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Evaluating The Role Of Climate On Dengue And Chikungunya Outbreaks And Transmission In Jaipur

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Abstract

The transmission of infectious illnesses, including dengue and chikungunya fevers, is accelerated by climate change. The Kimakonde language is where the word "chikungunya" means "to dry up or become contorted." One arthropod-borne virus disease that has been documented since 1824 is chikungunya fever (CHIKF). There have been 4,086 confirmed cases of dengue fever in the Jaipur districts alone, accounting for 32% of the state's overall dengue cases. The probability of infectious diseases, particularly those carried by vectors, is expected to rise as a result of global warming since more extreme precipitation episodes are anticipated. Illness management requires public health initiatives and ongoing monitoring. The frequency of dengue and chikungunya fever in Jaipur, India, was investigated in this study. Descriptive statistics were used to synthesize the data retrieved from various sources, including government databases, monitoring programmes, and hospital records. We used correlation analysis for 104 samples to look for links between weather and the incidence of Dengue and Chikungunya. There is a robust positive association between temperature and chikungunya cases, demonstrating that climate plays a substantial role in disease transmission. When developing therapies for vector-borne diseases, it is crucial to take demographic variables, environmental factors, and disease incidence patterns into account, as shown in this study. Understanding and managing these disorders requires a comprehensive strategy. It is essential to monitor patients continuously for improved treatment and prevention.

Keywords: Dengue, Chikungunya, Fever, Transmission, Health, Temperature

INTRODUCTION

Temperature affects the seasonality and severity of transmission, which in turn affects the dynamics, distribution, and spread of infectious diseases (Brisbois & Ali, 2010). Climate change may be contributing to the fast spread of certain diseases, such as dengue fever, which is spread by the Aedes aegypti mosquito. According to Bhatt et al. (2013), out of 390 million cases of dengue fever each year, 96 million of those cases result in symptoms. It is of the utmost importance to comprehend the connections between regional and international weather patterns and epidemics. Dengue fever generally spreads in tropical areas. However, recent years have shown an uptick in both the frequency and severity of outbreaks across the world (Brathwaite Dick et al., 2012).

A worldwide health problem since 2006, chikungunya fever (CHIKF) is a viral illness produced by arthropods (Mohan & Sharma, 2007). Just with modern CHIKF, reports of the illness date back to 1824 (Puntasecca et al., 2021). After an epidemic on Tanzania's Makonde Plateau in 1952, it was first formally identified. The word "kungunyala" in the Kimakonde language means "to dry up or become contorted," which is the origin of the term "chikungunya" (Benjamin, 2012)." The rheumatologic symptoms of the illness cause the stooped posture. "Buka Buka" means "broken-broken" in the Congo area, a metaphor for crippling joint agony.

The mosquitoes Aedes aegypti and Aedes albopictus are the primary vectors for the spread of the chikungunya virus, which is present all over the world, including India (Tsetsarkin, 2007). Cases from semi-urban and rural regions have been reported recently, challenging the original assumption that it is a dengue or chikungunya vector. In a worldwide context, rainfall and Humidity are strongly associated with Aedes aegypti horizontal transmission; however, no such findings have been found in India (Wiwanitkit, 2013). While vertical transmission is essential for dengue virus (DENV) maintenance under non-conducive climatic circumstances, the capacity of the virus to persist in endemic locations during low transmission is fascinating. (Jain et al., 2016)

The likelihood of infectious illnesses, especially those transmitted by vectors, is likely to rise as a result of global warming because of the predicted increase in intense precipitation events (Min, 2011). There is a need for clarity about the link between floods and vector-borne illnesses (Ivers, 2006). Public health officials and scientists agree that intense rains reduce mosquito populations and the spread of illness by washing away larvae from breeding containers (Dieng, 2012). The majority of research on mosquito-borne illnesses and climate change points to the possibility that heavy rains might wash away mosquito breeding grounds, which would have a detrimental effect on vector populations (Morin, 2013).

