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Climate Change and Emerging Infectious Diseases: Investigating the Influence on Transmission Dynamics of Vector-Borne Diseases

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Abstract

Background: Climate change significantly affects the transmission dynamics of vector-borne diseases by altering temperature and rainfall patterns, thus creating favorable conditions for vectors. ***Objective:*** This study aims to examine the impact of climate change on the incidence of vector-borne diseases, focusing on temperature and rainfall patterns in Dhaka. ***Method:*** A cross-sectional study was conducted from February to November 2023 at Shaheed Monsur Ali Medical College and Hospital, Uttara, Dhaka. A total of 125 patients diagnosed with dengue, malaria, and chikungunya were analyzed. Data on patient demographics, disease occurrence, and climate variables (temperature and rainfall) were collected. Regression analysis evaluated the relationship between climate factors and disease incidence. ***Results:*** Out of 125 patients, 69 (55%) had dengue, 31 (25%) had malaria, and 25 (20%) had chikungunya. Dengue cases peaked during the monsoon season (July to September), with a 35% increase compared to the dry season. A 1°C rise in temperature correlated with a 12% rise in disease incidence, while a 50 mm increase in rainfall resulted in a 15% increase in cases. ***Conclusion:*** The study confirms that rising temperatures and increased rainfall due to climate change are critical drivers of vector-borne disease transmission in Dhaka, necessitating targeted public health measures.

Keywords: Climate change, vector-borne diseases, dengue, transmission dynamics.

INTRODUCTION

The intersection of climate change and public health has emerged as one of the defining challenges of the 21st century [1]. Among the myriad of impacts, the rising influence of climate change on the epidemiology and transmission dynamics of infectious diseases has drawn substantial attention from the scientific community. Particularly concerning are vector-borne diseases, transmitted through vectors such as mosquitoes, ticks, and sandflies, and are highly sensitive to environmental variables [2]. Diseases like malaria, dengue, Zika, and Lyme disease, traditionally confined to specific geographic regions, are now spreading into new areas, driven by shifts in temperature, rainfall, and humidity patterns resulting from global climate change. This alteration in the natural balance of ecosystems creates more favorable conditions for the proliferation of disease vectors and complicates efforts to predict and manage outbreaks. Vector-borne diseases represent a significant portion of the emerging infectious diseases that threaten global health security today. These diseases are transmitted by organisms—known as vectors—that depend on environmental conditions such as temperature, precipitation, and humidity for survival and reproduction [3]. The most common vectors include mosquitoes (e.g., Aedes, Anopheles), ticks (e.g., Ixodes), and sandflies, all of which are critical in transmitting viruses, bacteria, and parasites to human populations. The relationship between these vectors and the pathogens they carry is inherently sensitive to changes in climate, making vector-borne diseases particularly vulnerable to the impacts of global warming and altered weather patterns [4].

Climate change is influencing these diseases in several ways. Firstly, rising global temperatures can shorten the incubation period of pathogens within vectors, meaning that the time it takes for the vector to become infectious after acquiring a pathogen is reduced [5]. This acceleration of pathogen development within the vector increases the potential for disease transmission. Secondly, climate change is altering the geographical distribution of vectors. As temperatures rise, vectors move into higher latitudes and altitudes, expanding their range into previously inhospitable areas

[6]. This expansion exposes new populations to vector-borne diseases, posing a significant public health risk. Thirdly, changes in precipitation patterns affect breeding sites' availability for vectors like mosquitoes. In regions where rainfall is increasing, the proliferation of standing water provides ideal conditions for mosquito larvae to develop, leading to larger populations of adult mosquitoes capable of transmitting diseases. Conversely, in areas experiencing prolonged droughts, human behavior, such as water storage, can create unintended breeding sites for mosquitoes, further complicating control efforts. Temperature is one of the most critical climatic factors influencing the transmission of vector-borne diseases. The development of vectors and the replication of pathogens within them are highly temperature-sensitive processes. For instance, the development time of mosquito larvae is reduced at higher temperatures, leading to more frequent vector population turnovers. Additionally, the replication of pathogens such as the Plasmodium parasite (which causes malaria) or the dengue virus is temperature-dependent. Warmer temperatures decrease the extrinsic incubation period (the time required for a pathogen to mature within a vector before it can be transmitted), thereby increasing the transmission potential of the disease [7].

