jones *et al.* 2008; King *et al.* 2006; Kock *et al.* 2012; Rweyemamu *et al.* 2006; Taylor, Latham & Woolhouse 2001; Woolhouse 2008; Woolhouse, Gowtage-Sequeria & Evans 2006; World Bank 2010; Zinsstag *et al.* 2011). It is therefore evident that environmental, economic and socio-ecological factors are inextricably linked with burden of disease. The latter is generally measured in terms of commonest diseases; direct and indirect costs incurred on disease treatment, control and prevention; years lived with disability; and years of life lost due to disease. Rarely captured in the burdens are the linkages with animals and the environment. This is particularly relevant to the livestock livelihood communities. A considerable body of research pinpoints weak health systems as critical impediment to improved health across Africa (Anyangwe & Mtonga 2007). Likewise, sub-Saharan African countries are faced with a number of problems due to a limited financial and human resource base. Weak and dysfunctional health systems are the major reasons why many effective low-cost health interventions remain underutilised whilst people continue to suffer and die in the midst of existing opportunities. In many cases, the failure to

deliver affordable and effective interventions to predictable, preventable and treatable CDs is a major weakness in the health systems of many developing countries. Health systems research can help identify best practices and prioritise areas that need strengthening (De Savigny & Adam 2009). Whilst health systems in general have received worldwide attention, little has been done to strengthen facility, district and national institutions responsible for stewardship of health systems in the region.

Ministries of Health in sub-Saharan Africa maintain two major systems for collecting and analysing information regarding CDs, namely the Health Management Information System and the Integrated Disease Surveillance and Response Strategy. Accurate epidemiological surveillance data are essential for adequate disease control. Surveillance requires impact indicators, based on standardised case definitions on morbidity and mortality. Definitions will vary, depending on diagnostic capabilities at different levels of the health care system, and most importantly, whether the case definition is based on confirmatory tests or not. Adequate case definition serves to provide indicators of disease epidemiology, which can be used for needs assessment, situation analysis and to evaluate the effectiveness of the disease control programmes. They also serve to guide and adapt control activities. The effectiveness of a health information system at the national, district and facility levels depends on the ability of staff to utilise the information properly. In many sub-Saharan African countries, these systems are not functioning properly.

Integrated disease control employing an ecosystem approach

In sub-Saharan Africa there is a bidirectional link between livelihoods, ecosystem and health. Environmental changes, especially those brought about by agricultural and water development as well as construction projects, often lead to changes in the ecology of some diseases. For instance, agriculture, which accounts for the occupation of the majority of rural people in sub-Saharan Africa and serves as food source for its urban population, is closely tied to human health (Hawkes & Ruel 2006). Good health affects agriculture by boosting people's capacity for work and thus increasing agricultural productivity. On the other hand, unintended side-effects associated with certain agricultural production systems may increase human exposure to vectors of diseases (Ijumba & Lindsay 2001; Mboera *et al.* 2007). In agricultural communities, poor health directly reduces income and productivity, further decreasing people's ability to address poor health and inhibiting economic development more severely, whilst in the population at large, malnutrition and disease patterns influence market demand for agricultural products.

Examining health in an ecosystemic context is therefore important because environment present not only opportunities for improving health but also risks to ill health. Most CDs are linked to the environment (Prüss-Üstün & Corvalán 2006; Weiss & McMichael 2004). Understanding the determinants of health is fundamental to understanding how communities and individuals adapt to avoid risk and illness. The prevailing approach to CD control, a highly successful



one, has focused on mass immunisation or rapid diagnosis, isolation and treatment for non-vaccine preventable diseases. The emergence late in the 20th century of antimicrobial resistance, the difficulties in finding effective vaccines for diseases such as HIV and malaria, the experiences from SARS and pandemic influenza have highlighted the need for alternative or complementary approaches that emphasise disease prevention, in addition to control.

For vector-borne disease like malaria, vector-eradication campaigns relying primarily on insecticides (either using insecticide-treated nets or indoor residual spraying) have remained the most widely used approach. Meanwhile, changes in the ecology of vectors have accelerated because of environmental and climate changes, changes in host ecology, and selection pressures from insecticides. Because microbes and vectors are living organisms, they will continue to adapt, change and pose threats to human health.

An ecosystem approach to preventing CDs considers drivers of risk in terms of the underlying ecological, social, cultural, political and economic factors of transmission dynamics. Like other health problems, the ecology and transmission of most CDs can be linked to interactions among several factors, such as demographic changes, poverty, urbanisation, deforestation, changes in agriculture modes of production, changed relationships between people and animals, natural resource management, gender differences and cultural patterns. An understanding of the complex interactions between these factors, and their local manifestations and risk factors for disease, require research across current boundaries of scientific disciplines and sectors (Boischio *et al.* 2009; Spiegel *et al.* 2005). The prevention of disease and the prevention of serious harm to livelihoods from such diseases depend on sound and resilient environments in ecological, social and economic terms.

