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Climate Change and Vector Borne Diseases: The Case of Malaria in Kenya

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ABSTRACT

Current information about climate change leans towards the fact that inter- annual and inter-decadal climate variability have a direct influence on the epidemiology of vector-borne diseases.
The current discussions on climate change estimate that average global temperatures will increase the likelihood of many vector borne diseases in tropical countries like Kenya.
Malaria and dengue fever are among the most important vector borne diseases in tropical climates like the one we experience here in Kenya. Human settlements in different parts of Kenya will influence disease trends. The proportion of urbanized Kenyan population is less that 45%. Climatic anomalies associated with the Elnino- Southern Oscillation phenomenon and resulting in drought and floods are expected to increase in frequency and intensity. These conditions have in the past been linked to outbreaks of highland malaria in Kenya. Climate change has far reaching consequences and touches on all life-support systems. This is a factor that should be placed high among those that affect human health and survival for people living in the tropics.
Objectives: The main objective of this review is to demonstrate from literature the underlying principles of the effect of climate change on vector borne disease transmission and to highlight the malaria experiences in Kenya.
Methodology: Review literature globally including whatever is available in Kenya.
Expected output: To prepare a firm ground for a concept note aimed at conducting a comprehensive study of the scenario in Kenya. Armed with such information, the health system will be better placed to respond appropriately to the changing situation.

Keywords: Disease vectors, Disease transmission, malaria, transmission, communicable diseases, health surveys.

Introduction

Human existence is dependent on the dynamics of Earth's Climate system. The workings of the atmosphere, oceans, and land surface determine Earth's surface climate (**Houghton JT *et al* 1997**). Atmospheric concentrations of greenhouse gases that include carbon dioxide, methane, and nitrous oxide are ever increasing in our atmosphere. This is mainly due to human activities such as use of petroleum products, coal, and land use change and agriculture irrigation schemes (**Watson RT *et al* 1998**). The increase in the greenhouse gases inevitably leads to warming of the atmosphere and Earth's surface.

In this article an attempt is made to assess evidence of past and current impacts of inter-annual and inter-decadal climate variability on vector-borne diseases on a continental basis and more specifically in Kenya with an aim of showing a link between possible future trends, particularly in view of the increased likelihood of climate change.

It is now estimated that global temperatures will rise by 1.0-3.5 degrees Celsius by 2100 (Watson et al 1995). This will inadvertently lead to the increasing likelihood of vector-borne diseases in tropical countries. The spatial changes in temperatures, precipitation and humidity that are expected to occur under different climate change scenarios will affect the biology and ecology of vectors and their intermediate hosts. These effects will consequently lead to increased disease transmission in tropical countries like Kenya.

Mosquito species such as the Anopheles gambie complex are responsible for the transmission of most vector-borne diseases. They are sensitive to temperature changes as immature stages in the aquatic environment as well as adults. If water temperatures rise, the larvae take a shorter time to mature (**Rueda LM *et al* 2008**). As a result of this there is a greater likelihood to produce more larvae offspring during the transmission period. In these warmer climates, adult female mosquitos digest blood faster and feed more frequently (**Gillies MT 1953**). This increases disease transmission intensity.

To compound the direct influence of temperature on the biology of vectors and parasites, changing rainfall patterns also have short-term and long-term effects on vector habitats.

Human settlements patterns also influence disease trends. In Africa more than 70% of the populations live in rural areas. In these areas, vector control like removal of larval breeding sites is most of the time difficult.

The recent literature includes a number of disease-specific reviews. This review offers a Kenyan perspective, attempting to capture the essential events observed under different climate variations and expected as a result of climate change.

Kenya

The tropical climate in Kenya is often favourable to most major vector-borne disease including malaria, Rift valley fever and tick-borne haemorrhagic fevers. It is also not uncommon to hear of episodic outbreaks of dengue fever in some urban areas.

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It is estimated that equatorial countries like Kenya, Uganda and Cameroon will experience a rise in temperatures of about 1.6 degrees Celsius by 2050 (**Watson RT *et al* 1998**).

