Dynamics of Urban Arboviruses Transmitted by Aedes Aegypti in Brazil: Integrative Literature Review

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Background: Urban arboviruses transmitted by Aedes aegypti represent a growing challenge for Brazilian public health, with significant impacts in terms of morbidity and mortality, overload of health services and socio-environmental inequalities.

Objective: Analyze the dynamics of urban arboviruses transmitted in Brazil as a basis for more effective control actions.

Method: This is an integrative literature review, with searches carried out in the SciELO, LILACS, PubMed and BVS databases, using descriptors such as "arboviruses", "Aedes aegypti", "dengue", "chikungunya" and "Zika virus". Complete articles in Portuguese, English and Spanish, published between 2018 and 2025, with a clinical, epidemiological, environmental or political focus were included. Data analysis was performed through thematic categorization.

Results: Twenty-three studies were selected and organized into five categories: epidemiological patterns; environmental and climatic conditions; epidemiological surveillance and monitoring technologies; clinical aspects and complications; and prevention and control strategies. A progressive increase in cases, influence of socio-environmental factors, limitations in surveillance, clinical severity and weaknesses in the implementation of public policies were observed.

Conclusion: The analysis indicates that the persistence of arboviruses in Brazil results from the interaction between structural failures and a fragmented institutional response. It concludes that strengthening epidemiological surveillance, combined with the integration of sustainable, evidence-based public policies, is essential to reducing the impact of these diseases.

Keywords: Arbovirus infections; communicable diseases; emerging; epidemiologic surveillance services; public health.

1. INTRODUCTION

Arboviruses transmitted by the Aedes aegypti mosquito have become a major public health challenge at a global and national level. These viral diseases include dengue, Zika, chikungunya and urban yellow fever, which are responsible for high morbidity and mortality, especially in tropical and subtropical regions. It is estimated that, globally, billions of people live in areas at risk for arboviruses, with hundreds of millions of infections occurring each year (Fernandes et al., 2024; Medeiros, 2024).

Recently, the proliferation of these urban arboviruses in Brazil has been driven by interconnected factors such as uncontrolled urban growth, environmental degradation, globalization, and climate change. The uncontrolled growth of cities, characterized by inadequate infrastructure, such as poor sanitation, the presence of breeding sites, and high waste accumulation, combined with changes in rainfall and temperature patterns resulting from global warming, has significantly expanded the breeding grounds for Aedes aegypti and favored the emergence and reemergence of outbreaks. Without the availability of effective vaccines or specific treatments, continuous entomological and epidemiological surveillance is essential to

confront these health challenges in Brazil (Faustine et al., 2017; Maia et al., 2023).

Aedes aegypti, the main vector of these urban viruses, is widely distributed in Brazilian cities and has adapted effectively to the domestic environment, which makes vector control particularly difficult. The widespread dissemination of this mosquito – combined with its increasing resistance to conventional insecticides – compromises the effectiveness of prevention measures and favors the persistence of arbovirus transmission (Dye-Braumuller; Prisco; Nolan, 2025).

In Brazil, urban arboviruses are among the main public health problems, generating recurring epidemics with a major national impact. The country has borne a disproportionate burden of these diseases compared to the rest of the Americas (PAHO, 2020).

For example, in 2019, more than 2.2 million cases of dengue were reported in Brazil, approximately 70% of all cases reported in the Americas that year. Furthermore, the four serotypes of the dengue virus (DENV-1 to 4) circulate simultaneously in the country, contributing to successive epidemics and increasing the risk of severe forms of the disease (WHO, 2019).

In subsequent years, the high incidence of dengue fever has continued, with recent unprecedented epidemic peaks: in 2023, Brazil faced one of the largest dengue fever epidemics ever recorded, even surpassing the figures for 2019. In addition to dengue fever, the country began to face, from the mid-2010s onwards, the emergence of new urban arboviruses transmitted by Aedes aegypti. The Zika virus, detected in Brazilian territory in 2015, spread rapidly and was associated with an unexpected increase in congenital malformations, including thousands of cases of microcephaly in newborns (Haider et al., 2024; Barçante; Cherem, 2025).

Almost simultaneously, chikungunya fever established itself in Brazil after its introduction in 2014, causing successive outbreaks of great magnitude. Since 2016, Brazil has been considered the epicenter of chikungunya epidemics in the Americas, with more than 1.6 million cases reported to date. Unlike dengue and Zika, chikungunya virus infection is marked by intense arthralgia; it is estimated that approximately 30% of patients develop chronic and debilitating joint conditions that can persist for years (Badawi et al., 2018; Resck et al., 2024).

These impacts highlight the potential of these arboviruses to cause not only acute disease, but also long-term sequelae, such as congenital Zika syndrome and chronic chikungunya arthritis (Badawi et al., 2018). The simultaneous circulation of multiple arboviruses in urban areas poses additional challenges for the health system. These infections often share similar clinical signs (fever, headache, myalgia, rash, etc.), which makes differential diagnosis difficult and can lead to underreporting or inadequate clinical management in the absence of laboratory confirmation (Santiago et al., 2023; Medeiros, 2024).

Consequently, during outbreaks, health services are overloaded and hospitalizations and treatments are expensive, increasing the impact of these diseases on the population and the economy (Siqueira Júnior, 2022; Macêdo; Bispo Júnior, 2024). The socio-environmental conditions of Brazilian cities also strongly influence the transmission dynamics of these arboviruses. Rapid and often disorderly urbanization, combined with the lack of adequate basic sanitation, has increased the vulnerability of urban populations to the proliferation of Aedes aegypti and the occurrence of epidemics (Silva et al., 2025).

Containers with stagnant water in households without adequate sanitary infrastructure provide abundant breeding grounds for mosquitoes, increasing the risk of viral transmission in communities. In addition, climate change contributes to expanding the geographic distribution and seasonality of these diseases (Nonato; Mendonça, 2025).

Global warming and changes in rainfall patterns have provided more favorable conditions for vector reproduction and virus persistence throughout the year, including in areas that previously did not register significant transmission (Lima-Camara, 2024).