It has been realised that there is interplay between livestock, wildlife and humans, and therefore between animal and human diseases. Thus, collaborative efforts between different sectors are required to realise effective control and/or eradication of emerging CDs in sub-Saharan Africa (Karimuribo *et al.* 2010). There is a need to promote collaborations between human and animal health sectors if meaningful prevention and control of emerging and re-emerging diseases is to be realised in sub-Saharan Africa. It is therefore essential to build intersectoral policy options that target disease prevention (Bazzani & Wiese 2012). Bringing different people and their contributions together in pursuit of a shared goal is a widely recognised strategy to harness capacity to address complex societal challenges, including CDs. Working together across sectors and disciplines to tackle complex interactions between health, environment and equity is now widely recognised to be beneficial in development research (Charron 2012).

Despite major progress in understanding CDs and substantial investments into control, the diseases remain major public health problems and pose serious challenges to development. The burden of CDs in sub-Saharan Africa is influenced by poverty, rapid and transformative economic development, and chronically weak health systems. Under

these conditions, innovative approaches are needed to develop and deliver CDs interventions in more context-adapted, effective and sustainable ways. CD control needs to be better integrated within highly variable local realities of community livelihoods, environments and health services. Integrated disease control can be defined as applied research that explores and creates synergies among environmental, health systems and community-based approaches to disease control. It has the potential to tackle root causes of CDs beyond the medical and public health aspects of the disease.

A number of studies have indicated that an ecohealth approach is the most appropriate way to address CDs. The approach strives for improved human health and well-being, based on sustainable ecosystems, with more equitable development and less poverty. The ecohealth approach supports systems-based, policy-relevant research on the relationships between ecosystems, human livelihoods and health to define, assess and mitigate priority problems that affect the well-being of people and the services provided by ecosystems they depend upon. In seeking to improve human health and well-being whilst simultaneously maintaining ecosystems and their services, the ecohealth approach puts forward an approach that requires a holistic framing of health-environment issues. In doing so, ecosystem and human dimensions along with gender and social equity issues are considered through different disciplines and non-academic knowledge, working together in a trans-disciplinary fashion and at the research-policy interface. Multistakeholder participation is encouraged, particularly those from the community and research end-users, including policy makers.

Conclusion

Delivering public health services requires functional and effective country-level health systems, including capable innovative health leadership, adequate financial resources, qualified healthcare providers, effective human resource systems, effective health information systems and adequate physical infrastructure. To be effective, intervention tools need to be usable within the available health system framework and implemented appropriately so that the end-user is able to benefit from them. The new approach to disease control should take into consideration the following: (1) socio-ecological and socio-economic approach as key elements for the risk management of disease; (2) understanding ecological processes (social, cultural, environmental and economic factors) contributing to disease occurrence and persistence at a time of rapid population growth, urbanisation, food system and environmental change; (3) improving specific determination of disease aetiologies and their drivers in poor and vulnerable communities; and (4) appropriate policies and health delivery systems.

Further progress in controlling CDs almost certainly requires some combination of biomedical technologies and social and environmental strategies coordinated among relevant sectors. Addressing CDs requires intersectoral cooperation and strong partnerships. Many CDs are rooted in environmental and livelihood conditions and mediated by social and individual determinants. It is now increasingly recognised



that a much broader, coordinated and intersectoral ecohealth approach is required to address them. An ecohealth approach has been shown to be more robust in public health interventions than the traditional medical approach. The approach helps to generate an understanding of ecosystem factors that influence the emergence and spread of both emerging and re-emerging diseases, considers temporal and spatial dimensions of disease infection and allows systems thinking. In conclusion, the establishment of intersectoral linkages is important to facilitate joint efforts to address CDs at the national, district and community levels.

Acknowledgements

Competing interests

The authors declare that they have no financial or personal relationships that may have inappropriately influenced them in writing this article. C.S. is a PhD student supported by Wellcome Trust Grant WT087546MA to SACIDS and the contribution of E.D.K. was supported by Rockefeller Foundations grants 2008-DSN310 and 2009-DSN305.

Authors' contributions

L.E.G.M. (National Institute for Medical Research) did a critical literature review and produced a first draft that was improved by the co-authors. S.G.M. (Muhimbili Medical Research Centre) contributed to the writing of manuscript. E.D.K. (Sokoine University of Agriculture) contributed to the writing and proof-reading of the manuscript. S.F.R. (National Institute for Medical Research) was responsible for proof-reading and improving the manuscript. C.S. (Tabora Medical Research Centre) contributed to the writing and proof-reading of the manuscript.

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