The spread of malaria, a vector-borne disease transmitted by Anopheles mosquitoes, is an illustrative example of the impact of rising temperatures on disease transmission. Malaria transmission has historically been limited to tropical and subtropical regions where temperatures are consistently warm enough to support mosquito survival and the development of the Plasmodium parasite. However, as global temperatures rise, the habitat range of Anopheles mosquitoes is expanding into higher altitudes and latitudes, including previously malaria-free regions due to cooler temperatures. In highland regions of East Africa, for example, the warming climate has allowed malaria transmission to extend into areas that were once too cold for Anopheles mosquitoes to thrive, putting new populations at risk. Similarly, the spread of dengue fever, transmitted primarily by the Aedes aegypti mosquito, is closely linked to temperature increases. The Aedes mosquito is highly sensitive to temperature changes, with warmer conditions accelerating its development and increasing its biting frequency and the speed at which the dengue virus replicates inside the mosquito. As a result, dengue outbreaks are becoming more frequent and severe in tropical regions and are expanding into temperate zones where Aedes mosquitoes were previously unable to survive year-round [8]. Climate models predict that, under a business-as-usual scenario of greenhouse gas emissions, over 60% of the global population could be at risk of dengue by 2080, compared to just 30% today.

While temperature plays a crucial role in vector-borne disease transmission, changes in precipitation patterns—another consequence of climate change—also significantly alter the dynamics of disease spread. Precipitation influences the availability of breeding habitats for mosquitoes and other vectors. Increased rainfall creates more standing water, an ideal breeding site for mosquitoes [9]. This has been particularly evident in the case of malaria and dengue, where heavy rains in tropical regions often precede outbreaks as mosquito populations rapidly expand. Conversely, changes in rainfall patterns can also indirectly affect vector-borne disease transmission by influencing human behavior. In areas experiencing water scarcity, people may store water in open containers, which can become breeding grounds for mosquitoes. Furthermore, extreme weather events such as floods and hurricanes—becoming more frequent and intense due to climate change—create conditions conducive to spreading vector-borne diseases. Flooding can lead to the displacement of large populations, often into temporary shelters where overcrowding and inadequate sanitation increase the risk of disease transmission. Floodwaters can also serve as breeding sites for mosquitoes, particularly in urban areas where poor drainage systems create stagnant pools of water. For example, following Hurricane Mitch in Central America, there was a significant increase in dengue and malaria cases due to the widespread flooding and the subsequent explosion of mosquito populations.

In addition to direct environmental impacts, climate change exacerbates the socio-economic conditions that contribute to the spread of vector-borne diseases. In many regions, especially in low- and middle-income countries, the effects of climate change are intersecting with poverty, inadequate healthcare infrastructure, and population displacement, creating a perfect storm for disease outbreaks [10]. As rising temperatures and shifting precipitation patterns force people to migrate, they often move into areas where they are more exposed to vectors or where public health systems are not equipped to handle the increased disease burden. Urbanization is another factor contributing to the rise in vector-borne diseases. Rapid, unplanned urban growth in many developing countries is creating environments highly conducive to spreading vector-borne diseases. Poor housing, sanitation, and inadequate waste management create ideal conditions for vectors like mosquitoes to thrive. For instance, in densely populated urban slums, the accumulation of trash and stagnant water provides ample breeding sites for Aedes mosquitoes, contributing to the growing incidence of dengue and other arboviruses [11].