Precipitation rates in Kenya are reported to be increasing over time (Carter TR, Hulme M 1999). Climate change is projected to have both short- and long-time impacts on disease transmission in Kenya. The short term increase in temperature and rainfall seen recently has already started causing upsurges in the plasmodium falciparum malaria epidemics (***Weekly epidemiologic Record, 2015***). A similar scenario was seen during the 1997 - 1998 El Nino malaria epidemics (***Weekly epidemiologic Record, 1998***). The number of water-borne illnesses have also been reported with quite a number of urban areas reporting malaria and diarrheal related illnesses. Cholera has been the leading cause of death (***Weekly epidemiologic Record, 2015***). This may be due to accelerated microbial/parasite development and an explosion of vector populations.

Overall the resultant increase in precipitation in the East African Region may be responsible for the rapid development of malaria vectors and parasites. Vectors in Kenya seem to adapt to ecosystems ranging from humid forests to dry savannahs. As these ecosystems change so will the distribution of vectors species. *Anopheles gambiase* prefers humid zones. The distribution and relative abundance of these species can be predicted fairly accurately using climate models (**Lindsay SW *et al* 1998**). This can also be used to indicate future changes in vector distribution associated with the changing climate.

It must also be emphasised that adaptation strategies to climate change such as irrigation schemes can also increase the risk of malaria transmission due to increase breeding sites.

More over, factors such as social economics, health seeking behaviour, geographical location, and population growth will also determine the vulnerability of populations to climate change.

In Kenya where the per capita gross domestic product is in the range of US $110- 500 highland malaria continues to be a major concern. This is a reflection of the low resource allocation for health at the government as well as the individual level. The emergence of drug resistant malaria is also a compounding factor. In many poor homesteads in Kenya malaria cases are treated at home which can lead to treatment failures due to drug resistance.

Destruction of forest covers like the Mau escarpment to create new settlement sites continues to be a main issue in Kenya due to the political dimension it tends to take. This can cause local temperatures to raise creating new breeding sites for vectors. This phenomenon has serious consequences on malaria transmission in the Kenyan Highlands.

At Equatorial altitudes like the Kenyan Highlands malaria transmission may become more intense (**Lindsay SW *et al* 1998**). Individuals at these altitudes may have a low immunity leading to high rates of mortality and morbidity.

In western Kenya, the mean monthly temperature at 2000m is 18 degrees Celsius. This is the threshold temperature for ***P. falciparum*** transmission. Theoretically, further warming will affect the areas above 2000m in western Kenya.

Current episodes of climate change variability in Kenya are likely to intensify the transmission of malaria especially in the highland areas.

While climate change continues to be a major co-factor in malaria epidemiology, other factors like drug resistance, reduced purchasing power and poor health infrastructures may be of importance as well. These are the tools and resources that reduce the impact of disease outcomes.

Conclusion

Together with the existing drivers of vector-borne diseases, such as the seasonal weather variation, socio-economic status, vector control programmes, environmental changes and drug resistance, climate change and variability are highly likely to influence current vector-borne disease epidemiology in Kenya. The epidemic effects are likely to be expressed in many ways from short-term epidemics to long-term gradual changes in disease trends. Results in Kenya suggest that anomalies in climate change variability account for up to 26% of the anomalies in hospital-based highland malaria cases according to A.K. Githeko, unpublished data 2006.

A multivariate analysis needs to be carried out to establish the contribution of all the other factors affecting disease transmission and clinical outcomes in Kenya.

There are few published information that provide such information, partly as a result of the poorly developed science of climate change and health. The contribution of climate change to vector-borne diseases may still be unknown, making this a serious obstacle to evidence based health policy change. Although the impacts of climate variability on vector-borne diseases are easy to detect, the same is not true of climate change because of the slow rate of change. It may also be possible that human beings may adapt to changes in climate thus minimising the impacts. Malaria in Kenyan Highlands could become gradually stable leading to a reduction in epidemics.

Adaptation strategies to climate change and variability in Kenya will depend to a large extent on the level of health infrastructure in general. The cost and efficacy of prevention and cure will be critical to disease management. In some parts of Kenya such as the highlands where a great diversity of disease vectors that are sensitive to climate change exist, greater efforts and resources will be needed to control the expected change in disease epidemiology.

Climate change variability unlike any other epidemiologic factor has the possibility to lead to simultaneous multiple disease outbreaks and other types of disasters. Climate change will have far reaching consequences that go beyond health and touch on all life-support systems. It is a fact that should be rated high among those that affect human health and survival.

Recommendations

1. There is an urgent need to respond to the effects of climate change on transmission of vector borne diseases in Kenya.

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2. There is an urgent need to include the effects of climate change and its consequences as issues that affect overall human health and survival and take appropriate action.

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