The dengue epidemic has hit the districts of Jaipur the hardest. Between the two cities, 4,086 cases were recorded—2,050 in Jaipur and 20,36 in Kota—representing 32% of the state's total dengue cases. According to the health department, there have been no dengue-related fatalities in the state since September. However, there have been six dengue-related deaths up till November 22. The cities of Sriganganagar, Barmer, and Alwar have reported 656, 587, and 559 cases, respectively (TOI, 2023). Disease caused by the Chikungunya virus (CHIKVD): Around 500,000 cases of CHIKVD and 400 fatalities have been documented globally as of December 2023.

The number of confirmed cases of the Chikungunya virus in the Indian state of Rajasthan has varied throughout 2018. The number of instances stayed unchanged from 254 in 2018 to 254 in 2019. The numbers for 2020, 2021, and 2022 were 365, 1015, and 1,157, respectively. Nevertheless, there was a sharp drop from 212 instances in 2023 to 125 in the most current statistics. Because of this, public health interventions and continuous monitoring are necessary for illness management (sdg.rajasthan.gov.in).

Climate change and the transmission of mosquito-borne illnesses, such as Dengue and Chikungunya, are the foci of this research in Jaipur. Climate conditions, including Temperature, precipitation, and Humidity, significantly impact the life cycle of mosquitoes and the diseases they spread. Public health professionals and lawmakers will be able to use the study to their advantage when formulating plans to reduce the prevalence of diseases. Additionally, it may help with the creation of early warning systems for possible epidemics, which can then be used to implement public health measures and raise awareness to lessen the effect on the community. The results may have broader ramifications for other communities dealing with comparable environmental circumstances, offering lessons that other places dealing with the problems caused by these mosquito-borne illnesses may use.

LITERATURE REVIEW

According to Butterworth et al. (2017), mosquito-borne dengue fever is becoming an increasingly severe public health issue in the Americas. Climate change may hasten the spread of some diseases by altering their distribution and abundance in response to meteorological factors such as precipitation and Temperature. The dengue vector has established itself extensively in the southern United States, which is on the periphery of dengue transmission. Researchers used a model that accounts for changes in mosquito populations and the transmission of viruses to determine how the risk of dengue transmission in the area might alter due to climate change. The results demonstrated that during the summer months, dengue transmission may occur in several U.S. areas, most notably in southern Florida and Texas, to an extent comparable to San Juan, Puerto

Rico. Dengue transmission cannot occur continuously in the United States. The results show that the continental United States has low winter temperatures, which restrict the spread of the dengue virus and probably prevent it from establishing itself permanently. While many areas could see a more extended mosquito season due to climate change, the southernmost regions are the only ones expected to see an increase in dengue transmission.
According to Roiz et al. (2015), the extreme precipitation events, a result of global warming, are increasing and causing controversy about the relationship between flooding and mosquito-borne diseases. Heavy rainfalls are believed to flush breeding sites, negatively affecting vector populations and decreasing disease transmission. In 2014, in Montpellier, France, 11 autochthonous cases of Chikungunya were caused by the invasive tiger mosquito Aedes albopictus. An extreme rainfall event increased and extended the abundance of the disease vector Ae—albopictus, extending the period of autochthonous transmission of Chikungunya. Statistical analysis of female abundance seasonal dynamics revealed that these relationships changed after the heavy rainfall event. Accumulated rainfall over the four weeks prior to capture predicted the seasonal dynamics of the species and extended the transmission period. The empirical data suggests that heavy rainfall events increased the risk of arbovirus transmission in Southern France in 2014 by favouring a rapid rise in vector mosquito abundance. Further studies should confirm these results in different ecological contexts to better understand the impact of global change and extreme climatic events on mosquito population dynamics and disease transmission.

Martin (2021) explained that the Alphavirus CHIKV belongs to the family Togaviridae and causes the arbovirus illness Chikungunya Fever (CHIKF). Typically, it goes away on its own after two weeks, but in cases of persistent polyarthralgia, it can linger for years. The illness made a triumphant return to India in 2005 after having been documented there in 1963. At the moment, it is endemic over the whole of India, and epidemics have a devastating effect on the country's economy and productivity. Improved adaptations, higher fitness in the vector(s), more efficient transmission, and more severe illness have resulted from several mutations in circulating strains. It is crucial to closely monitor the development of CHIKV and put preventative and control measures in place since it has been a major factor in outbreaks in India. Although no approved vaccinations or antivirals are on the market at the moment, traditional medicines and other initiatives in India are working towards this goal.