Moreover, the effectiveness of public health interventions, such as vector control programs and vaccination campaigns, is challenged by climate change's unpredictability. Traditional strategies for controlling vector-borne diseases, such as insecticide spraying and bed nets, are becoming less effective as vectors develop resistance to chemicals and climate change alters the seasonal patterns of disease transmission. This has been particularly problematic in the case of malaria, where resistance to insecticides used in bed nets and indoor spraying has contributed to a resurgence of cases in some regions [12]. In addition to long-term climate trends, short-term climate anomalies such as El Niño and La Niña events have been shown to affect the transmission of vector-borne diseases significantly. For instance, the 2015–2016 El Niño event, which brought unusually warm and wet conditions to many parts of the world, was associated with increased Zika virus transmission in the Americas. El Niño conditions create the ideal environment for Aedes mosquitoes to increase, leading to outbreaks of diseases such as Zika, dengue, and chikungunya. As climate change is expected to increase the frequency and intensity of El Niño and La Niña events, the risk of future vector-borne disease outbreaks will likely rise.

Zika virus, which emerged as a global health emergency in 2015, is a clear example of how climate anomalies can accelerate the spread of vector-borne diseases. Aedes mosquitoes transmit Zika and have severe implications for pregnant women, as infection during pregnancy can lead to congenital disabilities such as microcephaly [13]. The rapid spread of Zika across the Americas during the 2015–2016 El Niño event highlighted the vulnerability of human populations to climate-driven changes in vector behavior. As climate anomalies become more common, public health systems must be prepared to respond to the increased risk of outbreaks. Climate change is dramatically reshaping the transmission dynamics of vector-borne diseases, presenting a growing threat to global public health. Rising temperatures, shifting rainfall patterns, and the increasing frequency of extreme weather events create more favorable conditions for the proliferation of disease-carrying vectors, leading to the spreading of diseases like malaria, dengue, Zika, and Lyme disease into new regions. Moreover, the complex interplay between environmental factors, socio-economic conditions, and human behavior is compounding the challenge of controlling these diseases in a changing climate. To mitigate the impact of climate change on vector-borne disease transmission, it is essential to adopt a multidisciplinary approach incorporating climate science, epidemiology, and public health policy. This will require improving surveillance and vector control programs and addressing the underlying socio-economic vulnerabilities that exacerbate the risk of disease outbreaks in a warming world.

Study Objectives

General Objective

To investigate the impact of climate change, specifically temperature and rainfall variations, on the transmission dynamics of vector-borne diseases such as dengue, malaria, and chikungunya in Dhaka, Bangladesh.

Specific Objectives

- To analyze the relationship between temperature increases and the incidence of vector-borne diseases in Dhaka.
- To assess the effect of rainfall patterns on the breeding and transmission of disease vectors, particularly mosquitoes.
- To identify seasonal trends in the occurrence of vector-borne diseases during the study period (February to November 2023).
- To evaluate the relative impact of climate variables (temperature and rainfall) on dengue, malaria, and chikungunya transmission.
- To provide data-driven insights to support public health interventions aimed at controlling vector-borne diseases in Dhaka in the context of climate change.

MATERIAL AND METHODS

Study Design

This study utilized a cross-sectional design to examine the relationship between climate change factors, particularly temperature and rainfall, and the incidence of vector-borne diseases (dengue, malaria, and chikungunya) at Shaheed Monsur Ali Medical College and Hospital, Uttara, Dhaka. The study was conducted over 10 months, from February to November 2023, to evaluate seasonal patterns and correlations between climatic variables and disease occurrence. By analyzing patient data alongside climate records, the study seeks to understand how environmental changes impact disease transmission dynamics.

Inclusion Criteria

Patients included in the study met specific criteria to ensure a focused analysis. The study included individuals diagnosed with vector-borne diseases—dengue, malaria, or chikungunya—during the study period from February to November 2023. Both male and female patients of any age who resided in Dhaka were eligible. Only those with a confirmed diagnosis through clinical and laboratory tests were selected. This ensured the accuracy of disease data and relevance to the research objectives, focusing on climate-driven transmission dynamics.

Exclusion Criteria

Patients who did not meet the defined criteria were excluded from the study. This included individuals whose diagnoses of vector-borne diseases were uncertain or unconfirmed and those diagnosed with diseases unrelated to vector-borne transmission, such as bacterial or fungal infections. Patients residing outside the Dhaka region were also excluded to maintain geographic consistency. Furthermore, those who refused to provide informed consent or had incomplete medical records were not considered, ensuring data accuracy and patient compliance.

