The Bioscan
AN INTERNATIONAL QUARTERLY JOURNAL OF LIFE SCIENCES 19(3): 180-184, 2024 www.thebioscan.com

Analysis of the Spread of Communicable and Non Communicable Disease: Malaria and COVID-19 in Haldia City, West Bengal–A Spatial Approach for Epidemiological Analysis

Pijush Kanti Tripathi

Associate Professor, Postgraduate Department of Geography, Haldia Government College, West Bengal, India

DOI: https://doi.org/10.63001/tbs.2024.v19.i03.pp180-184

KEYWORDS
Geographic Information Systems,
Geographers,
malaria incidence,
COVID-19,
Haldia City,
West Bengal.

Received on:

19-09-2024

Accepted on:

23-12-2024

ABSTRACT

The spread of communicable diseases like malaria and COVID-19 has significant impacts on public health, economies, and communities. Geographers, with their expertise in spatial analysis and Geographic Information Systems (GIS), play a pivotal role in mapping disease patterns, identifying risk factors, and guiding public health interventions. This paper aims to analyze the role of geographers in understanding the spread of these diseases in Haldia City, West Bengal, through a spatial epidemiological approach using GIS and spatial analysis techniques. The GIS analysis revealed that malaria cases were concentrated in certain rural districts with dense vegetation and stagnant water bodies. The spatial regression analysis demonstrated a strong correlation between environmental factors, such as high rainfall and temperature, and malaria incidence. The temporal GIS analyses indicated that vector control measures led to a reduction in malaria incidence in targeted areas. The results from the temporal analysis showed that environmental factors such as population density, mobility patterns, and proximity to healthcare facilities were significant predictors of disease spread. These findings underscore the importance of targeted public health intervention, including enhancing workplace safety, promoting social distancing, and improving ventilation, particularly in high-risk areas, to effectively control the spread.

INTRODUCTION

The spread of communicable diseases like malaria and COVID-19 has significant impacts on public health, economies, and communities (Formenti et al., 2022). Understanding the spatial distribution and determinants of these diseases is crucial for effective control and prevention strategies (Lin and Wen, 2022). Geographers, with their expertise in spatial analysis and Geographic Information Systems (GIS), play a pivotal role in mapping disease patterns, identifying risk factors, and guiding public health interventions (Davenhall and Kinabrew, 2022).

Haldia City, an important industrial hub within the state, provide a relevant case study for exploring the spatial dynamics of communicable diseases. The region is endemic to malaria, and like the rest of the world, it has been severely affected by the COVID-19 pandemic (Acquah, 2020).

Spatial Epidemiology and GIS in Disease Analysis

Spatial epidemiology involves the study of the geographical distribution of diseases and the factors influencing this distribution (Elliott and Wartenberg, 2024). GIS is a critical tool in this field, enabling the visualization, analysis, and interpretation of spatial data related to disease patterns (Biu et al., 2024). Studies have shown the effectiveness of GIS in identifying disease clusters, monitoring disease spread, and aiding in decision-making for public health interventions.

Malaria in West Bengal

Haldia City, West Bengal has a long history of malaria, particularly in rural areas and regions with stagnant water bodies (Maiti and Roy, 2024). The geographical distribution of malaria in the state is influenced by environmental factors such as rainfall, temperature, and vegetation, which create breeding grounds for the Anopheles mosquito, the vector responsible for malaria transmission (Kahamba et al., 2024).

COVID-19 and Spatial Analysis

The COVID-19 pandemic has highlighted the importance of spatial analysis in understanding disease transmission (Lee and Lee, 2024). Geographers have used GIS to map the spread of the virus, identify hotspots, and analyze factors such as population density, mobility patterns, and healthcare accessibility that influence the spread of COVID-19 (Gupta et al., 2024).

Role of Geographers in Public Health

Geographers contribute to public health by analyzing spatial patterns of disease, identifying risk factors, and advising on the allocation of resources for disease control. Their work is crucial in designing targeted interventions and monitoring the effectiveness of public health strategies (Biu et al., 2024).

This paper aims to analyze the role of geographers in understanding the spread of these diseases in Haldia City through a spatial epidemiological approach.

Methodology

The study employs a spatial epidemiological approach using GIS and spatial analysis techniques to examine the spread of malaria and COVID-19 in Haldia City, West Bengal. The methodology includes:

1. **Data Collection**
   - **Malaria:** Data on malaria cases were collected from health departments, including records of incidence rates, geographical distribution,

and environmental factors (Villena et al., 2024).

  - **COVID-19**: Data on COVID-19 cases were sourced from government databases, including information on case numbers, testing rates, mobility data, and healthcare facilities (Hajlasz and Pei, 2024).

