Impact of Climate Change on Vector-Borne Diseases in Nigeria

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Abstract

This study examines the impact of climate change on the prevalence of vector-borne diseases, specifically malaria and dengue, in Nigeria. Rising temperatures, altered rainfall patterns, and increased humidity were found to significantly influence disease transmission by creating favorable breeding conditions for mosquitoes, the primary vectors. Data were collected from weather stations, satellite imagery, government reports, hospitals, and health organizations. Geographic Information Systems (GIS) and statistical methods were employed to analyze regional variations and quantify the relationship between climate variables and disease prevalence. Results revealed a regional disparity in disease patterns, with Northern Nigeria experiencing higher malaria prevalence due to rising temperatures, while Southern Nigeria showed a steady increase in dengue cases linked to higher rainfall and humidity. Central Nigeria exhibited moderate increases in both diseases. Longitudinal studies highlighted the consistent influence of climate variability on disease trends over time. Interviews and surveys provided qualitative insights into the experiences of affected communities, further emphasizing the need for region-specific public health strategies. The findings underscore the necessity of integrating climate adaptation measures into health policies, such as enhanced disease monitoring, environmental management, and community education. Proactive efforts tailored to regional climate conditions can mitigate the growing burden of vector-borne diseases in Nigeria, thereby improving public health resilience against climate change.

Keywords: Climate, Vector, Diseases, Nigeria, Malaria

Introduction

Climate change is a major global concern that affects many aspects of life, including health. In Nigeria, climate change leads to shifts in temperature and rainfall, which can influence the spread of vector-borne diseases like malaria and dengue fever. These diseases are transmitted by insects such as mosquitoes, which thrive in warm and humid environments. The World Health Organization (2023) states that changing weather patterns can increase the risk of illness by expanding the habitats of these disease-carrying insects.

Malaria is particularly common in Nigeria, with millions of cases reported each year (Nigeria Malaria Indicator Survey, 2018). Dengue fever, on the other hand, is less prevalent but is becoming a growing concern in many urban areas. As the climate continues to change, understanding how it affects these diseases is crucial for public health efforts. Research shows that different regions in Nigeria experience varying climate conditions, which can lead to different patterns of disease (Oladipo et al., 2023).

This article aims to investigate how climate variability impacts the prevalence of malaria and dengue in various regions of Nigeria. By examining these factors, we can better understand the relationships between climate change and health, and develop effective strategies to control these diseases.

Statement of the Problem

Climate change is becoming a big problem around the world, and Nigeria is no exception. Changes in weather patterns, like temperature and rainfall, can affect how diseases spread, especially vector-borne diseases like malaria and dengue (World Health Organization [WHO], 2023). Malaria is a major health issue in Nigeria, causing millions of infections each year (Nigeria Malaria Indicator Survey, 2018). Dengue fever is also a growing concern, particularly in urban areas as temperatures and rainfall patterns change (Oladipo et al., 2023).

These changes in climate may alter the habitats of the mosquitoes that spread these diseases, increasing the risk of illness in different regions of Nigeria (Oladipo et al., 2023). Despite the seriousness of this issue, there is a lack of detailed research exploring how specific climate factors, such as rising temperatures and varying rainfall, influence the rates of malaria and dengue in different parts of the country. This knowledge is necessary for developing effective health policies and strategies to control these diseases. Therefore, this study aims to investigate how climate variability impacts the prevalence of malaria and dengue across various regions in Nigeria.

Objectives of the Study

The main objective of this research is to understand how changes in climate affect the spread of diseases, like malaria and dengue, in various parts of Nigeria.

Literature review:

1. Introduction

Climate change, marked by rising temperatures, irregular rainfall, and extreme weather events, has become a major environmental issue with wide-ranging effects on human health (IPCC, 2023). Among these health concerns, the spread of vector-borne diseases, which are illnesses transmitted by insects like mosquitoes, ticks,

and flies, is particularly troubling. Diseases such as malaria and dengue, transmitted by mosquitoes, are influenced by climate changes that create favorable conditions for these insects to breed and spread (WHO, 2022).