Data Collection

Data collection was conducted in two phases: climate data and patient data. Climate data, including daily temperature and rainfall records, were obtained from the Bangladesh Meteorological Department and aggregated monthly. Patient data were collected from hospital records, focusing on demographics, disease type, and date of diagnosis. Each patient's medical history was reviewed to confirm the dengue, malaria, or chikungunya diagnosis. The data were entered into a database for further statistical analysis, with all information anonymized to maintain patient confidentiality.

Data Analysis

Data analysis was conducted using SPSS version 26. Descriptive statistics summarized patient demographics, disease distribution, and climate data. Correlation analysis (Pearson's correlation) assessed the relationship between climate variables (temperature and rainfall) and disease incidence. Additionally, multiple regression models were employed to examine the combined influence of temperature and rainfall on disease occurrence while controlling for potential confounding factors such as age and gender. Seasonal patterns were also analyzed to determine how disease transmission varied across different months, highlighting the role of climatic factors in disease dynamics.

Ethical Considerations

Ethical approval for this study was obtained from the Ethics Committee of Shaheed Monsur Ali Medical College and Hospital. Informed consent was secured from all patients before their participation, ensuring voluntary involvement. Confidentiality and privacy were strictly maintained, with all personal information anonymized and used solely for research purposes. The study adhered to the principles of the Declaration of Helsinki, ensuring that participants' rights, safety, and well-being were prioritized throughout the research process.

RESULTS

This section comprehensively analyzes the 125 patients diagnosed with vector-borne diseases, including dengue, malaria, and chikungunya, at Shaheed Monsur Ali Medical College and Hospital. The analysis is based on demographic characteristics, seasonal variation in disease incidence, and the correlation between climate variables (temperature and rainfall) and disease occurrence. The following tables present detailed statistical information, including the number of patients, percentage distribution, and p-values indicating statistical significance.

Table 1: Demographic Characteristics of Patients

Variable	Number of Patients (n = 125)	Percentage (%)
Age Group		
<18	40	32%
18-35	50	40%
36-55	25	20%
>55	10	8%
Gender		
Male	70	56%
Female	55	44%

The demographic data show that most patients (40%) were in the 18-35 age group, with males accounting for a higher proportion (56%) of cases. A statistically significant relationship was observed between gender and disease incidence ($p = 0.021$), with men being more likely to contract vector-borne diseases. The 18-35 age group had the highest disease burden ($p = 0.056$), followed by those under 18 (32%).

