Microbes and Infectious Diseases 2023; 4(3): 1053-1058

Microbes and Infectious Diseases

Journal homepage: https://mid.journals.ekb.eg/

Mini-review article

Climate change and change in transmissibility of vector-borne diseases: A narrative review and bibliometric analysis

Naushaba Akhtar [1], Shakti Rath [*2]

1- ICMR Regional Medical Research Centre, Bhubaneswar, Odisha, India

2- Central Research Laboratory, Institute of Dental Sciences, Siksha 'Anusandhan (Deemed to be University), Bhubaneswar, Odisha, India

ARTICLE INFO

Article history:

Received 14 January 2023

Received in revised form 7 February 2023

Accepted 11 February 2023

Keywords:

Climate change

Vector-borne diseases

Transmissibility

Bibliometric analysis

ABSTRACT

The development of diseases like malaria, dengue, chikungunya, Japanese encephalitis, filariasis, visceral leishmaniasis, etc. is a result of the changing environment. Though these diseases differ by their mode of transmission and the vector, changing climatic conditions is one common factor among all which favours the spread of all vector-borne diseases and brings about new challenges for public health workers. This paper gives a bibliometric analysis of the literature conducted in the past on topics related to climate change and change in the transmissibility of vector-borne diseases from the available literature in the last 5 years from PubMed. It is also a narrative review of global climatic variations and how these changes have affected the transmission of vector-borne diseases. This piece of study provides sufficient information on vector-specific disease transmissibility and the bibliometric analysis provides sufficient knowledge on types of studies conducted so far which would give scope for further research in this area.

Introduction

The change in climatic conditions is attributable to human activities either directly or indirectly. It is responsible for causing alteration in the atmospheric composition of the earth, thereby causing climatic and seasonal variations. [1]. The greenhouse gases present in the atmosphere have been responsible for an increase in earth's temperature by 1°C according to Intergovernmental Panel on Climate Change (IPCC). These types of climatic variations are likely to be responsible for causing expansion in the transmissibility of vector-borne diseases irrespective of time and space [2].

A vector is a live organism that spreads an infectious pathogen from one animal to another. Arthropods such as mosquitoes, ticks, flies, fleas, and lice are common vectors [3]. As a suitable climate is essential for the persistence of vectors and even the emergence of vectors, the varying temperature and climate enable the opportunity for vectors to thrive. There have been numerous studies conducted in the past that show evidence of climate change and how it influences the rate of transmission of vector-borne diseases. Climatic factors such as temperature, humidity, and rainfall have been playing a major role in the increase in the transmission of disease. The changing climate is allowing expansion to diseases like malaria, dengue,

DOI: 10.21608/MID.2023.187471.1451

* *Corresponding author:* Shakti Rath

E-mail address: dr.shaktirath@gmail.com

chikungunya, Japanese encephalitis, filariasis, and visceral leishmaniasis[4].

Studies have proven that extreme climatic conditions observed, especially increase or decrease in temperature to an optimum level influence the life cycle of the vectors, increase the rate of reproduction of parasites and other microbial pathogens by providing a suitable breeding ground and gradually elevating the risk of transmission. This issue of fluctuation in temperature has become evident since 1990 and there have been numerous efforts conducted so far at both National and International grounds to level up efforts to tackle this global issue nation [2]. Climate change can be the major precursor for the increase in the prevalence of vector-borne diseases [5]. The higher transmission rate and favourable climate also bring about great challenges for the prevention and control of diseases [6].

Several organizations have been working together like the United Nations, United Nations Framework Convention on Climate Change (UNFCCC), and the Global Environmental Facility on IPCC which is an inter-Governmental Panel on climate change several projects are been funded for assessment in various parts of the world, World Health Organization (WHO) has also played a major role in combatting the issue of climate change and vector-borne diseases which is evident in the report of Global vector control response (GVCR) 2017-2030 [7]. The current climatic scenario, which is partly influenced by political factors, might act as a relapse for the control of public health prevention and control measures.

Transmissibility of vector-borne diseases

It has been evident in numerous studies that a favourable climate is essential for the transmission of vector-borne diseases. The high incidences of cases of malaria in different parts of the world in different climatic and seasonal conditions have proven the consistency of its occurrence with varying climatic conditions. Among the vector-borne diseases, the incidence of malaria has always remained high in the past few years which accounts for 241 million cases and 627000 deaths in 2020 worldwide according to World Malaria Report [8]. According to WHO, the African region has been home to 95% of total malaria cases, because of which malaria seeks greater attention from the healthcare system [8]. In Western Kenya where malaria outbreaks took studied when the mean temperature exceeded 18°C in a month [9]. One of the reports also suggests that 2000 malaria cases are detected every year in the USA [10]. Reports show that India alone accounts for about (82.5%), followed by Indonesia (15.6%) and Myanmar (1.6%) of the total malaria cases in the southeast region of Asia [8]. Unlike malaria, the transmission of dengue is also prevalent, research conducted in the past shows that a slight increase in temperature up to 4°C increases the transmission rate by two to five folds [11]. The first-ever cases of dengue fever were evident in parts of Asia, Africa, and North America in the year between, 1779-1780 [12]. A study conducted in the past indicates a higher incidence of dengue cases in around 192.73 of 1000 population in Trang provinces of Andaman region observed in July 1995 [13]. In this case, dengue ecology plays a vital role in the transmission apart from the competency of the vector itself [13]. Evidence shows the re-emergence of cases of kala-azar in parts of western India from the year 2007 after it was last reported in 5 districts of Gujrat in 1976 [14]. Apart from mosquito-borne diseases, Ticks are also susceptible to climatic variations, especially humidity, and temperature. Several studies show a high incidence of tick-borne disease in various parts of Europe, like Austria, Germany, Norway, etc [5]. **Table 1** shows types of vector-borne diseases and their favourable condition for transmission into hosts.