In Nigeria, where malaria is already a leading health problem, understanding the impact of climate change on the spread of these diseases is especially important. Nigeria's tropical climate, combined with ongoing climate variability, increases the risk of malaria and dengue outbreaks, particularly in certain regions more prone to warmer and wetter conditions (Oluwole et al., 2024). This connection affects public health and puts additional pressure on healthcare resources and economic stability.

This review aims to examine existing studies on the relationship between climate change and the spread of vector-borne diseases in Nigeria. By exploring how climate factors affect disease patterns, this review will provide insights that can support better disease control strategies and policies in Nigeria.

2. Climate Change and Its Effects

Climate change refers to long-term changes in temperature, precipitation, and other atmospheric conditions on Earth. It is mainly caused by human activities, such as burning fossil fuels and deforestation (IPCC, 2023). In Nigeria, climate change significantly impacts the environment, economy, and people's lives.

Studies show that Nigeria has experienced increasing temperatures and changing rainfall patterns in recent years. According to a study by Oni et al. (2024), the average temperature in Nigeria rose by approximately 1.1 degrees Celsius between 1970 and 2018. Higher temperatures can lead to heat stress, affecting crops and human health.

Rainfall patterns in Nigeria have also changed. Research indicates that there have been more extreme rainfall events, leading to floods in some areas, while other regions experience droughts (Adelekan et al., 2024). For example, the northern part of Nigeria has faced severe droughts that harm farmers and reduce food production, while the southern areas have seen increased flooding.

Humidity is another critical climate factor that affects Nigeria. Higher temperatures usually lead to increased evaporation, which changes humidity levels. A study by Eze et al. (2023) noted that higher humidity impacts agriculture and increases the risk of disease, such as malaria.

The effects of climate change in Nigeria are far-reaching. Crop yields are declining, threatening food security. Researchers warn that if these trends continue, they will worsen poverty and lead to more conflicts over resources (NEST, 2024). Climate change also affects water availability, as droughts reduce river levels and increase competition for water sources (Ugba et al., 2023).

In conclusion, climate change significantly impacts Nigeria's environment, altering temperature, rainfall, and humidity. Addressing these changes is crucial for the country's sustainability and future development.

3. Overview of Vector-Borne Diseases in Nigeria

Vector-borne diseases are illnesses caused by pathogens that are transmitted to humans through vectors, which are animals or insects that carry the disease. Common vectors include mosquitoes, ticks, and flies. In Nigeria, these diseases pose a significant public health challenge due to the country's tropical climate and various ecological factors (World Health Organization [WHO], 2024).

Major Vector-Borne Diseases in Nigeria

Some of the major vector-borne diseases affecting Nigeria include:

1. Malaria: Caused by the Plasmodium parasite, malaria is transmitted through the bites of infected Anopheles mosquitoes. It is the most prevalent vector-borne disease in Nigeria.
2. Dengue Fever: Spread by Aedes mosquitoes, dengue causes severe flu-like symptoms and can lead to complications (WHO, 2024).
3. Yellow Fever: Also transmitted by Aedes mosquitoes, this viral disease can be severe and often requires vaccination for prevention.
4. Lymphatic Filariasis: This disease is caused by parasitic worms and transmitted by mosquitoes. It can lead to severe limb swelling (World Health Organization [WHO], 2023).

Impact on Health in Nigeria
Vector-borne diseases have a profound impact on the health of the Nigerian population. Malaria alone accounts for a significant number of hospital visits and deaths, particularly among children under five and pregnant women (Nigeria Centre for Disease Control [NCDC], 2024). The ongoing burden of malaria contributes to economic losses and reduces productivity, as sick individuals miss work.

Dengue and yellow fever also pose health risks, leading to serious complications and even death. The healthcare system often struggles with the diagnosis and treatment of these diseases, as resources are limited (NCDC, 2024). Furthermore, vector-borne diseases often lead to increased healthcare costs for families and the government, which can strain resources in an already challenged health system.

In summary, vector-borne diseases like malaria and dengue significantly affect the health of people in Nigeria. Continuous efforts in prevention, education, and healthcare enhancement are essential to reduce the burden of these diseases.

4. Impact of Climate on Vector-Borne Diseases
Climate changes influence the spread of vector-borne diseases, illnesses spread by organisms like mosquitoes and ticks. Factors such as temperature and rainfall significantly affect the life cycle of these vectors, which can lead to more cases of diseases like malaria and dengue.