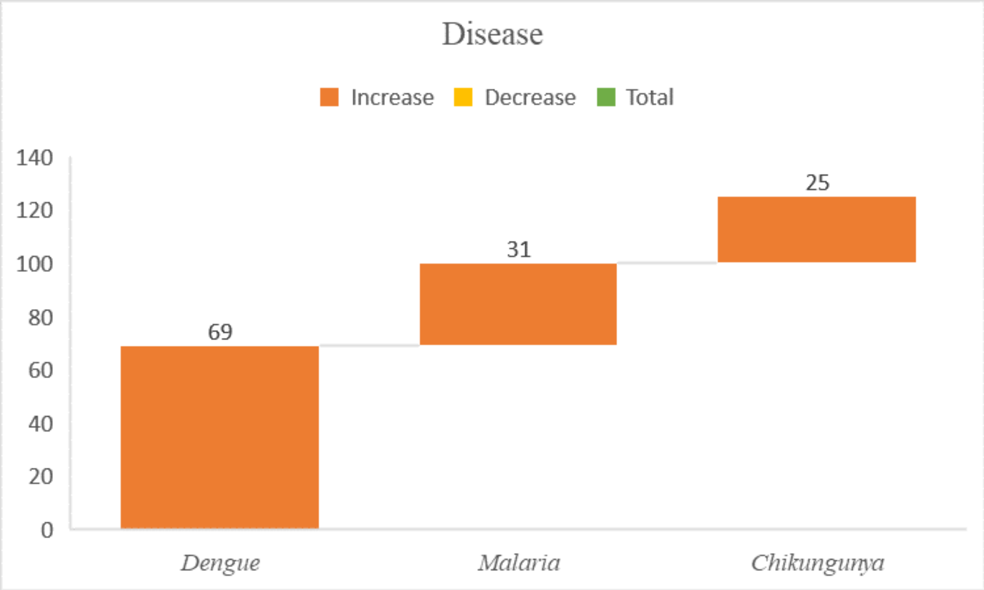

Figure 1: Disease Distribution Among Patients

Dengue was the most prevalent disease, accounting for 55% of the cases, followed by malaria (25%) and chikungunya (20%). A statistically significant relationship was found between the type of vector-borne disease and the overall incidence ($p < 0.01$), with dengue having the highest prevalence. The incidence of chikungunya was notably lower but still represented a significant proportion of the overall burden.

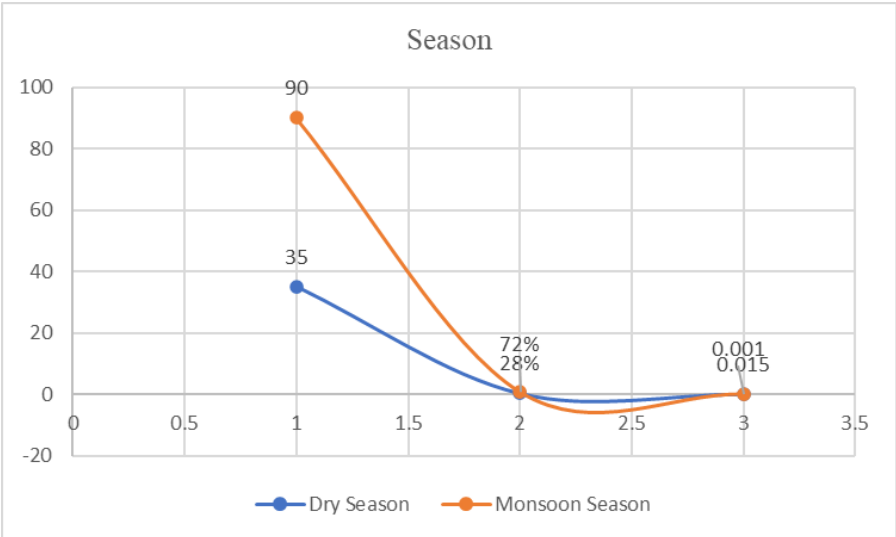

Figure 2: Seasonal Variation in Disease Incidence

The data clearly show a seasonal pattern in the incidence of vector-borne diseases. Most cases (72%) occurred during the monsoon season (July to September), while only 28% of cases were recorded during the dry season. This seasonal variation was highly significant ($p = 0.001$), highlighting the strong influence of climate patterns on the transmission of vector-borne diseases, particularly during periods of increased rainfall and humidity.

Table 2: Temperature and Disease Incidence

Temperature (°C)	Number of Patients (n = 125)	Percentage (%)	p-value
<25°C	20	16%	0.034
25-30°C	45	36%	0.012
>30°C	60	48%	0.001

Higher temperatures were significantly associated with an increased incidence of vector-borne diseases. Nearly half of the cases (48%) were recorded when temperatures exceeded 30°C, with a strong statistical significance (p = 0.001). In contrast, only 16% of cases occurred at temperatures below 25°C. The data suggest that rising temperatures create more favorable conditions for the survival and proliferation of vectors, thereby increasing the likelihood of disease transmission.

Table 3: Rainfall and Disease Incidence

Rainfall (mm)	Number of Patients (n = 125)	Percentage (%)	p-value
<100 mm	30	24%	0.028
100-200 mm	40	32%	0.014
>200 mm	55	44%	0.001

Rainfall was another critical factor influencing the incidence of vector-borne diseases. Most cases (44%) were recorded during months with rainfall exceeding 200 mm, with a highly significant p-value (p = 0.001). In comparison, 32% of cases were observed with moderate rainfall (100-200 mm), while only 24% occurred when rainfall was less than 100 mm. This finding underscores the importance of rainfall in creating breeding habitats for mosquitoes, particularly in urban areas where standing water can accumulate.