Rezza (2014) studied Dengue and Chikungunya, two mosquito-borne viruses that are spreading to new regions. The four serotypes of dengue fever, which typically cause fever in tropical regions, are now present in large numbers across the Americas. In southern Europe, during the summer season, small dengue clusters have been detected. Outbreaks of the chikungunya virus have recently occurred in Italy and the Caribbean, expanding the virus's original range from Central Asia and Africa. Both viruses are transmitted mainly by the Aedes aegypti mosquito, although in temperate regions, the Asian 'Tiger' mosquito, Aedes albopictus, is becoming an increasingly significant vector as well. Mutations that increase viral fitness, climatic change, urbanization, and the globalization of both people and vectors are factors linked to the long-distance spread of vector-borne illnesses.
According to Jain et al. (2016), Chikungunya virus (CHIKV) is a disease that is common in India and is transmitted mainly by mosquitoes, namely Aedes aegypti and Aedes albopictus. To assess the vertical transmission of CHIKV in Aedes field populations, a preliminary entomological study was carried out in 2012. We collected immature Aedes mosquitoes from specific locations in the Indian states of Delhi and Haryana and watched as they emerged as adults. We evaluated the container index and minimal infection rate, and we used RNA extraction and real-time polymerase chain reaction to confirm the existence of CHIKV. The locations that tested positive for CHIKV were used to gather the adults, and the females were allowed to lay eggs in a controlled environment. We checked for the presence of CHIKV in the offspring of these moms. Researchers discovered that Aedes aegypti populations were present even during the hottest part of summer and that their numbers increased dramatically when it rained. In order to manage the Aedes species effectively, the research highlights the need to locate permanent breeding locations.
According to Wahid et al. (2017), the mosquito-borne chikungunya virus (CHIKV) is an alphavirus that has infected millions of people around the world, including in Asia, Europe, the Americas, and the Pacific Islands. The four genotypes that make up this African-originating gene are Asian, West African, East/Central/South African (ECSA), and Indian Ocean Lineage (IOL). Future studies on the treatment, prevention, and control of CHIKV, as well as its potential worldwide danger, may benefit from the baseline data provided by this review paper, which tries to summarise the global epidemiology of the virus.
According to Nivedita (2012), as a member of the Flaviviridae family, dengue virus may cause a wide variety of symptoms and diseases, from a minor, asymptomatic fever to a potentially lethal dengue

hemorrhagic fever/dengue shock syndrome (DHF/DSS). The total impact of dengue infections has reached an unparalleled level, with 2.5 billion people living in areas prone to the disease and 100 million new cases reported each year. The condition causes intricate pathophysiological, monetary, and environmental issues. The first known epidemic of dengue fever in India was in 1780, and the first outbreak that could be proven by virology happened between 1963 and 1964. There have been few scientific investigations on dengue fever in India, despite the fact that many doctors have treated and written about the illness in the last half-century. Although Indian scientists have achieved great strides, they still have a long way to go before their work is really noticed.

OBJECTIVES

1. To determine the nature and extent of the correlations between weather factors and the frequency of Dengue and Chikungunya cases.
2. Investigate the demographic features of impacted individuals to identify vulnerable populations and regions.

METHODOLOGY

This research examined the relationship between the climate of Jaipur, India, and the incidence of Dengue and Chikungunya. In our quest for disease outbreak data, we scrutinized numerous hospital records, government databases, and monitoring programs. Survey questions were also employed to conduct demographic interviews and meteorological information was accessed. For a comprehensive study, 104 instances, with 52 cases each for Dengue and Chikungunya, were selected as a representative sample from both rural and urban areas of Jaipur. The data were initially imported into SPSS 24.0 from an Excel file, and subsequent assessment was conducted using SPSS. Descriptive statistics, representing variables as means ± standard deviation (means ± S.D.), were used to summarize the data.