Given the complexity of biological, environmental and social factors that fuel urban arbovirus epidemics, the need for integrated control and prevention strategies becomes evident (Cofone et al., 2025). In recent years, health authorities have been investing in improvements in epidemiological surveillance, vector control (including new technologies, such as genetically modified mosquitoes infected with Wolbachia), and vaccine development, measures that have already shown promising results, although they face operational challenges (Turco; Paiva, 2021; Braga et al., 2025; Costa Filho et al., 2024).

However, long-term success requires continued community engagement and effective public policies. A multisectoral approach, involving governments, the private sector, and civil society, is considered essential to implement sustainable strategies to combat these diseases and mitigate their impact on the population's health and the country's economy (Beraldo; Rocha; Araújo, 2024).

In this context, this study aims to analyze the dynamics of urban arboviruses transmitted in Brazil to support more effective control actions.

2. MATERIALS AND METHODS

This study consists of an integrative literature review with narrative synthesis, a methodological approach that allows for the systematic and comprehensive synthesis of the results of relevant research on a given phenomenon, promoting an in-depth understanding of a topic and supporting evidence-based practices. The review followed the steps proposed by Mendes, Silveira and Galvão (2008), including the formulation of the research question, definition of inclusion and exclusion criteria, identification of

studies, critical evaluation, extraction and analysis of data and presentation of results.

The guiding question of this review was: "What is the dynamics of urban arboviruses transmitted by Aedes aegypti in Brazil, according to the scientific literature published between 2018 and 2025?" To answer this question, a systematic search for studies was carried out in the databases SciELO (Scientific Electronic Library Online), LILACS (Latin American and Caribbean Literature in Health Sciences), PubMed (US National Library of Medicine) and the Virtual Health Library (VHL). The search strategy involved the use of controlled descriptors from the DeCS and MeSH vocabularies, in addition to free terms combined by Boolean operators AND and OR.

Terms such as "arboviruses", "Aedes aegypti", "vector-borne diseases", "Brazil", "dengue", "Zika virus", "chikungunya", "epidemiology", "outbreak", "epidemic" and "urban transmission" were used. The combination of descriptors varied according to the database, being adapted to increase the sensitivity of the search. An example used in the PubMed database was: ("Arboviruses" OR "Dengue" OR "Zika Virus" OR "Chikungunya") AND "Aedes aegypti" AND "Brazil". The inclusion criteria adopted were scientific articles published between January 2018 and May 2025, available in full online, written in Portuguese, English or Spanish, that addressed urban arboviruses transmitted by Aedes aegypti in the Brazilian context, with epidemiological, clinical, environmental or public policy approaches. Were excluded editorials, letters to the editor, event abstracts, dissertations, theses, non-systematized narrative reviews and studies conducted in exclusively international or rural contexts, unrelated to the urban reality of Brazil.

Therefore, this review focuses on the following arboviruses: dengue, zika virus and chikungunya.

The selection of studies was carried out in three sequential stages: reading the titles, reading the abstracts and, finally, reading the full texts. The entire process was conducted by two independent reviewers, and disagreements were resolved with the participation of a third reviewer. The selected studies were organized in a spreadsheet containing information such as: authors, year of publication, study location, database, arbovirus investigated, objectives, type of study, main findings and conclusions.

Thematic analysis was used to analyze the data, which allows the findings to be grouped into categories of meaning, in order to critically interpret the content extracted from the literature. The results will be presented in a descriptive and interpretative manner, in order to highlight the identified patterns and promote a critical discussion on the dynamics of urban arboviruses transmitted by Aedes aegypti in Brazil during the period analyzed.

3. RESULTS AND DISCUSSION

For this study, 23 articles were selected, which were analyzed and organized in the following Table 1.

The analysis of the selected studies allowed the categorization of the findings into three major themes: (1) epidemiological patterns and trends of arboviruses in Brazil, (2) environmental, climatic and urbanization conditions, (3) epidemiological surveillance and monitoring technologies, (4) clinical aspects and complications of arboviruses and (5) prevention, control and public policy strategies.

3.1 Epidemiological Patterns and Trends of Arboviruses in Brazil

Urban arboviruses, notably dengue, chikungunya and Zika virus infection, have emerged as major challenges to Brazilian public health, characterizing a scenario of hyperendemicity marked by cyclical outbreaks and increasing infection rates. A recent study points to a significant increase in the incidence of these diseases, with a focus on dengue, which remains the arbovirus with the greatest impact on the country in terms of reported cases, hospitalizations and deaths (Gonçalves et al., 2025). Data compiled by the Pan American Health Organization (2020) reveal that Brazil was responsible for more than 70% of dengue cases recorded in the Americas in the first half of 2025, surpassing the mark of 4 million probable cases. This trend had already been observed in 2019, when the country reached more than 2.2 million notifications and a significant number of deaths, a scenario that worsened even further in the following years, especially after the resumption of intense circulation of people in the post-pandemic period (WHO, 2019). The simultaneous circulation of the four serotypes of the dengue virus (DENV-1 to DENV-4) intensifies the complexity of coping, as it leads to secondary infections with a greater risk of evolving into

severe and hemorrhagic forms (Fernandes et al., 2024). Chikungunya, introduced in Brazil in 2014, has also shown a growing and worrying pattern. Although less lethal than dengue, chikungunya causes high morbidity associated with chronic joint pain, affecting the quality of life of those infected, especially the elderly and individuals with comorbidities (Resck et al., 2024). Between 2016 and 2023, more than 1.6 million probable cases of chikungunya were recorded in the country, with significant outbreaks in the northeastern states of Bahia, Pernambuco, and Ceará (Gonçalves et al., 2025).

Regarding Zika virus infection, its emergence in 2015 was marked by rapid national and international spread, in addition to an association with congenital Zika syndrome, responsible for cases of microcephaly and other neurological alterations in newborns (Fernandes et al., 2024). Despite the decrease in the number of reported cases in subsequent years, Zika remains in silent circulation, representing a latent risk especially for pregnant women and vulnerable populations (PAHO, 2020).