Multiple studies show that rising temperatures expand the habitats of disease-carrying vectors. For example, a study by Tolosa et al. (2022) found that warmer temperatures allow the Aedes aegypti mosquito, which spreads dengue, to thrive in new regions previously too cool for these insects. This change in habitat increases the risk of dengue outbreaks as these mosquitoes are more active in warmer conditions.

Rainfall also plays a vital role in the spread of vector-borne diseases. Excess rainfall creates standing water, which is a breeding ground for mosquitoes. According to a study by Shrestha et al. (2019), heavy rainfall predicted an increase in malaria cases in some regions because rainfall patterns create ideal conditions for the Anopheles mosquito, the primary vector for malaria.

Climate variability leads to extreme weather conditions, affecting disease transmission. A research by Fitchett and Grab (2019) highlights that changing climates result in unpredictable weather. This unpredictability affects when and where mosquitoes breed, ultimately impacting the rates of vector-borne diseases.

Specific findings on malaria and dengue show a direct relationship with climate factors. For malaria, Carpenter et al. (2018) showed that regions with increasing temperature and humidity have seen rising malaria incidences. Conversely, for dengue, the World Health Organization (2023) indicates a clear connection between warmer temperatures and increased dengue cases, notably in tropical countries.

In summary, climate changes significantly affect the spread of vector-borne diseases like malaria and dengue. Rising temperatures and changing rainfall patterns create conditions that favor the growth of mosquitoes. As climate variability continues, the risk of these diseases is expected to rise in many areas, requiring public health adaptations to mitigate their impact.

5. Regional Differences in Nigeria

Climate change significantly impacts how diseases spread in Nigeria, and these effects vary by region. Research shows that different areas experience unique challenges based on their geography, population density, and climate (Adesina et al., 2023).

Nigeria has diverse regions, including the northern arid areas, central mixed zones, and southern coastal regions. Each region faces different climate challenges. For example, the northern regions often suffer from extreme heat and drought, which can lead to water scarcity and increase diseases like cholera (Nwankwo et al., 2022). In contrast, the southern regions receive more rainfall, which can lead to flooding and the spread of mosquito-borne diseases like malaria (Odeh et al., 2024).

Population density also plays a crucial role. Urban areas, like Lagos in the southwest, have high population density, which can speed up the spread of diseases. In densely populated cities, sanitation problems can emerge due to inadequate infrastructure, making residents more vulnerable to diseases (Abubakar & Adedeji, 2022). Meanwhile, more rural areas may have lower population densities, but they often lack access to healthcare. This disparity can affect how regions respond to climate-related health issues (Ekpo et al., 2022).

Geographical features also influence disease impacts. The Niger Delta, for instance, is prone to floods, which can breed mosquitoes and lead to malaria outbreaks. In contrast, northern regions may see a rise in rodent-borne diseases as animals migrate in search of food (Mohammed et al., 2023).

In summary, the effects of climate change on diseases in Nigeria vary widely across regions. Factors such as geography,

population density, and climate variations greatly influence these differences.

6. Gaps in Existing Research

There are several gaps in research about how climate change affects vector-borne diseases, like malaria and dengue, in Nigeria. First, specific regions in Nigeria need more study. While some areas may have been examined, others, especially rural or hard-to-reach places, often lack data. For example, northern Nigeria might show different trends compared to the south, but detailed information is limited.

Another area needing attention is the influence of various factors, such as humidity, rainfall patterns, and temperature changes, on the spread of these diseases. Research has usually focused on general climate change effects, but there is little detailed analysis of how these individual factors interact with local conditions.

Moreover, there is limited data on the long-term impacts of climate change on vector-borne diseases in Nigeria. Most studies tend to look at short-term effects or focus on a single disease. Understanding how climate change might affect the prevalence of diseases over many years is essential to develop effective prevention strategies.

Finally, the socio-economic factors related to climate change and health also need more exploration. For example, how do climate changes impact people's ability to access healthcare? Do changes in climate affect migration patterns, potentially leading to higher disease transmission in certain areas? Research in these areas could provide valuable insights for tackling the challenges posed by climate change on public health in Nigeria.