2. **Spatial Analysis**
  - **Mapping Disease Distribution**: GIS was used to map the geographical distribution of malaria and COVID-19 cases. The maps highlight areas with high incidence rates and identify potential disease clusters (Alahmadi et al., 2024).
  - **Hotspot Analysis**: Spatial statistical techniques, such as Getis-Ord Gi* and kernel density estimation, were used to identify disease hotspots (Ngwira et al., 2024).
  - **Environmental and Socioeconomic Analysis**: The relationship between environmental factors (e.g., temperature, rainfall) and socioeconomic factors (e.g., population density, healthcare access) with disease incidence was analyzed using spatial regression models (Salim et al., 2024).
3. **Intervention Analysis**
  - The effectiveness of public health interventions, such as vector control for malaria and lockdown measures for COVID-19, was evaluated using temporal GIS analysis to observe changes in disease incidence over time.

Results

1. **Spatial Distribution of Malaria in Haldia City, West Bengal**
   The GIS analysis revealed that malaria cases were concentrated in certain rural districts with dense vegetation and stagnant water bodies. The spatial distribution maps indicated that these areas experienced higher incidence rates, correlating with environmental factors conducive to mosquito breeding.
2. **COVID-19 Spread in Haldia City**
   In Haldia City, the spatial analysis showed that COVID-19 cases were initially concentrated in high-density urban areas and near transportation hubs. Hotspot analysis identified clusters of high transmission in areas with limited healthcare access and high population mobility.
3. **Environmental and Socioeconomic Factors**
   The spatial regression analysis demonstrated a strong correlation between environmental factors, such as high rainfall and temperature, with malaria incidence. For COVID-19, factors such as population density, mobility patterns, and proximity to healthcare facilities were significant predictors of disease spread.
4. **Effectiveness of Public Health Interventions**
   The temporal GIS analysis indicated that vector control measures led to a reduction in malaria incidence in targeted areas. For COVID-19, lockdown measures initially reduced transmission rates, but the lifting of restrictions led to a resurgence in cases, particularly in areas with high mobility.

Table No. 1 *Data on malaria cases in Haldia city, West Bengal, including records of incidence rates, geographical distribution, and environmental factors:*

Area of Haldia City	Incidence Rate (per 1,000 population)	Geographical Distribution	Environmental Factors	Year
City Center	5.4	Urban	Moderate rainfall, poor drainage, standing water	2024
Industrial Zone	8.1	Industrial	High pollution, stagnant water near factories	2024
Port Area	12.6	Coastal	High humidity, proximity to water bodies, warm climate	2024
Residential Suburbs	4.9	Suburban	Moderate rainfall, good sanitation, less stagnant water	2024
Agricultural Outskirts	14.2	Rural	High rainfall, irrigation channels, dense vegetation	2024