Studies also indicate that the distribution pattern of arboviruses in Brazil is intrinsically associated with seasonal and geographic factors. The country experiences seasonal peaks during the rainiest periods, especially between January and May, when there is a greater proliferation of Aedes aegypti, favored by high temperatures and accumulation of stagnant water (Brazil, 2024). Silva et al. (2025) confirm the strong correlation between climate variables, such as average temperature and rainfall volume, and the increase in dengue cases, with emphasis on the 2024 epidemic, which resulted in more than 6.6 million reported cases and more than 6 thousand deaths, becoming the largest outbreak of arboviruses ever recorded in the country.

In addition, the spatial distribution of arboviruses reveals a greater concentration in the Southeast, Central-West and Northeast regions, with significant differences at the municipal and state levels. This pattern highlights social and structural inequalities, such as poor basic sanitation, disorderly urbanization and limited coverage of primary health care. In these regions, the combination of environmental and socioeconomic factors creates an environment conducive to perpetuating the transmission cycle, with recurrent outbreaks and overloading of health services (Fernandes et al., 2024; Ministry of Health, 2024).

Therefore, the data discussed demonstrate that urban arboviruses in Brazil follow a trend of expansion and complexity. Coexistence with successive epidemics and co-circulation of viruses increase the challenges for epidemiological surveillance, clinical diagnosis and the implementation of effective control measures. This reinforces the need for coordinated and continuous actions, integrating environmental monitoring, epidemiological surveillance and community participation, in order to mitigate the impacts of these diseases that affect millions of Brazilians every year (Pescarini et al., 2022; Donateli; Campos, 2023; Medeiros, 2024).

3.2 Environmental, Climatic and Urbanization Conditions

Environmental and climatic conditions, combined with rapid unplanned urbanization, play a decisive role in the transmission dynamics of urban arboviruses in Brazil. Scientific literature shows that the built environment, the precariousness of urban infrastructure and regional climate patterns create a scenario that is highly conducive to the proliferation of the Aedes aegypti mosquito and the persistence of viral transmission. These factors, when combined with social vulnerability, intensify the challenges faced by public policies for the prevention and control of arboviruses (Medeiros, 2024; Nonato; Mendonça, 2025).

One of the main aspects discussed in the studies refers to the direct influence of the tropical climate on the life cycle of the vector. High temperatures and frequent rainfall increase the mosquito reproduction rate and favor the hatching of eggs laid in artificial breeding sites, especially in urban areas without an adequate storm drainage system (Donateli; Campos, 2023).

During periods of higher rainfall, such as the first months of the year, there is a significant increase in vector density and, consequently, in cases of dengue, Zika and chikungunya. A study revealed a significant correlation between average temperature, rainfall index and the explosion of dengue cases in Brazil during the summer of 2024, reinforcing the relationship between seasonality and viral transmission (Gonçalves et al., 2025).

Table 1. Summary of studies on nursing management

N	Author, title and year	Periodical	Objective	Methods	Main Results
1	Gonçalves, A. I., et al. Dengue in Brazil: an ecological study of burden, hospitalizations, and mortality trends (2019–2024). (2025).	Discover Public Health	To provide a comprehensive epidemiological assessment of dengue in Brazil, identifying emerging patterns and their potential implications for evidence-based public health policies and strategic interventions.	Observational, cross-sectional ecological study	Cumulative and biannual patterns reveal critical gaps in vector control, disease surveillance, and health preparedness. Integrated public health strategies—including sustained mosquito control efforts, enhanced entomological and clinical monitoring, and strengthened hospital preparedness—are essential to mitigate the impact of dengue.
2	Donateli, C. P., & Campos, F. C. de. Visualização de dados de vigilância das arboviroses urbanas transmitidas pelo Aedes aegypti em Minas Gerais, Brasil. (2023).	Journal of Information Systems and Technology Management	Develop a management panel (or dashboard) for systematizing and visualizing surveillance data on urban arboviruses transmitted by Aedes (Dengue; Zika and Chikungunya) in order to promote their wide availability, accessibility and relevance for data-driven health decision-making.	Operational study with dashboard	The dashboard developed consists of four distinct management panels: three of them present, individually, the data related to each of the arboviruses analyzed, while the fourth panel brings together, in an integrated manner, consolidated information on the three diseases. The tool proved to be functional and applicable to health management, offering decision-makers a clear, accessible and strategic view of epidemiological data, contributing to more effective and evidence-driven actions in public health.
3	Monteiro, F. J. C, et al., Prevalence of dengue, Zika and chikungunya viruses in Aedes (Stegomyia) aegypti (Diptera: Culicidae) in a medium-sized city, Amazon, Brazil (2020).	Rev Inst Med Trop Sao Paulo	To identify and compare the infestation and infectivity of Ae. aegypti females in the city of Macapá, state of Amapá (Amazon region), Brazil.	Historical-institutional study	The results indicate similar levels of mosquito infestation between neighborhoods and a low level of mosquito infectivity, although dengue virus was found only in Marabaixo. Virological surveillance of Ae. aegypti was important to identify infection sites and determine possible transmission routes, allowing health surveillance teams to adopt preventive strategies where infected mosquitoes are present and to act more quickly.