Bibliometric analysis

This bibliometric analysis shows literature from the past 5 years on the topic related to climate change and vector-borne disease transmission. It is an essential procedure that would help in assessing the trend and pattern of research on a specific domain. It shows existing studies on the current topic and provides scope for further research in a similar domain. In this study, searches have been made using the keywords ‘climate change’ in combination with other search terms and selected 382 articles relevant from PubMed for the procedure of bibliometric analysis. The bibliographic data have been constructed using the keywords from titles from 382 selected articles, their association strength has been depicted in the below map **(Figure 1)**.

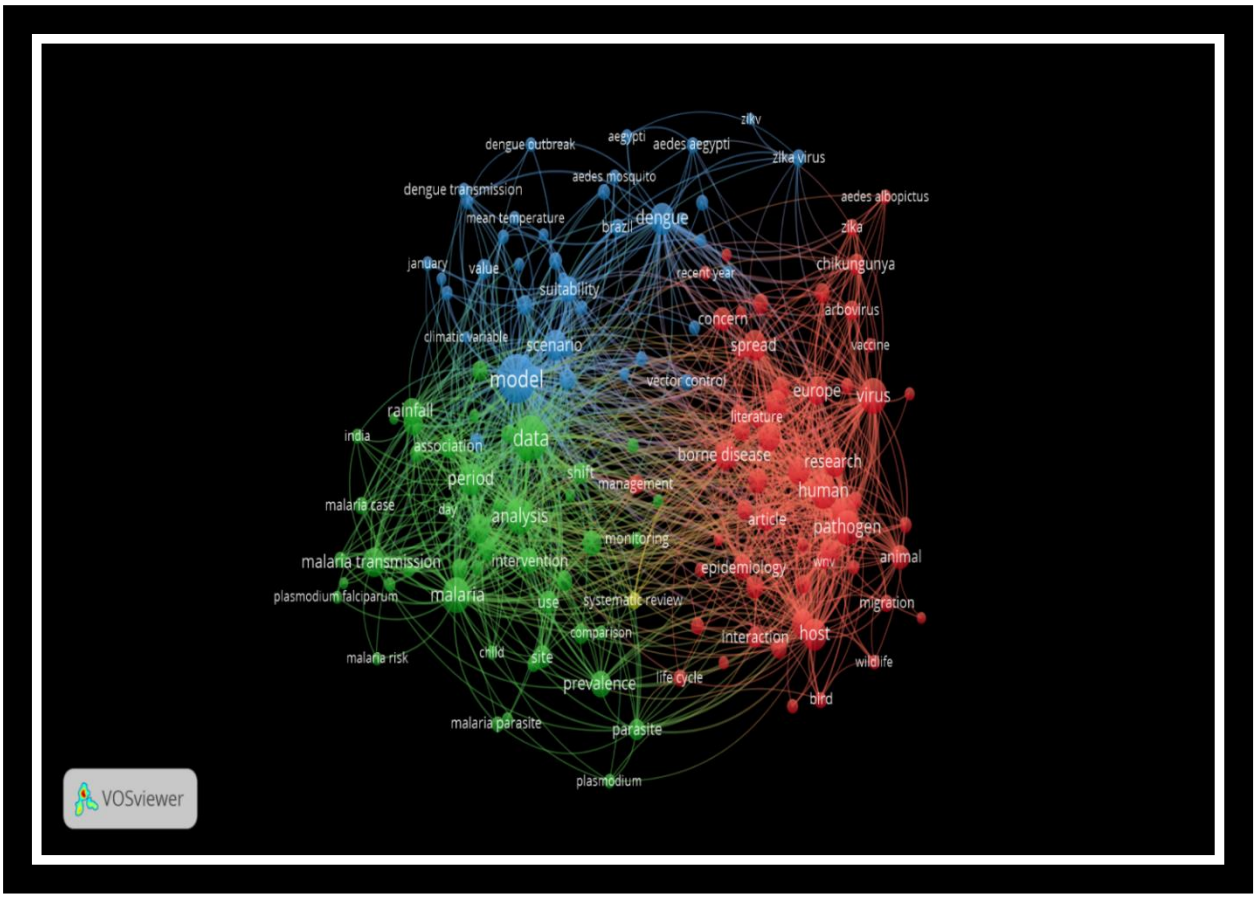
Table 1. Diseases transmitted by vectors and the conditions that favour transmission to hosts [7]