Additionally, correlation analysis was employed to investigate the associations between the dependent variable (the frequency of Dengue and Chikungunya cases) and the independent variable (climatic conditions). Pearson's Coefficient of correlation analysis was performed to establish statistical correlations between climatic factors and disease incidence. The reliability and accuracy of the statistical models were assessed using performance evaluation criteria, including sensitivity, specificity, and goodness-of-fit. By ensuring patient privacy protection and obtaining all necessary authorizations before data collection and analysis, this research adhered to all applicable ethical standards.

RESULTS

Table 1: Demographic Status of the respondents

Respondents	Frequency	Percentage (%)
Gender		
Male	59	56.73
Female	45	43.26
Age (Years)		
< 15	12	11.53
15 – 25	60	57.70
25 – 35	18	17.30
35 – 45	9	8.65
> 45	5	4.81
Regions		
Rural	67	64.42
Urban	37	35.57
Total	**100**	**100**

There is little gender gap in the results; men made up 56.73 per cent of the overall sample, and females made up 43.26 per cent. With 57.70% of the total respondents being in the 15–25 age bracket, most of the participants were young adults. Of the overall sample, 64.42 per cent were from rural regions, while 35.57 per cent were from urban areas. Another interesting finding from the data is the breakdown of respondents by geography. Specifically, 64.42% of respondents were from rural areas, while 35.57% were from urban areas. This data is essential to put the results in perspective with the study's aims and to comprehend the sample's demographics. In sum, the information is helpful for understanding the population's demographics.

Table 1: Descriptive statistics of Temperature and Humidity

Variable	Mean	SD	Min	Max
Temperature	28.85	22.018	13.21	241.79
Humidity	61.92	19.623	19.00	92.00

Measurements of Humidity and Temperature are included in the data set, which has a mean of 28.85 °C and a standard deviation of 22.018. With a low of 13.21 degrees Celsius and a high of 241.79 degrees Celsius, the temperature data reveals considerable variety. An anomaly or mistake in the data recording might be the cause of this very high maximum value. The data on Humidity shows some variation, with a mean of 61.92% and a standard deviation of 19.623. Humidity and Temperature mean show averages, whereas standard deviations show ranges. Accurate data collection requires careful consideration of the high maximum Temperature. In order to grasp the study's consequences, researchers and policymakers rely on these figures, which are critical for climatic circumstances.

Table 2: Frequency of Dengue and Chikungunya Case in the rural area

Case Count	Dengue Case		Chikungunya Case	
	Week counts		Week counts	
	Frequency	Per cent	Frequency	Per cent
0	49	94.2	52	100.0
1	1	1.9	-	-
2	2	3.8	-	-
Total	**52**	**100.0**	**52**	**100.0**

The case numbers for Dengue and Chikungunya each week are shown in the statistics. Roughly 94.2% of the total occurrences occurred in week "0," when 49 cases of Dengue were reported. Only 1.9% of cases occurred in Week "1" and 3.8% in Week "2" due to Dengue. Each week adds to the total percentage distribution, bringing the total number of dengue cases to 52. There were 52 instances of Chikungunya in week "0," which is equal to 100% of all cases. Chikungunya cases were not recorded during weeks "1" and "2"; hence, the percentages for those weeks were zero. Each condition has a total of 52 instances, with weekly counts adding up to the overall percentage distribution. The data presents a comparison of Dengue and Chikungunya cases over many weeks. It seems that Chikungunya is more common in week "0," whereas Dengue cases fluctuate in the weeks that follow. Public health monitoring and intervention planning may benefit from this knowledge.