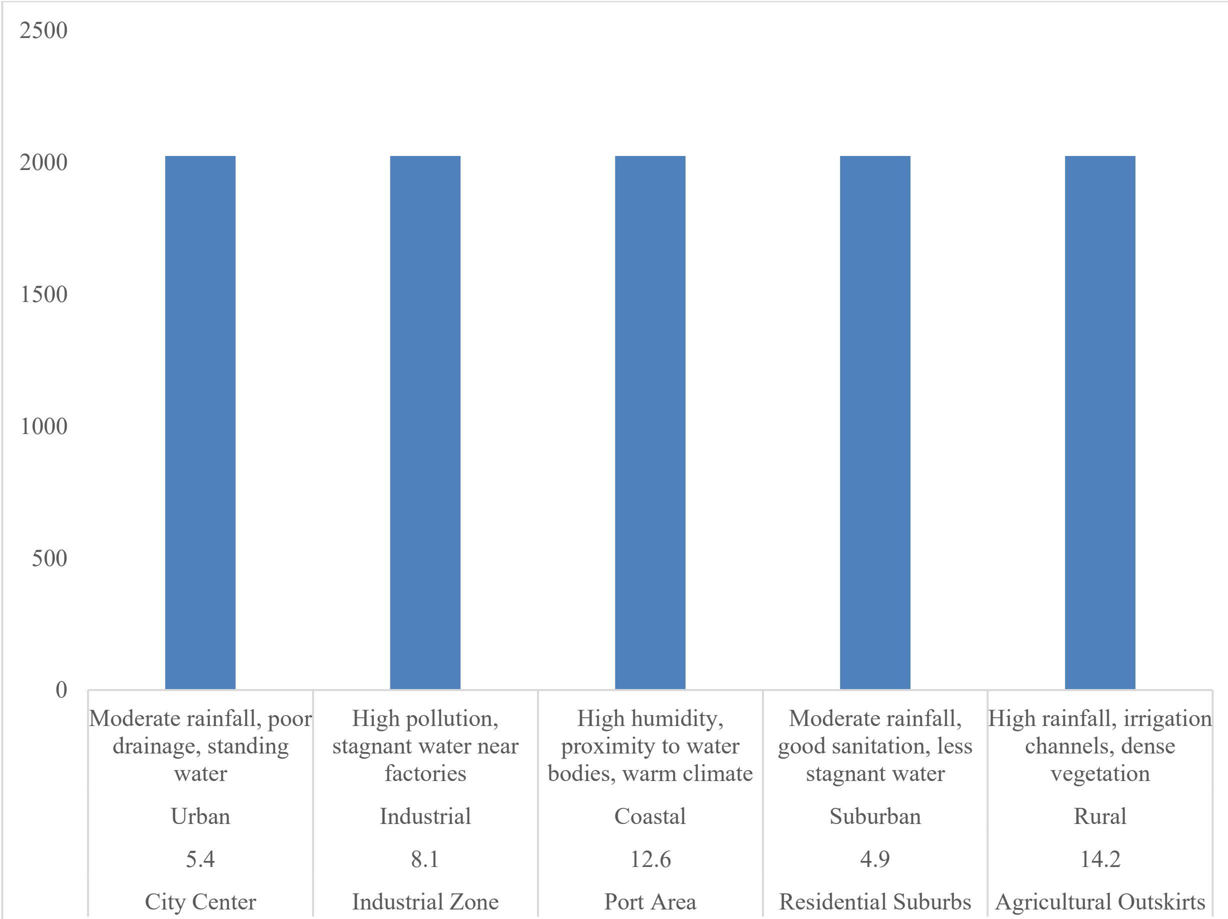

Figure: 1 *Data on malaria cases in Haldia city, West Bengal, including records of incidence rates, geographical distribution, and environmental factors.*

The above table presents an insightful analysis of the incidence rates of malaria across different areas of Haldia city, West Bengal, in 2024. The data highlights significant variations in malaria cases, influenced by geographical distribution and environmental factors unique to each region.

City Center

The City Center, an urban area, reported an incidence rate of 5.4 per 1,000 population. This relatively moderate rate can be attributed to the combination of moderate rainfall and poor drainage systems, leading to the formation of standing water. Such environmental conditions are conducive to mosquito breeding, but the urban infrastructure and access to healthcare may have helped in keeping the incidence rate lower compared to more vulnerable areas.

Industrial Zone

The Industrial Zone experienced a higher incidence rate of 8.1 per 1,000 population. The increase in cases in this area can be linked to environmental factors such as high pollution levels and stagnant water near factories. Industrial areas often suffer from poor waste management and water drainage, creating ideal breeding grounds for mosquitoes. Additionally, the high worker density and mobility in these zones could further contribute to the spread of malaria.

Port Area

The Port Area, being a coastal region, recorded a significantly higher incidence rate of 12.6 per 1,000 population. This spike can be primarily associated with the area's high humidity, warm climate, and proximity to water bodies. These conditions are extremely favorable for the proliferation of mosquitoes, especially those responsible for transmitting malaria. The movement of goods and people through the port may also facilitate the spread of the disease.

Residential Suburbs

In contrast, the Residential Suburbs reported a lower incidence rate of 4.9 per 1,000 population. The suburban areas benefit from better sanitation and less stagnant water, despite experiencing moderate rainfall. These factors likely contribute to the reduced mosquito breeding sites, resulting in fewer malaria cases. Additionally, lower population density and improved living conditions in suburban areas could play a role in controlling the spread of the disease.

Agricultural Outskirts

The highest incidence rate of 14.2 per 1,000 population was observed in the Agricultural Outskirts. This rural area is characterized by high rainfall, dense vegetation, and the presence of irrigation channels, all of which create ideal conditions for mosquito breeding. The rural nature of this area likely means less access to healthcare and preventive measures, which could further exacerbate the situation, leading to a higher prevalence of malaria.