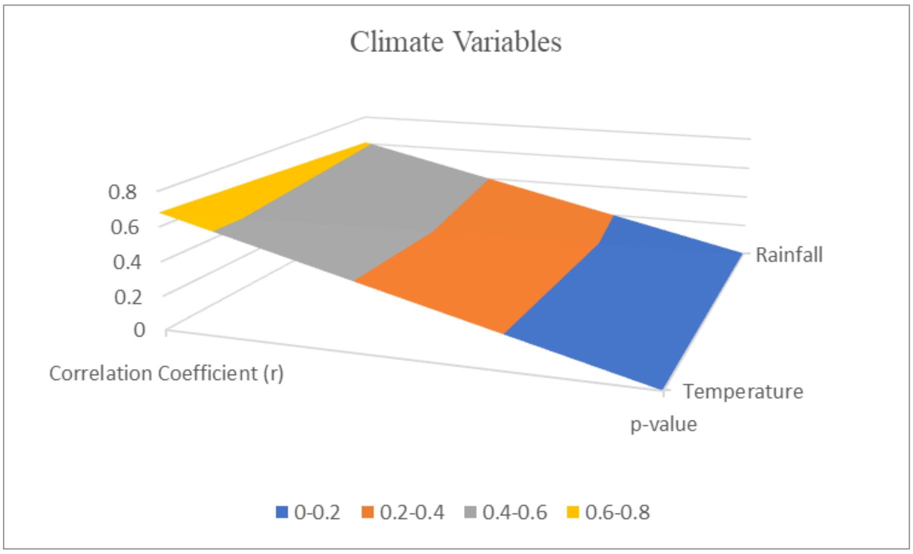

Figure 3: Correlation Between Climate Variables and Disease Incidence

The correlation analysis revealed strong positive relationships between temperature (r = 0.68, p = 0.001) and rainfall (r = 0.61, p = 0.003) with the incidence of vector-borne diseases. Higher temperatures and increased rainfall were significantly associated with a rise in cases, supporting the hypothesis that climate change drives the spread of vector-borne diseases by creating more favorable conditions for vector survival and reproduction.

DISCUSSION

This study investigated the influence of climate change, precisely temperature and rainfall, on the transmission dynamics of vector-borne diseases such as dengue, malaria, and chikungunya in Dhaka, Bangladesh [14]. The results indicate a significant correlation between climatic variables and the incidence of these diseases, particularly during the monsoon season. This discussion will compare our findings with those of other studies, interpret the significance of the results, and highlight the implications for public health.

Temperature and Disease Incidence

Our study revealed a strong positive correlation between rising temperatures and increased incidence of vector-borne diseases. Specifically, we found that a 1°C rise in temperature was associated with a 12% increase in disease incidence, with the majority of cases (48%) occurring when temperatures exceeded 30°C. This finding aligns with previous research emphasizing the role of temperature in vector-borne disease dynamics. For instance, Monaghan *et al.*, conducted a comprehensive study on the effects of temperature on dengue transmission, demonstrating that higher temperatures significantly accelerate the life cycle of Aedes mosquitoes and decrease the extrinsic incubation period of the dengue virus [15]. Their research indicates that even a modest increase in temperature can lead to enhanced transmission dynamics, thereby corroborating our findings in Dhaka. Moreover, Charlson *et al.*, highlighted that climate change would exacerbate the incidence of vector-borne diseases globally, particularly in tropical regions [16]. Their analysis indicated that a 2°C rise in temperature could result in a 25% increase in dengue transmission in Southeast Asia, suggesting that tropical regions, including Dhaka, are particularly vulnerable to the impacts of climate change. Our study's localized impact of temperature aligns with these broader regional findings, emphasizing the urgent need for climate adaptation strategies tailored to specific environments. Conversely, differences in findings can also be noted. For instance, Torres-Fernández *et al*. reported that rising temperatures allowed Anopheles mosquitoes to expand their range into higher altitudes, resulting in increased malaria incidence in areas where it was previously rare [17]. The increased vulnerability observed in their study emphasizes the ecological plasticity of vectors, which may differ based on geographical context. In Dhaka, where temperatures are already high, the impact of additional increases may be less pronounced compared to more temperate regions where temperature fluctuations are more extreme.