N	Author, title and year	Periodical	Objective	Methods	Main Results
4	São Paulo. Situação epidemiológica arboviroses urbanas: dengue, chikungunya e zika SE 01-05/2025. Boletim epidemiológico. (2023).	Epidemiological bulletin of Sao Paulo	Present notification data for urban arboviruses in the ESP, registered in the Information System for Notifiable Diseases (SINAN) online (dengue and chikungunya) and SINAN net (Zika virus), between epidemiological weeks (SE) 01 to 05 of 2025	Theoretical and entomological review	In 2025, there was an 18% increase in the number of reported cases of Dengue compared to 2024; As for Chikungunya, compared to 2024, there was a 50% increase in reported cases. And as for Zika Virus, there was a slight increase in the number of reported cases. Climate and sanitation were indicated as the main influencers of these arboviruses.
5	Brasil. Plano de Ação para redução da Dengue e de outras arboviroses (2024).	Ministério da Saúde	Present a response plan for the 2024/2025 seasonality, aiming to reduce cases and deaths from dengue, chikungunya, Zika and Oropouche.	Action plan	The actions were organized along the following axes: prevention, surveillance, vector control, organization of the care network and clinical management, emergency preparedness and response, and community communication and participation.
6	Lima-Camara, T. N. A dengue é produto do meio: uma abordagem sobre os impactos do ambiente no mosquito Aedes aegypti e nos casos da doença. (2024).	Revista Brasileira de Epidemiologia	Present the main factors that contributed and contribute to the frequent dengue epidemics that have occurred in recent years, such as vector behavior, climate change and social, political and economic aspects.	Bibliographic study	The intersection between different factors in the dynamics of the disease is highlighted, including the increase in the mosquito population due to higher temperatures and rainy periods, the influence of socioeconomic conditions, mosquito control strategies, such as drones and the Wolbachia bacteria, and the dengue vaccine. The need for integrated and effective public policies to reduce social inequalities and the impacts of climate change on the spread of dengue is emphasized.
7	Resck, M. E. B. et al. Spatial–temporal distribution of chikungunya virus in Brazil: a review on the circulating viral	Frontiers in Public Health,	To review the CHIKV genotypes circulating in Brazil, the spatial and temporal distribution of Chikungunya cases, and the susceptibility to infection and	Ecological study of spatiotemporal distribution	The predominance of the ECSA genotype, its wide geographic dispersion since 2014, and the emerging role of Aedes albopictus as a potential complementary vector to Aedes aegypti were highlighted. Regional differences in epidemic patterns were

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	genotypes and Aedes (Stegomyia) albopictus as a potential vector. (2024).		transmission (vector competence) of Ae. albopictus for CHIKV to better understand its relative contribution to the transmission dynamics of the virus.		identified, with a greater impact in the Northeast and successive peaks in the Southeast, Central-West, and North regions. The research also addressed viral mutations, such as E1-A226V, associated with the greater vector competence of Ae. albopictus, whose presence has already been recorded in all Brazilian states. Laboratory studies have demonstrated the high susceptibility of Ae. albopictus to different CHIKV genotypes, highlighting its capacity for early transmission after infection.
8	Fernandes, C. O. S., et al. Arboviroses emergentes e reemergentes no Brasil: dengue, chikungunya e zika. (2024).	Brazilian Journal of Implantology and Health Sciences	Analyze the main challenges and strategies for controlling these diseases in the Brazilian context, emphasizing recent advances in epidemiological surveillance, innovations in vector control technologies, and future perspectives for the development of effective vaccines.	Integrative Literature Review	An integrated approach, involving collaboration between government, the private sector and civil society, is essential for the implementation of sustainable and effective strategies to control these diseases, minimizing their impact on public health and the country's economy.
9	Dye-Braumuller, K. C., Prisco, R. A., & Nolan, M. S. (Re) Emerging Arboviruses of Public Health Significance in the Brazilian Amazon (2025).	Microorganisms	Describe the history of landscape changes in the country and compile all known information on all arboviruses found in Brazil (endemic and imported) associated with human and mosquito diseases, including their original isolation, associated vertebrate animals, mosquitoes and other associated arthropods,	Bibliographic study	Continued changes in the landscape will result in the emergence and re-emergence of new vector-borne arboviruses and disease cases.

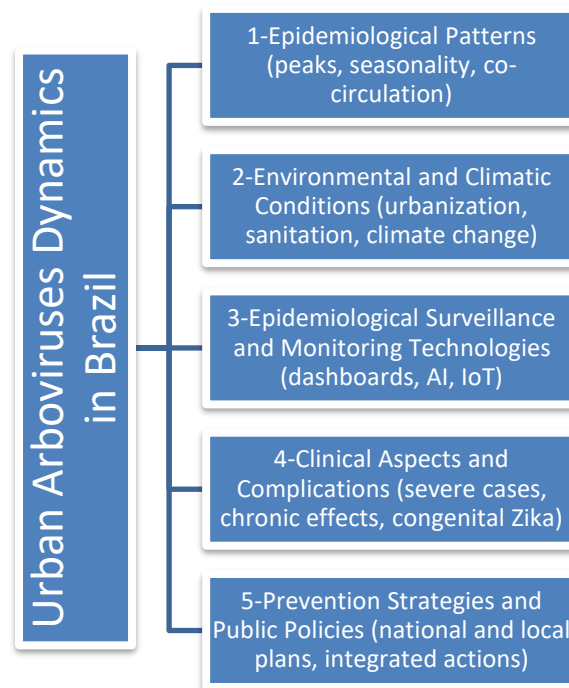| N	Author, title and year	Periodical	Objective	Methods	Main Results
			and presentations of symptoms of human diseases.		
10	Macêdo, T. F. C., & Bispo Júnior, J. P. Estratégia Saúde da Família na atenção e prevenção das arboviroses: entre assistência, educação em saúde e combate ao vetor (2024).	Interface-Comunicação, Saúde, Educação	Analyze the performance of the Family Health Strategy (ESF) in the care and prevention of arboviruses in areas with a high risk of infection.	Qualitative study carried out in Vitória da Conquista through 22 semi-structured interviews, participant observation and documentary analysis.	The results demonstrated limitations in care actions under the influence of the overload of activities and the adopted care model. Content-based and vertical educational practices predominated, with community mobilization strategies based on campaigning and hygiene. Surveillance and control actions were not routinely undertaken by the teams studied. The limitations identified demonstrate the need to strengthen the ESF as a strategic action to face the persistent problem of arboviruses.
11	Silva, A. P. P., et al. A influência de fatores socioambientais na incidência de dengue no Brasil (2025).	Revista Eletrônica de Administração e Turismo-ReAT	Correlate socio-environmental variables with the incidence of dengue fever through statistical modeling.	Documentary research with secondary data from the Ministry of Health, IBGE and SNIS, covering information on sanitation, environment and demographics.	The study indicated an increase in the incidence of dengue fever, especially in the Southeast and Central-West regions. In addition, the influence of socioeconomic factors, such as the HDI, on the spread of the disease was highlighted. Endemic outbreaks occurred throughout the country, notably in 2013, 2014 and 2017.
12	Nonato, L. T. G., & de Mendonça, L. A. Impacto das mudanças climáticas na disseminação de doenças tropicais em Manaus-AM. (2025).	Observatório de la economía latinoamericana	Analyze the relationship between climate change and the spread of tropical diseases in Manaus-AM, considering environmental, epidemiological and biomedical aspects.	Systematic literature review	The results showed that the advance of climate change has favored the geographic and temporal expansion of tropical diseases, while weakening institutional responses for prevention and control. The discussion highlighted the need for interdisciplinary strategies that articulate public policies, applied science and community participation.
13	Cofone, L., et al. Urban, Architectural,	Sustainability	To assess the relationship between urban-architectural	Systematic review	Socioeconomic status emerges as a determining factor. Low-income areas have