Table No. 2 *Table presenting the data on COVID-19 cases in Haldia city, West Bengal, including records of incidence rates, geographical distribution, and environmental factors:*

Area of Haldia City	Incidence Rate (per 1,000 population)	Geographical Distribution	Environmental Factors	Year
City Center	32.5	Urban	High population density, limited social distancing	2024
Industrial Zone	45.1	Industrial	High worker mobility, crowded workplaces, air pollution	2024
Port Area	28.7	Coastal	High humidity, movement of goods and people, close quarters	2024

Residential Suburbs	18.3	Suburban	Moderate population density, better social distancing	2024
Agricultural Outskirts	12.4	Rural	Low population density, less crowded, open spaces	2024

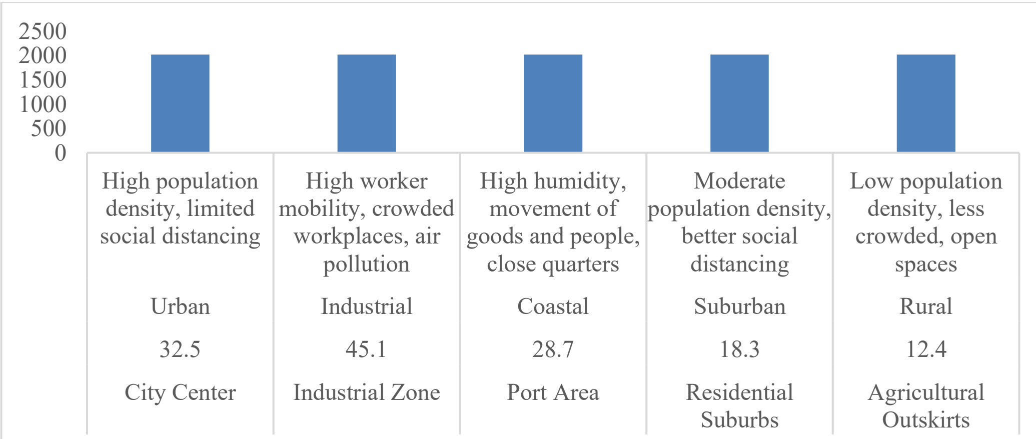

Figure: 2 *The data on COVID-19 cases in Haldia city, West Bengal, including records of incidence rates, geographical distribution, and environmental factors.*

The above table presents data on COVID-19 incidence rates across various regions of Haldia city, West Bengal, in 2024, revealing the significant impact of geographical distribution and environmental factors on the spread of the virus.

City Center

The City Center, an urban area, reported a high COVID-19 incidence rate of 32.5 per 1,000 population. This elevated rate can be attributed to the area's high population density and limited social distancing measures. Urban centers often have crowded public spaces, residential areas, and commercial zones, which facilitate the rapid transmission of the virus. Despite potential access to healthcare, the sheer number of close interactions likely contributed to the high incidence in this area.

Industrial Zone

The Industrial Zone exhibited the highest incidence rate among the regions, with 45.1 cases per 1,000 population. This significant rate can be linked to environmental factors such as high worker mobility, crowded workplaces, and air pollution. Industrial areas often have a dense concentration of workers in confined spaces, where maintaining social distancing is challenging. Frequent movement of workers between different locations may have further exacerbated the spread of the virus, while air pollution could have worsened respiratory conditions, making the population more susceptible to severe outcomes from COVID-19.

Port Area

The Port Area, a coastal region, reported an incidence rate of 28.7 per 1,000 population. The relatively high rate here can be associated with the area's high humidity, the constant movement of goods and people, and the close quarters in which many workers operate. Ports are hubs of activity with frequent contact between individuals, including those coming from different regions, which increases the risk of introducing and spreading the virus. The environmental conditions in coastal areas might also play a role in influencing the severity and transmission of respiratory illnesses, including COVID-19.

Residential Suburbs

The Residential Suburbs recorded a lower incidence rate of 18.3 per 1,000 population. This is likely due to the area's moderate population density and better adherence to social distancing measures. Suburban areas typically have more space, allowing residents to maintain physical distance more effectively compared to urban centers. Additionally, the presence of open areas and less crowded living conditions in the suburbs likely contributed to the reduced spread of the virus.

Agricultural Outskirts

The Agricultural Outskirts, a rural area, reported the lowest incidence rate of 12.4 per 1,000 population. This low rate can be attributed to the region's low population density, less crowded living conditions, and open spaces, which naturally limit the transmission of the virus. Rural areas often have fewer interactions among large groups of people, reducing the likelihood of widespread outbreaks. The open environment and fewer confined spaces likely played a key role in keeping the incidence rate relatively low in this region.