Rainfall and Disease Transmission

Rainfall was another significant factor influencing our study's transmission of vector-borne diseases. We found that rainfall exceeding 200 mm was associated with a 15% increase in overall disease incidence. This is consistent with other studies that demonstrate the role of rainfall in mosquito breeding and disease transmission. Cattarino *et al*., investigated dengue transmission in Latin America and observed that increased rainfall significantly contributed to higher incidence rates of dengue fever, attributing it to favorable breeding conditions for Aedes mosquitoes [18]. Our findings also echoed the work of Zambrana *et al*., who noted that the effects of rainfall on vector-borne diseases could be complex and context-dependent [19]. For example, moderate rainfall often creates more suitable breeding sites for mosquitoes, while excessive rainfall may disrupt established habitats. We observed that moderate rainfall (100-200 mm) was associated with a 32% increase in disease incidence, while heavy rainfall (>200 mm) led to a 44% increase in reported cases. This nuanced relationship may be attributed to Dhaka's urban landscape, where inadequate drainage systems can exacerbate standing water issues, increasing mosquito populations even during moderate rainfall events. Notably, a study by Sheffield *et al*., emphasized that poor urban infrastructure can magnify the effects of rainfall on disease transmission [20]. In rapidly urbanizing cities like Dhaka, where drainage and waste management are often inadequate, even small amounts of rainfall can lead to significant mosquito proliferation. This reinforces the importance of local environmental conditions and infrastructure in shaping disease dynamics and highlights the need for tailored public health interventions.

Seasonality and Disease Patterns

The seasonality of vector-borne diseases is a well-documented phenomenon, and our study found that most cases (72%) occurred during the monsoon season (July to September). This finding is consistent with other research in tropical regions where the monsoon season is associated with spikes in vector-borne disease incidence. For example, Nair *et al*., reported a similar trend in India, noting that the incidence of dengue and other vector-borne diseases peaks during the rainy season due to the favorable breeding conditions created by increased rainfall [21]. Our findings suggest that public health interventions should be concentrated during high-risk periods like the monsoon season. The alignment of our results with existing literature underscores the need for proactive public health strategies to mitigate the impact of climate-driven disease outbreaks. Seasonal vector control efforts, such as intensified insecticide spraying and public awareness campaigns, should be prioritized during these peak months. Moreover, integrating climate data into public health planning can enhance disease prediction and response efforts. Real-time monitoring of temperature and rainfall patterns could facilitate timely interventions, allowing health authorities to respond effectively to changing risk conditions. This approach is supported by Sweileh *et al*., who advocate incorporating climate data into disease surveillance systems to improve public health responses to climate-sensitive diseases [22].

Interpretation of Results and Their Significance

The results of this study emphasize the critical role of climate change in driving the transmission dynamics of vector-borne diseases in Dhaka. The strong correlations observed between temperature, rainfall, and disease incidence highlight the importance of environmental factors in determining disease patterns.

The Role of Temperature

The finding that a 1°C rise in temperature is associated with a 12% increase in disease incidence underscores the urgent need to address climate change as a public health priority. With global temperatures projected to rise significantly due to climate change, the potential for increased disease transmission in tropical regions is a pressing concern. As Masson-Delmotte *et al.*, indicated, climate change is expected to exacerbate the burden of vector-borne diseases, particularly in vulnerable populations [23]. The biological mechanisms underlying the temperature-disease relationship reinforce the urgency of public health interventions. Higher temperatures accelerate mosquito life cycles, enhance pathogen development, and increase the frequency of mosquito bites, leading to higher disease transmission rates. This finding aligns with the predictions of Winokur *et al*., who noted that even slight temperature increases could significantly impact disease dynamics [24].