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	and Socioeconomic Factors Contributing to the Concentration of Potential Arbovirus Vectors and Arbovirosis in Urban Environments from a One Health Perspective: A Systematic Review. (2025).		and socioeconomic factors and vector concentrations in the urban environment.		higher mosquito densities due to overcrowding, poor infrastructure and environmental neglect. This review highlights the importance of implementing a standardized and effective global approach to urban health planning.
14	Braga, I. A., et al. Avaliação da aplicação espacial intradomiciliar usando o sistema Aero System® para controle de Aedes aegypti e o uso de ovitrampas para direcionar as ações de intervenção. (2025).	Studies in Health Sciences	To evaluate the impact of insecticide application on the control of Ae. aegypti using two portable devices widely used in Brazil: the Aero System® and the Guarany® backpack nebulizer.	Study carried out in São Domingos do Prata and Pará de Minas, located in the state of Minas Gerais, Brazil.	Ovitraps have proven effective as an entomological surveillance tool, predicting areas at risk of transmission. The Aero System® (permethrin AS) has demonstrated efficiency in controlling mosquitoes indoors, complementing larval control actions and reducing vector density. In addition, the study investigated the acceptance of the system by Endemic Disease Control Agents (ECA) and residents, with positive results: the Aero System® was preferred by the ECAs because it is easier to operate and less physically demanding than the backpack nebulizer, while 94% of residents approved the new technology.
15	Costa Filho, J., et al. Avaliação da aplicação de Bacillus Thuringiensis Israelensis (BTI) para o controle do Aedes aegypti utilizando a tecnologia Wals®. (2024).	Seven Editora	To evaluate the methodology of spatial application of larvicide using Bacillus thuringiensis israelensis (Bti) in vehicle-mounted equipment with Wals® technology compared with the methodology of traditional application of focal treatment	Study carried out throughout 2022, in the region known as Estância, Brazil.	The results obtained show that the IPO, IDO and IMO indices, throughout the epidemiological weeks of the study, were lower in the area of spatial application through a vehicle with Wals® technology, when compared to the coastal application area and the focal application area. However, it is observed that most of the p-values were greater than 0.05, indicating that

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			of breeding sites by Endemic Control Agents and with motorized perifocal backpack application, in addition to evaluating the dispersion of the product in both Wals® and backpack areas.		no significant difference was observed between the areas, except for the IMO index between Areas I and III, which presented a p-value of 0.043.
16	Turco, C. S., & Paiva, E. N. Normas e atribuições institucionais para avaliação de mosquitos modificados para o controle de arbovírus no Brasil. (2021).	Vigilância Sanitária em Debate: Sociedade, Ciência & Tecnologia	To analyze the regulatory trajectories of two new biotechnologies for controlling arboviruses transmitted by A. aegypti: transgenic A. aegypti and A. aegypti infected with the Wolbachia bacteria.	Qualitative analysis of publicly accessible documents made available by official bodies.	The results describe the different regulatory trajectories and the attempt to standardize the two biotechnologies in the country and present the gaps and controversies involving the regulatory processes of these new artifacts.
17	Siqueira Junior, J. B., et al. Epidemiology and costs of dengue in Brazil: a systematic literature review. (2022)	International Journal of Infectious Diseases	Characterize the epidemiological and economic impact of dengue in Brazil.	Bibliographic study	The incidence of dengue fever in Brazil is increasing and is probably underestimated. Therefore, developing and implementing new strategies, including vaccination, is essential to reduce the incidence of the disease.
18	Pescarini, J. M., et al. Dengue, Zika, and Chikungunya viral circulation and hospitalization rates in Brazil from 2014 to 2019: An ecological study. (2022).	PLoS Neglected Tropical Diseases,	Investigate whether local increases in arbovirus notifications were associated with excess hospitalization.	Longitudinal study at municipal and state level with data from January 1, 2014 to December 31, 2019.	Between 2014 and 2019, Brazil recorded more than 7.5 million cases of dengue, 433,000 of chikungunya, and 159,000 of Zika. Dengue showed an endemic-seasonal pattern in 95.8% of municipalities, concentrated between February and May. Chikungunya had a similar pattern, but with a smaller coverage (78.8%), and Zika was reported in 46.3% of municipalities. Dengue and chikungunya were associated with hospitalizations due to arboviruses, while Zika was related to hospitalizations due to neurological diseases.