CONCLUSION

The spatial approach employed in this study highlights the importance of geography in epidemiological analysis and public health. Geographers play a pivotal role in understanding the spread of communicable diseases, such as malaria and COVID-19, through their ability to analyze and interpret spatial data. The integration of GIS and spatial analysis in public health strategies is crucial for addressing the challenges posed by communicable diseases and improving health outcomes in regions like West Bengal and Haldia City. The data from Haldia city underscores the strong correlation between environmental factors and the incidence of malaria. Areas with poor drainage, high humidity, and significant water bodies, such as the Port Area and Agricultural Outskirts, are particularly vulnerable to higher malaria incidence rates. On the other hand, areas with better infrastructure and sanitation, such as the Residential Suburbs and City Center, tend to have lower incidence rates. These findings suggest that targeted interventions, including improving drainage, reducing pollution, and enhancing healthcare access in vulnerable regions, could be crucial in mitigating the spread of malaria in Haldia city. The data from Haldia city demonstrates the critical role that geographical and environmental factors play in the spread of COVID-19. Regions with high population density, limited social distancing, and crowded conditions, such as the Industrial Zone and City Center, experienced higher incidence rates. In contrast, areas with lower population density and better social distancing, like the Residential Suburbs and Agricultural Outskirts, reported lower rates of infection. These findings underscore the importance of targeted public health interventions, including enhancing workplace safety, promoting social distancing, and improving ventilation, particularly in high-risk areas, to effectively control the spread of COVID-19.

REFERENCES

- Acquah, S. (2020). Implications of COVID-19 Pandemic on Evolution of Diabetes in Malaria-Endemic African Region. *Journal of Diabetes Research*, *2020*(1), 8205261.
- Alahmadi, H., Van Niekerk, J., Padellini, T., & Rue, H. (2024). Joint quantile disease mapping with application to malaria and G6PD deficiency. *Royal Society Open Science*, *11*(1), 230851.
- Biu, P. W., Nwasike, C. N., Tula, O. A., Ezeigweneme, C. A., & Gidiagba, J. O. (2024). A review of GIS applications in public health surveillance. *World*

Journal of Advanced Research and Reviews, *21*(1), 030-039.

- Davenhall, W. F., & Kinabrew, C. (2022). Geographic Information Systems in Health and Human Services. In *Springer Handbook of Geographic Information* (pp. 781-805). Cham: Springer International Publishing.
- Elliott, P., & Wartenberg, D. (2004). Spatial epidemiology: current approaches and future challenges. *Environmental health perspectives*, *112*(9), 998-1006.
- Formenti, B., Gregori, N., Crosato, V., Marchese, V., Tomasoni, L. R., & Castelli, F. (2022). The impact of COVID-19 on communicable and non-communicable diseases in Africa: a narrative review. *Le Infezioni in Medicina*, *30*(1), 30.
- Gupta, M., Sharma, A., Sharma, D. K., Nirola, M., Dhungel, P., Patel, A., ... & Gupta, A. (2024). Tracing the COVID-19 spread pattern in India through a GIS-based spatio-temporal analysis of interconnected clusters. *Scientific Reports*, *14*(1), 847.
- Hajlasz, M., & Pei, S. (2024). Predictability of human mobility during the COVID-19 pandemic in the United States. *PNAS nexus*, pgae308.
- Kahamba, N. F., Okumu, F. O., Jumanne, M., Kifungo, K., Odero, J. O., Baldini, F., ... & Nelli, L. (2024). Geospatial modelling of dry season habitats of the malaria vector, Anopheles funestus, in south-eastern Tanzania. *Parasites & vectors*, *17*(1), 38.
- Lee, J., & Lee, S. (2024, July). Spatial Analysis of Health System Factors in Infectious Disease Management: Lessons Learned from the COVID-19 Pandemic in Korea. In *Healthcare* (Vol. 12, No. 15, p. 1484). MDPI.
- Lin, C. H., & Wen, T. H. (2022). How spatial epidemiology helps understand infectious human disease transmission. *Tropical Medicine and Infectious Disease*, *7*(8), 164.
- Maiti, M., & Roy, U. (2024). Space–time clusters and co-occurrence of Plasmodium vivax and Plasmodium falciparum malaria in West Bengal, India. *Malaria Journal*, *23*(1), 189.
- Ngwira, A., Manda, S., Karimuribo, E. D., Kimera, S. I., & Stanley, C. (2024). Spatial analysis of livestock disease data in sub-Saharan Africa: A scoping review. *Scientific African*, e02113.
- Salim, K. U., Álvarez, F. S., Chan-Golston, A. M., Naughton, C. C., Cisneros, R., & Joyce, A. (2024). Socioeconomic and environmental factors associated with dengue fever incidence in Guatemala: Rising temperatures increase dengue risk. *PloS one*, *19*(8), e0308271.
- Villena, O. C., Arab, A., Lippi, C. A., Ryan, S. J., & Johnson, L. R. (2024). Influence of environmental, geographic, socio-demographic, and epidemiological factors on presence of malaria at the community level in two continents. *Scientific Reports*, *14*(1), 16734.