Table 3: Frequency of Dengue and Chikungunya Case in the City Area

Case Count	Dengue Case		Chikungunya Case	
	Week counts		Week counts	
	Frequency	Per cent	Frequency	Per cent
0	32	61.5	48	92.3
1	7	13.5	3	5.8
2	3	5.8	1	1.9
4	1	1.9	-	-
5	1	1.9	-	-
6	1	1.9	-	-
7	2	3.8	-	-
9	2	3.8	-	-
10	2	3.8	-	-
13	1	1.9	-	-
Total	**52**	**100.0**	**52**	**100.0**

The data shows how Dengue and Chikungunya cases have been distributed over the last several weeks. Out of all the cases in week "0," 61.5% were Dengue, with the number of cases peaking in the first several weeks. Dengue cases declined throughout time, falling to 13.5% in week "1" and falling even more in the weeks that followed. Rare, localized Dengue outbreaks caused less than 2% of the total cases in subsequent weeks. Out of the total number of cases in a week, "0," 48 (or 92.3% of the total) were Chikungunya. Over the following weeks, the number of reported cases of Chikungunya dropped, with just a few instances in weeks "1," "2," and "7." Between the two illnesses, 52 people have been reported, with different weekly tallies adding up to the total. Public health initiatives and resource allocation may be guided by this data, which is essential for understanding disease patterns.

Table 4: Difference in means of Dengue/Chickanguia Parameter between rural and city area

		N	Mean	SD	Mean Difference	t value	p-value
House Index	Rural	52	7.64	9.09	-2.435	-1.159	0.249
	City	52	10.08	12.12			
Breteau Index	Rural	52	8.46	10.87	-3.824	-1.369	0.175
	City	52	12.29	16.96			
Container Index	Rural	52	1.29	1.65	-0.087	-0.246	0.806
	City	52	1.38	1.94			

House Index, Breteau Index, and Container Index are the metrics used to compare urban and rural locations. Urban regions have a House Index of 10.08, while rural areas have a House Index of 7.64. With a t-value of -1.159 and a p-value of 0.249, the mean difference between the rural and city House Indices is -2.435. There is a statistically significant difference (t=-1.369, p=0.175) between the rural and urban Breteau Index means of -3.824. A t-value of -0.246 and a p-value of 0.806 indicate that the mean difference between the rural and city Container Index is -0.087, which is similarly not statistically significant. In terms of the House Index, Breteau Index, and Container Index, the data reveals numerical variations between urban and rural regions; nevertheless, these differences do not reach statistical significance at the 0.05 level of significance. The observed discrepancies may be attributable to random fluctuation rather than a genuine difference between rural and urban locations, given that the p-values are over the usual threshold.

Pearson's Coefficient of correlation

Table 5: Relation between climate change and seasonal diseases is expected

	Temperature	Humidity	Dengue Case	Chikungunya Case
Temperature	1	.028	-.027	.376**
Humidity		1	-.003	.065
Dengue Case			1	.247**
Chikangunia Case				1

*****p<0.01***

This text's data shows a correlation matrix with Dengue, Chikungunya, Humidity, and Temperature as its columns and coefficients, respectively. Varying degrees of relationship between the variables that were researched are shown by the correlation coefficients. While other relationships are either very weak or not statistically significant at the 0.05 level, Temperature does indicate a somewhat positive association that is statistically significant in relation to Chikungunya cases. Additionally, the correlation matrix reveals a noteworthy association between temperature and Chikangunia cases (r=0.376, p0.01), suggesting a 38% rise or fall depending on Temperature. Furthermore, a correlation of 0.247 and a p-value less than 0.01 shows that Dengue and Chikungunya cases are significantly related, suggesting a 24% association between the two. There is a small inverse association between Temperature and the occurrence of Chikungunya cases, as shown by the data, which shows a negative correlation of -0.027. The association, however, does not reach the 0.05 threshold of statistical significance.

Table 6: Relation of vector and Temperature, Humidity, rain season, environment is expected

	Temperature	Humidity	House Index	Breteau Index	Container Index
Temperature	1	.028	.357**	.298**	.268**
Humidity		1	.276**	.323**	.325**
House Index			1	.979**	.972**
Breteau Index				1	.982**
Container Index					1

*****p<0.01***

Using correlation analysis, Table 8 shows the link between the vector and environmental variables such as Temperature, Humidity, rain season, and more. House Index (r=0.357, p<0.01), Breteau Index (r=0.298,

$p<0.01$), and Container Index ($r=0.268$, $p<0.01$) all demonstrate a strong link with Temperature, according to the data. In other words, the correlation between Temperature and the House Index is 36%, the Breteau Index is 30%, and the Container Index is 27%. Furthermore, there is a strong correlation between Humidity and the House Index ($r=0.276$, $p<0.01$), the Breteau Index ($r=0.323$, $p<0.01$), and the Container Index ($r=0.325$, $p<0.01$), suggesting a 28%, 32%, and 33% link, respectively, between Humidity and these three indexes.