N	Author, title and year	Periodical	Objective	Methods	Main Results
19	Badawi, A., et al. Prevalence of chronic comorbidities in chikungunya: A systematic review and meta-analysis. (2018).	International Journal of Infectious Diseases	Describe the prevalence of chronic comorbidities in CHIKV and evaluate their possible contributions to disease severity.	Systematic review and meta-analysis	Among 2,773 CHIKV patients, hypertension was the most prevalent comorbidity (31.3%), followed by diabetes (20.5%), heart disease (14.8%), and asthma (7.9%). There was a significant 4- to 5-fold increase in the prevalence of diabetes, hypertension, and heart disease in CHIKV patients older than 50 years compared with their younger counterparts. Severe CHIKV cases had a significantly higher proportion of diabetes than nonsevere cases.
20	Oliveira, C. V. D. S., et al. A emergência do Zika vírus no Brasil e a resposta federal dos Sistemas Nacionais de Vigilância em Saúde e de Vigilância Sanitária. (2024).	Physis: Revista de Saúde Coletiva	To analyze the federal response of the National Health Surveillance and Sanitary Surveillance Systems to the Zika virus epidemic in Brazil, from 2015 to 2018, focusing on the political-institutional contexts and the content of the government measures developed during the period.	Historical institutionalist approach, comprising documentary analysis and interviews with key actors.	Vector control was central, valuing intersectoral and community actions, induced mainly by the Health Surveillance Secretariat of the Ministry of Health and complementary by the National Health Surveillance Agency. Significant limitations were observed in the allocation of new financial resources and changes in the organizational response apparatus, with effects on the continuity of policies in the post-emergency period, including the development of medicines, vaccines and tests.
21	Aira, J., et al. MosquIoT: A system based on IoT and machine learning for the monitoring of Aedes aegypti (Diptera: Culicidae). (2023).	IEEE Transactions on Instrumentation and Measurement	Design, develop and test an innovative system that integrates traditional ovitraps with Internet of Things (IoT) and Tiny Machine Learning (TinyML) technologies, enabling the automatic detection and quantification of Aedes aegypti eggs.	The method combines embedded hardware, low-power artificial intelligence and IoT connectivity to modernize entomological surveillance, making it more reactive, accurate and scalable.	The MosquIoT system demonstrated high accuracy in detecting and counting Aedes aegypti eggs in real time, achieving an accuracy rate of 90.4% with the embedded TinyML FOMO model. Field tests validated its functionality in urban environments, showing that the technology is effective, low-cost and energy-efficient for continuous entomological surveillance. In addition, the collected environmental data contributed to generating dynamic risk maps, expanding

N	Author, title and year	Periodical	Objective	Methods	Main Results
					the predictive capacity of vector control actions.
22	Araujo, E. C., et al. Large-scale epidemiological modelling: scanning for mosquito-borne diseases spatio-temporal patterns in Brazil. (2025).	Royal Society Open Science	Presents an unprecedented analysis, in terms of breadth, estimating the susceptible-infectious-recovered transmission parameters from incidence data in all 5570 municipalities in Brazil over 14 years (2010–2023) for both dengue and chikungunya.	Retrospective observational epidemiological analysis, with a space-time focus.	The results revealed distinct geographic patterns: dengue epidemics last longer in the North compared to the South, and viral peaks vary regionally. The average R_0 was approximately 1.97 for dengue and 2.12 for chikungunya, with a median duration of 27 and 25 weeks, respectively. Dengue outbreaks with higher R_0 tended to be shorter. Climate changes, such as temperature and precipitation, correlated with the intensity and timing of outbreaks. The study also highlights epidemiological competition, since the decrease in dengue cases in 2017–2018 coincided with an increase in chikungunya. The tool allowed mapping seasonality, spatial trends and their link with climate variations, providing support for targeted interventions in each region.
23	Passos, W. L., et al. Automatic detection of Aedes aegypti breeding grounds based on deep networks with spatio-temporal consistency. (2022).	Computers, Environment and Urban Systems	Introduce a comprehensive dataset of aerial videos, acquired with an unmanned aerial vehicle, containing possible mosquito breeding sites.	Experimental methodological study, focused on the development of an innovative procedure for collecting and analyzing videos captured by drones.	The automatic detection system for Aedes aegypti breeding sites from aerial videos proved to be effective: using deep networks with a spatiotemporal consistency module, the model achieved an F1 score of 0.65 in identifying tires and 0.77 in identifying water reservoirs (tanks), demonstrating that sequential frame analysis significantly reduces false positives and negatives, providing robustness to the entomological surveillance process.

Source: Authors, 2025.

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Urban Arboviruses Dynamics in Brazil
    ├── 1-Epidemiological Patterns (peaks, seasonality, co-circulation)
    ├── 2-Environmental and Climatic Conditions (urbanization, sanitation, climate change)
    ├── 3-Epidemiological Surveillance and Monitoring Technologies (dashboards, AI, IoT)
    ├── 4-Clinical Aspects and Complications (severe cases, chronic effects, congenital Zika)
    └── 5-Prevention Strategies and Public Policies (national and local plans, integrated actions)
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Fig. 1. Thematic categories identified in the integrative review on the dynamics of urban arboviruses transmitted by Aedes aegypti in Brazil

The process of accelerated urbanization, which has intensified in recent decades, is also indicated as a structuring factor of urban vulnerability to arboviruses. The disorderly expansion of Brazilian cities, often without basic infrastructure such as regular garbage collection, continuous water supply and sewage, favors the creation of breeding sites for the vector in improvised deposits of accumulated water and waste. Such conditions are especially prevalent in peripheral communities, where public services are precarious and populations live in higher densities, intensifying exposure to the mosquito and the risk of transmission (Cofone et al., 2025).

In addition, the study by Donateli and Campos (2023), when developing a surveillance panel in Minas Gerais, identified that the municipalities with the highest incidence of arboviruses were those with the worst indicators of environmental sanitation and high population density. These environmental and structural variables not only facilitate the cycle of Aedes aegypti, but also hinder the implementation of effective vector control strategies, such as focal treatment, elimination of breeding sites and environmental education of the population.