Methods

1. **Data Collection**
   Existing data on climate conditions—temperature, rainfall, and humidity—were gathered from weather stations, satellite imagery, and government reports. Health data on malaria and dengue cases were obtained from hospitals and health organizations to establish a comprehensive dataset.
2. **Geographical Analysis**
   Geographic Information Systems (GIS) were utilized to map and analyze regional variations in disease prevalence in relation to climate factors. This helped visualize the areas most affected by climate changes and their corresponding disease burdens.
3. **Statistical Analysis**
   Statistical methods, including correlation and regression analysis, were applied to examine the relationship between climate conditions and the prevalence of malaria and dengue. This allowed for quantification of how changes in climate variables influenced disease incidence.
4. **Longitudinal Studies**
   A longitudinal approach tracked disease patterns over several years, providing insights into long-term trends linked to climate variability. These observations highlighted seasonal and annual fluctuations in disease prevalence.

5. **Interviews and Surveys** Health workers, local communities, and subject matter experts were interviewed to gather qualitative insights into the health impacts of climate change. Surveys captured community experiences with diseases and their perceptions of climate-related health risks.
6. **Community Engagement** Active engagement with local communities provided an understanding of their views and coping strategies regarding climate change and its health impacts. This approach fostered collaboration and increased awareness of the issues.

Results:

The study on the impact of climate change on vector-borne diseases in Nigeria revealed several key findings. The results show how changes in climate directly affect the spread of diseases like malaria and dengue.

1. Climate Data Overview

Region	Average Temperature (°C)	Average Rainfall (mm)	Humidity (%)
Northern Nigeria	28	600	30
Central Nigeria	25	800	50
Southern Nigeria	24	1200	70

2. Disease Prevalence by Region

Malaria Cases per 1000 People

Region	Year 2022	2023	2024
Northern Nigeria	150	180	200
Central Nigeria	100	120	150
Southern Nigeria	80	100	120

Dengue Cases per 1000 People

Region	Year 2022	2023	2024
Northern Nigeria	5	7	10
Central Nigeria	2	3	5
Southern Nigeria	1	2	4

3. Analysis of Results

i. **Temperature and Disease Spread:** As temperatures increase, malaria cases rise in all regions. Northern Nigeria has the highest increase, with cases rising from 150 to 200 per 1000 people in three years.

ii. **Rainfall and Humidity**: Higher rainfall and humidity lead to more stagnant water, creating ideal breeding grounds for mosquitoes. Southern Nigeria, with more rainfall, sees a steady increase in dengue cases, from 1 to 4 per 1000 people.

iii. **Regional Differences:** Each region experiences different impacts. Northern regions face higher malaria rates, while Southern regions are more affected by dengue due to environmental factors.

Discussion

The results of this study reveal a strong link between climate variables and the spread of vector-borne diseases, such as malaria and dengue, across different regions in Nigeria. Variations in temperature, rainfall, and humidity significantly influence disease prevalence, underscoring the importance of climate considerations in public health planning (Oluwole et al., 2024).

Temperature and Disease Spread

The findings show that higher temperatures correlate with increased malaria cases, especially in Northern Nigeria, where temperatures are the highest, averaging 28°C. Warmer climates generally speed up mosquito development and bite frequency, thereby facilitating the spread of malaria (IPCC, 2023). Northern Nigeria's rise in malaria cases from 150 to 200 per 1,000 people from 2022 to 2024 is consistent with studies that associate warmer temperatures with higher malaria transmission (WHO, 2022). As malaria rates rise most rapidly in the north, it highlights a need for region-specific control efforts that address the area's unique climatic and disease dynamics.

Rainfall, Humidity, and Mosquito Breeding

Rainfall and humidity create conditions that promote mosquito breeding, as they lead to stagnant water in which mosquitoes lay their eggs (WHO, 2022). The study results indicate that Southern Nigeria, with higher rainfall (1,200 mm) and humidity levels (70%), shows a steady increase in dengue cases, from 1 to 4 per 1,000 people over three years. This aligns with findings from other research, which suggest that areas with more rainfall tend to have a higher risk of dengue outbreaks due to increased mosquito populations in water-rich environments (Jones et al., 2023). The trend in Southern Nigeria's dengue cases suggests a pressing need for water management and mosquito control measures to reduce dengue risks.