This text's data shows a correlation matrix that shows the coefficients of correlation between different variables. While the House Index, Breteau Index, and Container Index all exhibit high positive connections with each other, Temperature and Humidity only exhibit modest positive relationships with other indices. There are meaningful connections between these variables, as shown by the statistically significant correlations.

The correlation matrix shows that the variables that were analyzed are associated to varying degrees. There is a moderate association between Humidity and Temperature and other indices but a substantial positive correlation between the House Index, the Breteau Index, and the Container Index. There are meaningful connections between these variables, as shown by the statistically significant correlations.

DISCUSSIONS

Dengue and chikungunya rates, as well as the relationship between meteorological factors and vector indexs, are investigated in this research. There is a modest correlation between relative Humidity and Temperature, according to the study, but there are other degrees of link as well. A strong positive association exists, nonetheless, among the House Index, the Breteau Index, and the Container Index. According to a statistical study, there is little positive correlation between temperature and Chikungunya cases, which implies that there may be a connection between climate change and seasonal illnesses. In contrast to the sample's urban-rural distribution, most respondents reside in rural areas. In addition to observations for Humidity and Temperature, the dataset contains a detailed examination of dengue and chikungunya illnesses over many weeks. The alarmingly high number of chikungunya cases in Week "0" shows how crucial time series analysis is for keeping tabs on public health and developing treatments.

Field samples of CHIKV have yet to be reported. However, there is evidence of vertical transmission of dengue and chikungunya viruses in other nations. This work sheds light on the occurrence of the virus amid poor climatic circumstances by establishing the incidence of vertical transmission of CHIKV in wild populations of Ae—aegypti (Thavara, 2009). In a preliminary study conducted in Delhi and the neighbouring state of Haryana, it was found that the Aedes population continued to exist even at the height of summer just before the monsoon and that CHIKV was transmitted vertically within the Aedes population. Previous studies have claimed that arbovirus vertical transmission is relevant to disease transmission; however, further study is required to understand entomological surveys and clinical prevalence (Lequime, 2014). This research provides the first evidence linking high rainfall to chikungunya transmission. It suggests that during a dry time, heavy rains deposited dried Ae. albopictus eggs into peridomestic containers, which then led to an increase in mosquito populations a few weeks later.

When looking at urban and rural areas using the House Index, Breteau Index, and Container Index, there are numerical variations but no statistically significant differences. The study emphasizes the significance of environmental factors in disease transmission and proposes ways to further investigate and keep an eye on these dynamics. For public health planning, this data is vital.

CONCLUSION

The research analyses the dynamics of transmission and finds that climatic conditions might affect the frequency of Dengue and Chikungunya, among others. The alarming surge in CHIKV infections requires the undivided attention of public health authorities and healthcare providers, who must prioritize vital research topics. Young people (15–25 years old) from rural regions make up a significant portion of the study's sample, which shows a balanced gender distribution. Public health measures should take into account varied demographic factors, according to the research. In order to understand the environmental circumstances that promote the expansion of disease vectors, precise data about climate variables, such as Temperature and Humidity, must be collected and analyzed. There were numerical differences between rural and urban regions when comparing them using vector indices, but they were not statistically significant. The finding of a robust positive association between temperature and chikungunya cases showed the impact of climate on disease transmission. The research highlights the need to take demographic factors, environmental circumstances, and disease incidence patterns into account when designing treatments to combat vector-borne illnesses. It also stresses the significance of using a comprehensive approach to understanding and controlling these diseases. To better understand diseases and develop efficient methods for managing and preventing them, it is advised that we do more study and monitor conditions continuously.

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