The impact of climate change on the ecology of the vector has also been widely discussed. With the increase in global average temperatures and the intensification of extreme events, such as droughts and floods, there has been a geographic expansion of the risk area for arboviruses in Brazil, including municipalities that historically did not have high infestation rates. This expansion of the Aedes aegypti habitat into regions previously considered safe represents a new challenge for health surveillance services, which need to adapt to more complex and unstable epidemiological scenarios (Medeiros, 2024; Araujo et al., 2024; Nonato; Mendonça, 2025).

Finally, the precarious environment in Brazilian cities has direct repercussions on the effectiveness of actions to combat the vector. As evidenced in the study by Turco and Paiva (2021), even intensive campaigns to eliminate breeding sites and use insecticides tend to have limited impact if they are not accompanied by sustainable structural improvements, such as regular access to drinking water, formal urbanization, and adequate solid waste management. This finding reinforces the need for intersectoral approaches that integrate health, urban planning, the environment, and social policies, in order to address the structural causes that sustain the transmission of arboviruses in Brazilian cities (Braga et al., 2025).

Thus, the studies analyzed indicate that any strategy to combat urban arboviruses must necessarily consider the environmental, climatic and territorial determinants that shape the Brazilian epidemiological reality. Promoting healthy cities, with resilient urban infrastructure and continuous environmental surveillance, is essential for the lasting containment of these diseases (Dye-Braumuller; Prisco; Nolan, 2025).

3.3 Epidemiological Surveillance and Monitoring Technologies

Epidemiological surveillance plays a fundamental role in the control of urban arboviruses by enabling early detection of outbreaks, mapping of risk areas, and guiding public health actions. However, the Brazilian scenario reveals persistent structural challenges, such as deficiencies in timely reporting, fragmentation of information systems, and a shortage of qualified human resources (Medeiros, 2024). In this context, the incorporation of digital technologies and advanced analysis tools has proven to be a promising strategy for qualifying surveillance and expanding its response capacity to dengue, Zika, and chikungunya epidemics.

A study by Donateli and Campos (2023) highlights the potential of digital platforms and interactive visualization systems in the management of epidemiological data through the creation of a digital dashboard for real-time monitoring of urban arboviruses transmitted by A. aegypti in the state of Minas Gerais. The tool integrates data from SINAN, meteorological variables, and socio-environmental indicators, allowing the identification of seasonal and territorial patterns of transmission. In addition, the dashboard contributes to the planning of strategic actions, such as intensifying home visits and community mobilization campaigns in priority areas.

In addition, there is a growing investment in predictive technologies based on artificial intelligence and machine learning. Passos et al. (2022) demonstrated the applicability of deep learning algorithms for the automated detection of vector breeding sites in urban environments, using images captured by drones and fixed cameras. The use of these techniques enables more agile and precise interventions, reducing the time between identifying the focus and adopting corrective measures. Similarly, the MosquIoT system, developed by Aira et al. (2024), combines environmental sensors with predictive modeling to monitor, in real time, conditions favorable to the proliferation of the mosquito, signaling imminent risks of an outbreak.

In the epidemiological plan, studies such as that by Araujo et al. (2024) used space-time modeling to describe arbovirus distribution patterns over more than a decade (2010–2023), indicating the increase in transmission in areas previously considered low risk. The computational approach, using the Episcanner tool, revealed an association between climate variability and incidence of cases, especially during periods influenced by the El Niño phenomenon. Such information is valuable for intersectoral planning, allowing for the anticipation of intensification of actions in more vulnerable regions.

Despite technological advances, the literature warns of the persistence of operational obstacles. When analyzing the institutional response to the Zika epidemic, it was revealed that, although there was an initial effort to strengthen surveillance, the lack of continuity of strategies after the acute phase compromised the ability to prevent new outbreaks. The disconnection between the federal, state and municipal spheres and the turnover of managers also hinder the consolidation of innovative technological systems in the routine of the SUS (Costa Filho et al., 2024; Lima-Camara, 2024).

Therefore, the use of monitoring and prediction technologies to combat arboviruses represents a promising trend, but it requires integration with sustainable public policies and the formation of qualified teams. The effectiveness of these tools depends not only on their technical sophistication, but also on the health system's ability to interpret the data generated and transform them into coordinated and territorialized actions. The consolidation of modern, sensitive and continuous epidemiological surveillance is, therefore, essential to contain the progression of urban arboviruses in Brazil (Costa Filho et al., 2024; Lima-Camara, 2024).

3.4 Clinical Aspects and Complications of Arboviruses

Urban arboviruses caused by dengue, Zika, and chikungunya share important clinical similarities, but they also present specific manifestations that differentiate them, with potentially serious implications for public health. Recent studies

have emphasized the multisystemic nature of these infections, their atypical forms of clinical presentation, and, above all, their possible acute and chronic complications (Badawi et al., 2018; Resck et al., 2024).

Dengue, one of the most prevalent arboviruses in Brazil, is clinically characterized by high fever, myalgia, headache, rash, and retroorbital pain. In its classic form, the condition is self-limiting, but the infection can evolve into severe forms, such as dengue with warning signs or dengue hemorrhagic fever, especially in cases of secondary infection by a different serotype (Fernandes et al., 2024).

According to Gonçalves et al. (2025), the number of hospitalizations due to severe forms of dengue has increased in recent years, with a special incidence in children, the elderly and people with chronic diseases. Appropriate clinical management depends on monitoring signs of severity and early fluid replacement, and training of health teams in primary and hospital care is essential.

In most cases, Zika virus infection manifests with milder symptoms, such as low fever, rash and non-purulent conjunctivitis. However, the major impact of Zika is associated with neurological complications, especially when the infection occurs during pregnancy. The 2015–2016 epidemic revealed the association of the virus with Congenital Zika Syndrome, characterized by microcephaly, intracranial calcifications, motor disorders and hearing and vision problems in newborns. These findings reinforce the importance of prenatal screening and monitoring in endemic areas, in addition to public policies to support affected families (Monteiro et al., 2020; Fernandes et al., 2024).