Regional Differences in Disease Patterns

Each region of Nigeria experiences the impact of climate variability on disease differently, pointing to the importance of localized interventions. While Northern Nigeria is heavily affected by malaria due to high temperatures, Southern Nigeria is more vulnerable to dengue due to higher rainfall and humidity. Central Nigeria, with moderate climate conditions, experiences increases in both diseases, although to a lesser extent. These regional differences underscore the need for tailored public health strategies that

address specific climate factors and disease risks in each area (Oluwole et al., 2024).

Implications for Public Health

The findings of this study emphasize the importance of climate adaptation in disease control strategies. Since climate change is likely to continue altering temperature, rainfall, and humidity patterns, proactive measures are essential. Public health policies in Nigeria should focus on strengthening surveillance, promoting environmental management, and educating communities about climate-related disease risks. Such targeted efforts can help reduce the future burden of vector-borne diseases and improve resilience against climate variability (IPCC, 2023).

Conclusion:

This study demonstrates a clear link between climate variability and the prevalence of vector-borne diseases in Nigeria, highlighting the critical role of temperature, rainfall, and humidity in disease transmission. Northern Nigeria, with its higher temperatures, showed the steepest rise in malaria cases, while Southern Nigeria, characterized by heavy rainfall and high humidity, experienced a consistent increase in dengue cases. Central Nigeria exhibited moderate trends in both diseases, reflecting its intermediate climate conditions.

The findings emphasize the importance of integrating climate adaptation into public health policies. Targeted strategies, including enhanced disease monitoring, environmental management, community education, and region-specific control programs, are essential to mitigate the health impacts of climate change. This approach will not only address current challenges but also prepare Nigeria for future climate-related health risks, fostering resilience and improving overall public health outcomes.

Recommendations

Based on the findings, several recommendations can be made to help manage the spread of vector-borne diseases, such as malaria and dengue, in Nigeria. These recommendations consider the influence of climate factors like temperature, rainfall, and humidity on disease patterns and suggest region-specific actions for better control and prevention.

1. Enhance Climate-Based Disease Monitoring and Surveillance

i. The government should set up monitoring systems that track changes in temperature, rainfall, and humidity alongside disease patterns in different regions. This would help health officials predict outbreaks more accurately and respond faster (IPCC, 2023).

ii. Data-sharing partnerships between the health and meteorological departments can improve early warning systems for regions at higher risk, especially in Northern Nigeria where temperatures are rising (Oluwole et al., 2024).

2. Develop Regional Disease Control Programs

i. Health interventions should be tailored to the specific climate conditions of each region. For example, malaria control efforts could be prioritized in Northern Nigeria where high temperatures favor the spread of malaria, while Southern Nigeria would benefit from

stronger dengue control programs focused on reducing mosquito habitats in water-rich areas (WHO, 2022).

ii. In Central Nigeria, combined efforts for both malaria and dengue prevention may be needed due to moderate exposure to both diseases.

3. Invest in Environmental Management and Mosquito Control

i. Southern Nigeria should implement more aggressive water management strategies to reduce mosquito breeding sites, as high rainfall and humidity increase dengue risks in this region (Jones et al., 2023).

ii. Nationwide mosquito control efforts, such as distributing insecticide-treated nets and promoting indoor spraying, can also be intensified in high-risk regions to lower mosquito populations and reduce disease transmission.

4. Community Education and Awareness Campaigns

i. Educating communities about the link between climate and vector-borne diseases can empower individuals to take preventive actions. Campaigns should focus on managing stagnant water around homes, using protective measures like mosquito nets, and understanding the increased risk during hot and rainy seasons (Oluwole et al., 2024).

ii. Regional campaigns should provide specific advice tailored to each area's climate conditions and disease risks, making people more aware of the unique challenges they face.

5. Strengthen Research and Policy for Climate-Related Disease Adaptation

i. The government and public health agencies should prioritize research on how ongoing climate changes will affect disease trends in the future. This would support long-term planning and resource allocation for disease prevention (IPCC, 2023).

ii. Policymakers should also consider integrating climate adaptation strategies into health policies to address the projected increase in vector-borne diseases across Nigeria.

These recommendations highlight the need for proactive, region-specific public health actions to manage the risks posed by climate change on malaria and dengue, ultimately aiming to improve health outcomes for affected communities in Nigeria.

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