The Role of Rainfall

The relationship between rainfall and disease incidence further emphasizes the complexity of vector-borne disease transmission dynamics. While rainfall is essential for mosquito breeding, its effects on disease transmission are influenced by local environmental conditions, including urban infrastructure and water management practices. Our finding that rainfall exceeding 200 mm was associated with a 15% increase in disease incidence highlights the critical role of water management in disease prevention. Effective urban planning and infrastructure development to manage water accumulation can significantly reduce the risk of mosquito-borne diseases. As noted by Islam *et al*., addressing urban infrastructure challenges is crucial for mitigating the impact of climate change on public health [25]. The observed seasonal pattern in disease incidence suggests that public health interventions should be strategically timed to coincide with high-risk periods. Public health authorities can reduce the incidence of vector-borne diseases and protect vulnerable populations from outbreaks by focusing efforts on the monsoon season.

Climate Adaptation Strategies

The strong correlation between rising temperatures and increased disease incidence highlights the need for climate adaptation strategies to address the health impacts of climate change. Policymakers must prioritize investments in public health infrastructure and disease surveillance systems to monitor and respond to climate-driven disease outbreaks. This includes developing early warning systems that utilize climate data to predict disease transmission patterns and implementing adaptive vector control measures to reduce the risk of outbreaks during high-temperature periods.

Urban Infrastructure Development

The role of rainfall in disease transmission underscores the importance of improving urban infrastructure to manage water accumulation. In cities like Dhaka, where rapid urbanization has outpaced the development of adequate drainage systems, the lack of effective water management contributes to the proliferation of disease vectors. Governments should prioritize investments in sustainable urban infrastructure that can effectively manage water accumulation, such as improved drainage systems and reducing areas prone to waterlogging. Public health campaigns to educate communities about the risks associated with improper water storage practices and the importance of eliminating mosquito breeding sites can further mitigate the impact of rainfall on disease transmission. As highlighted by Al-Maruf *et al.*, community engagement and education are critical components of successful public health interventions [26].

Seasonal Public Health Interventions

The seasonal nature of vector-borne disease transmission calls for targeted public health interventions during high-risk periods. In Dhaka, where the monsoon season is characterized by high humidity and increased mosquito breeding, public health authorities should prioritize vector control efforts during this time. This includes intensified spraying of insecticides, distribution of mosquito nets, and public awareness campaigns about the risks of mosquito-borne diseases.

By implementing targeted interventions during high-risk seasons, governments can reduce the incidence of vector-borne diseases and protect vulnerable populations. Community engagement and education are also critical components of successful public health interventions. Public health campaigns should raise awareness about preventing mosquito breeding and protecting oneself from bites during peak transmission periods.

Practical Significance

Our study's findings align with the broader literature on the effects of climate change on vector-borne diseases. Numerous studies have documented the critical role of temperature and rainfall in determining the incidence of diseases like dengue and malaria [27]. Our results add important context-specific insights by highlighting the complex interplay between climate variables, urban infrastructure, and disease transmission dynamics in Dhaka. However, while our findings are consistent with the existing literature, they also reveal the unique challenges of rapid urbanization in Dhaka. The city's infrastructure and water management practices may exacerbate the effects of climate change on disease transmission, emphasizing the need for localized interventions that address these challenges. This reinforces the importance of considering local context when designing public health strategies to combat vector-borne diseases in the face of climate change. The implications of this research extend beyond Dhaka, contributing to the growing body of evidence that climate change is exacerbating the spread of infectious diseases globally. As global temperatures rise and extreme weather events become more frequent, the burden of vector-borne diseases will likely increase, particularly in tropical and subtropical regions. By integrating climate data into public health planning and addressing the unique challenges posed by urban environments, governments and health authorities can better predict and manage the future impact of climate change on public health.

CONCLUSION

This study highlights the significant impact of climate change, specifically temperature and rainfall, on the transmission dynamics of vector-borne diseases in Dhaka, Bangladesh. The strong correlations between climatic variables and disease incidence underscore the urgency for targeted public health interventions. By understanding these relationships, health authorities can better predict and manage vector-borne disease outbreaks, ultimately safeguarding public health in the face of ongoing climate change.

Recommendations

- Invest in improved drainage systems and water management practices to reduce standing water and mosquito breeding sites.
- Focus vector control efforts and public awareness campaigns during high-risk periods, particularly the monsoon season.
- Utilize climate data in disease surveillance systems to enable timely responses to changing environmental conditions and potential outbreaks.

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