

Climate Change and Health Nexus: A Review

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Abstract

Climate change is an atmospheric condition where there exist upward trends in temperature above normal. The rise in temperature has change the dynamics of the spread of thriving diseases and has exacerbated the incidence of certain disease (malaria, meningitis, cholera etc.) on areas where they were non-existent. They are pathways through which climate change has impacted human health; through weather variables (such as heat and storms), natural systems such as disease vectors; and through under nutrition. This review paper elucidated more on the nexus between climate change and disease spread and enunciated gaps for future research.

Keywords: Climate change; Temperature; Health; Disease

Introduction

Debates on climate change

The current debate in the scientific community is that global warming need to be limited to 2°C (3.6°F) above preindustrial levels by the end of the 21st century in order to avoid potentially dangerous impacts. This probably requires atmospheric concentration of CO₂ which in 2016 were estimated to be around 430 ppm to remain below 450 ppm. It can only be achieved through increasing the efficiency with which energy is used; decarbonizing the world energy systems through the use of renewable energy or carbon capture and changing the land use and managements systems [1]. However, since this effort are far from being realistic as the impacts of climate change on health and the environment are globally evident.

Climate change and health nexus

Climate change affects in detrimental ways some of the most fundamental determinants for good health: clean air and water, sufficient food, adequate shelter and freedom from disease. A warmer and more variable climate increases the transmission of water, vector and food borne diseases, and also threatens to change the prevalence of those associated with air pollutants and aeroallergens [2,3]. According to Ayoade, McMichael and Chimbari [4,5] respiratory illnesses due to worsening air quality are caused by changes in temperature and precipitation resulting in the formation of smog leading to morbidity and mortality especially among the elderly and children. Diseases such as schistosomiasis, fascioliasis, alveolar echinococcosis, leishmaniasis, lyme borreliosis, tick-borne encephalitis, and Hantavirus infections are all projected to increase as a result of global climate change [6].

Climate change lengthens the transmission season and expands the geographical range of many diseases. Examples are diseases moving northwards in the northern hemisphere due to rising temperatures and changing rainfall patterns, or appearing in tropical areas subject to devastating extreme events [7]. Prior to this time, Young et al. discovered the northwards extension of the vector tick for tick-borne

encephalitis in Sweden and northwards extension of the water snail that spread schistosomiasis in eastern China [8].

Climate change could alter and disrupt natural systems thereby bringing new challenges to the control of infectious diseases since a changing climate makes it possible for diseases to spread or emerge in areas where they had been limited or had not even existed before [9]. To support this claim, Wolff and Comerford, Suad, Githeko, Shanahan et al. and Caffrey and Farmer [10-13] reported the spread of malaria to low and medium elevation upland sites in the Middle East (Turkey, Tajikistan, Uzbekistan, Turkmenistan, Anatolia and the Urals) and East Africa where malaria is being transmitted in rural populations in a near-epidemic proportion as the highland areas in Burundi, Kenya and Uganda that were historically classed as malaria-free now experience epidemics.

In the United States of America, simulation was introduced for the investigation of disease spread by Butterworth et al. [14] to examine the potential impact of climate change on dengue transmission using dynamic mosquito population and virus transmission model driven by meteorological data to simulate *Aedes aegypti* populations and dengue cases in 23 locations in southeastern United States. This simulation compared estimates for each location base on observed data from San Juan and Puerto Rico, where dengue was endemic. The simulations suggested that dengue transmission at levels similar to San Juan was possible at several US locations during the summer months, especially in southern Florida and Texas.

Prior to this time, Climate change impact had extended to the spread of diarrhea and bodily injuries. A study of 120 nursing mothers who were victims of floods and rainstorm events in Ilorin, Nigeria, was conducted between 2000 and 2007 by Raheem [15] using number and location of victims of flood events in Ilorin metropolis. The results revealed that flood events had a broad range of health impacts as 61% of the mothers indicated bodily injuries caused by debris in the flood water, domestic water sources were disrupted in 65.7% of the households and new cases of childhood diarrhea occurred in 70.9 percent of the households sampled.

Methodology

Surveillance (largely controlled by the WHO through collaboration with nations) is a complex systematic tracking of the health of a population—whether general or particular indicators and involves identifying, mitigating public health problems (allergies), collecting data; which finally passes through a process of data analysis and reviews findings before needed actions are taken [16].

Areas where successes have been achieved are numerous and they are; the roll back malaria action and investment to defeat malaria 2016-2030 in Botswana which was able to alert and provide a rapid response unit with a time lead of four months in the fight against malaria. In east Africa a malaria epidemic prediction model was formulated to deal with the unstable transmission and climate sensitive epidemic and a successful two to four months detection signal was invented to deal with malaria cases among the common well and poorly drained valley ecosystems in the highlands of east Africa [17,18]. Surveillance was part of the strategy used by the global technical strategy for malaria (GTSm) 2016-2030 to reduce world malaria mortality rates by 66% amongst all age groups and by 71% amongst children under five and currently projected to use to reduce both mortality and morbidity by 90% by 2030.