Vector-Borne Diseases	Type of Vector	Pathogen/Vectors	Favourable Environment	Reservoir/ Host
Malaria	Mosquito	*Plasmodium* parasite-Female Anopheles mosquito	High Temperature, rainfall, and humidity	Human
Dengue	Mosquito	*P. flavivirus- Aedes aegypti* and *Ades albopictus*	During and after rainy seasons, air temperatures, precipitation, and humidity	Humans & Mosquito
Yellow fever	Mosquito	Aedes and Haemagogous	Tropical & densely populated areas	Monkeys and humans
Japanese encephalitis	Mosquito	Virus- *Culex titaeniorhynchus*	Rural & Suburbans where forests and residentials are closely packed	Mosquitoes, pigs, and water birds(enzootic cycle)
Zika virus	Mosquito	*P. flavivirus- Aedes aegypti*	Tropical & Sub-tropical	Monkeys, Mosquitoes & Human
Visceral Leishmaniasis- (also known as Kala-azar)	Sandfly	Protozoan parasite-bites of female phlebotomine sandflies	Changes in temperature, humidity, and rainfall. Small fluctuations in temperature, drought, famine, and flood	Humans and about 70 species of animals
Tick-borne encephalitis(TBE)	Ticks	*Ixodidae*	Higher Temperature	Small Rodents
Schistosomiasis	Snails	Parasitic worms-Trematode worm-*Schistosoma*	Tropical & sub-tropical climate	Cattle, dogs, cats, rodents, pigs, and horses but intermediate hosts are snails
West Nile Fever	Mosquito	Flavivirus -*Culex mosquitoes(Cx.pipiens)*	forest and residentials are closely packed	Birds

Table 2. Bibliometric analysis of the search strategy in the title, abstracts, and keywords.

Article Type	Article nos
Review	24
Note	0
Editorial	0
Research	358
All articles	382

Figure 1. Bibliometric map of the search strategy research database depicting their association.



Discussion

The many studies conducted in this area show the impact of climate change on the transmission of vector-borne disease. Climatic factors such as temperature, humidity, and rainfall have been playing a major role in the increase in the transmission of disease [15]. Climate factors have a direct impact on the survival and reproduction of pathogenic microbes, their vectors, and their animal reservoirs. Climate change has increased the geographic spread of several pathogenic microorganisms as a result of persistently rising temperatures at higher latitudes. Extreme weather events linked to climate change occur more frequently, creating environments that encourage the growth of pathogenic microbes and the emergence of new illnesses [15]. Increased human movement is associated with climate instability, and this disruption of the health care system, as well as the habitats of bacteria, vectors, and animal reservoirs, results in widespread poverty and overpopulation. Medics should be aware that climate change will have an impact on the prevalence and geographic distribution of infectious illnesses, many of which have cutaneous symptoms and may be met in daily practice. This review confirms the role of climatic factors that have been responsible for the spread of pathogens worldwide and also confirms that similar trends are likely to happen in near future [16, 17]. This paper gives a bibliometric analysis of the literature conducted in the past on topics related to climate change and change in the transmissibility of vector-borne diseases from the available literature in the last 5 years from PubMed. This piece of study provides sufficient information on disease vector-specific disease transmissibility and the bibliometric analysis conducted provides sufficient knowledge on types of study conducted so far which enables scope for further research. Though this narrative has been conducted on the role of climate change in the transmissibility of infection there is a further need to explore other aspects of this domain [18]. Several interrelated pathways contribute to anthropogenic climate change's impact on the prevalence of infectious illnesses. More people are now aware of how climate-sensitive infectious illnesses constitute an increasing threat to global public health in recent years [17]. The role of climate change and socio-environmental factors need to be assessed so to provide a complete scenario of the situation. [18].

Conclusion

This study has focused on the conditions of climate change and changes in the transmission of vector-borne disease. This research reveals that vector-borne diseases need optimal climatic conditions and reaching certain climatic conditions in an uneven pattern and multiple times give rise to the occurrence of vector-borne disease outbreak. Other than the varying climate certain regions of the world which have high or cool temperatures for a longer duration are susceptible to vector-borne outbreaks. Efforts are being made to monitor and control vector-borne diseases around the world. Many international and national collaborations are working together to address the issue of control of vector-borne disease control at the environmental level. Though changing scenario of globalization, the healthcare system, environmental policies, and identification of constraints in policy gaps are getting better along with changing climate, the threat of climate change on vector-borne diseases can be contradicted.

Conflicts of interest: None.

Financial disclosure: None.

Acknowledgement: None.

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Akhtar N, Rath S. Climate change and change in transmissibility of vector-borne diseases: A narrative review and bibliometric analysis. Microbes Infect Dis 2023; 4(3): 1053-1058.