In the same vein Mukhopadhyay [19] enumerated the usefulness of global positioning system (GPS), remote sensing and google earth in the mapping tracing and identification of disease and where it has been successfully deployed in the surveillance and monitoring of diseases spread. GPS was successfully used with precision and accuracy in the detection of cholera transmission risk system in Sabah, (Malaysia), Bengaluru, (India), Ilala district, (Tanzania), Lusaka, (Zambia) and Haiti in 2010. GPS was used to unravel that insufficient coverage of drainage networks was an elevated risk of cholera outbreaks in Zambia. Google earth was used to understand the cholera epidemic affecting Guinea-Bissau in 2008. These technologies have the potentiality to act as an early warning system for disease spread, surveillance and control. GPS technology combined with the google earth system is a useful tool to augment our understanding of preventive measure of any outbreak by providing the location of the households and an insight as to how people interact with the environment.

The MARA (Mapping malaria risk in Africa) research group combined elements of both biological and statistical methods on temperature-parasite relationships with field observations of climatic cut-offs for disease transmission to define a fuzzy logic measure of climatic suitability for malaria transmission. These relationships can be applied to climate and population distribution maps to define populations living in different levels of climate suitability for disease transmission, for different months of the year. The main advantages of this approach are, it does not rely on complete characterization of the transmission cycle, it avoids using coarse disease distribution maps to define the statistical relationships between climate and disease, and the final outputs of climate suitability and number of person-months exposed, are correlated with disease risk [4]. It is instructive to note that Nahideh et al. [20] assessed the nexus between meteorological and climate parameters effects (temperature, wind, humidity and rainfall) on the spread of Malta fever (Brucellosis) in Zanja province of Iran using inverse distance weighting and Kriging techniques in arc GIS to prepare a Malta fever (Brucellosis) distribution and meteorological zoning maps of the area. Climatic parameters maps of temperature, rainfall, wind and humidity for all the zones were compared to the spread of Malta fever (Brucellosis) for correlation, the results revealed

that the spread of Malta fever (brucellosis) was not influenced by the effects of meteorological and climatic parameters of wind, humidity, rainfall and temperature in Zanja province of Iran and concluded that other factors could be responsible.

Discussion

Gaps discovered

The United Nations Framework Convention on Climate Change Synthesis Paper report stated lucidly that Climate change affects health through three pathways: directly through weather variables (such as heat and storms); indirectly through natural systems such as disease vectors; and through pathways heavily mediated by human systems such as under nutrition. The report also situated the effect of climate change on health as significant and negative and estimated a projected health impacts from 2030 to expect exacerbation of health issues in the future, including under nutrition, heat mortality, vector-borne and waterborne diseases. Henderson et al. also reported a projection in the spread of water and vector borne as insects and other carriers have moved to higher latitude which consequently implies that a warmer climate also increases the concentration of smog (lung irritants).

The United Nations Framework Convention on Climate Change report enumerated the emerging diseases as a result of climate change in Asia, Africa and Latin America as Malaria, Dengue, West Nile Fever, Chikungunya, Ross River Virus, Zika Virus, Meningitis, Respiratory (Influenza), Zoonotic diseases, Food Borne Diseases, Bacteria diseases and Chronic diseases (Cardiovascular and Asthma). There is a need for contemporary studies on the impacts of high temperature on the spread of these diseases especially in sub-Saharan African and Nigeria as a case study.

Furthermore, the report elucidated that certain workers are particularly vulnerable to the impacts of climate change (e.g. farmers, construction, tourism and transportation workers etc. Heat stress can lead to lower productivity, unbearable working conditions and an increase in the risk of cardiovascular, respiratory and renal diseases. Climate change impacts on people's work can also lead to mental health problems, such as depression and suicide when people are not able to work and provide for themselves and their families especially amongst farmers in the agricultural sector. Studies on the impacts of high temperature (heat) on ambient workers with emphasis on their productivity are very necessary. Others are on the impacts of climate change on mental health, depression and the risk for cardiovascular, respiratory and the renal diseases.

Prior to this report Lugo [21] identified the main vector for dengue fever as *Aedes aegypti* which is also responsible for the spread of yellow fever, chikungunya and zika virus. What this portends is that there is a need for deciphering if the spread of dengue also mean the spread of zika virus, yellow fever and chikungunya. Studies are needed to understand the factors that influence the spread of *Aedes* mosquito, their distribution, changes and control. For accuracy and precision of these studies, remote sensing and geographical information systems can enhance our understanding of the relationship between climate and vector-borne/water-borne diseases [22].

Conclusion

Climate change is simply an observed upward trend in temperature above normal. This abnormality is the trigger for the high spread of

diseases to areas hitherto not thriving. Climate change has changed the meteorological conditions of the atmosphere to support the thriving and in some cases the destruction of diseases spread. The aim of this review is to elucidate grey areas for research.

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