Chikungunya, in turn, is clinically distinct because it causes significant rheumatological symptoms. Its acute phase involves high fever and intense joint pain, which can incapacitate the patient for days. However, what has generated greater concern is the progression to the chronic form, with persistent arthralgia and joint stiffness for months or even years after infection (Santiago, 2023; Resck et al., 2024).

A study by Badawi et al. (2018) indicates that approximately 30% of infected individuals develop chronic forms, often confused with rheumatoid arthritis, which directly impacts the quality of life and work capacity of patients.

There is also evidence that the elderly, women, and people with comorbidities are at greater risk of developing severe and chronic forms of chikungunya.

Another relevant clinical aspect is the difficulty in making a differential diagnosis between these arboviruses, since the initial symptoms are quite similar, especially in the first days of the disease. In contexts of co-circulation of viruses – as is often the case in Brazil – this clinical overlap can lead to underdiagnosis or inadequate management, especially in places with low laboratory testing coverage. The use of rapid antigen (NS1), serology (IgM/IgG), and RT-PCR tests has been encouraged by the Ministry of Health, but still faces operational and availability limitations in public health services (Pescarini et al., 2022).

Thus, the studies analyzed show that the clinical manifestations of urban arboviruses go beyond the acute phase and can generate lasting sequelae, both physical and neurological. Early identification of signs of severity, strengthening the care network for the most vulnerable populations and expanding laboratory diagnosis are essential measures to mitigate damage to the health and well-being of the population, in addition to reducing the costs of illness (Siqueira Júnior et al., 2022).

3.5 Prevention, Control and Public Policy Strategies

Combating urban arboviruses in Brazil requires coordinated surveillance, vector control, health education, and the formulation of sustainable public policies. Given the high epidemiological burden associated with dengue, chikungunya, and Zika, integrated action between the federal, state, and municipal spheres is essential, as well as the incorporation of multisectoral approaches involving health, sanitation, the environment, and urban planning. Studies highlight important regulatory advances in recent years, but also highlight weaknesses in the implementation of large-scale control strategies (Ministry of Health, 2024; Health Department of the State of São Paulo, 2025).

The National Plan for Combating Arboviruses, published by the Ministry of Health (2024), brings together technical guidelines aimed at entomological surveillance, control of breeding sites, and response to outbreaks. This document emphasizes the need to maintain permanent

monitoring actions, with a focus on reducing the Building Infestation Index (IIP), in addition to reinforcing the importance of community participation in the elimination of containers that can accumulate stagnant water. However, several authors point out that the implementation of these strategies encounters practical obstacles, such as the discontinuity of programs, the insufficiency of endemic agents, and the low adherence of the population to educational campaigns (Donateli; Campos, 2023; Fernandes et al., 2024).

Local experiences, such as the Arbovirus Contingency Plan in the State of São Paulo (2025–2026), reveal that regionalized planning and the use of risk indicators can contribute to more effective and timely responses. In this model, municipalities are classified according to the degree of epidemiological and environmental risk, which allows the mobilization of resources and actions proportional to the local situation. The São Paulo plan also recommends the use of technologies such as smart traps, drones and georeferencing to optimize vector surveillance and outbreak control (São Paulo State Health Department, 2025).

Despite these advances, the literature shows that most Brazilian municipalities still rely on traditional methods and delayed responses to epidemics, often only when cases have already reached alarming levels. The institutional response to the Zika epidemic was marked by specific emergency actions, without continuity in strengthening primary care or in assisting children affected by the congenital syndrome. This pattern is repeated in other arboviruses, highlighting the fragility of health policy with regard to the longitudinality of care and intersectoral coordination (Oliveira et al., 2024).
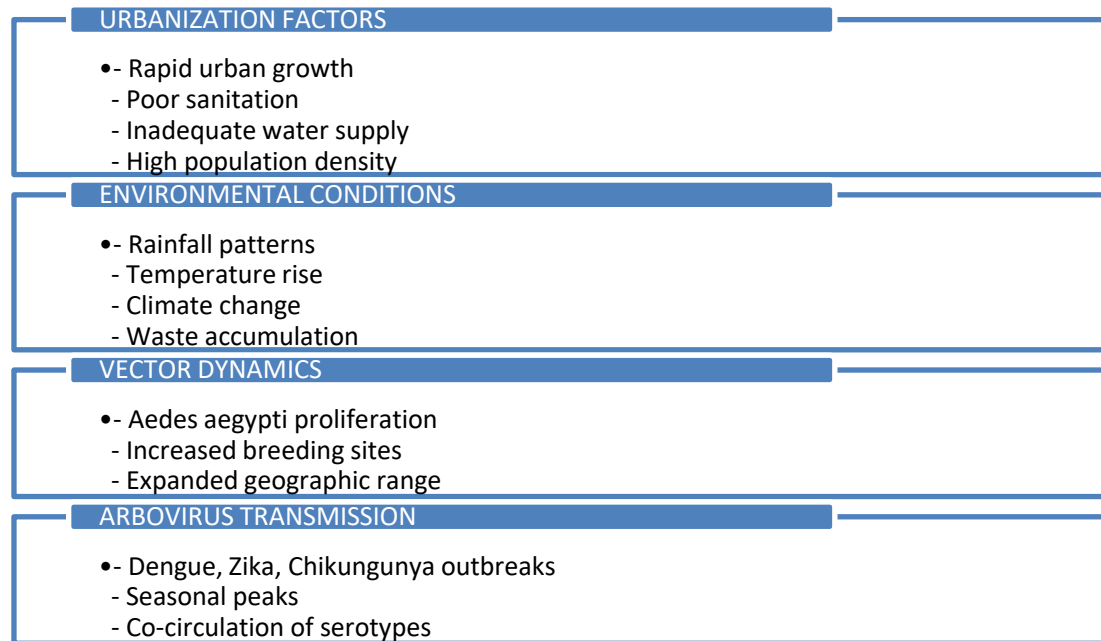
In the field of health education, periodic campaigns such as "D-Day to Combat Mosquitoes" focus on raising awareness among the population, but still lack greater capillarity and methodological innovation. Adherence to preventive measures, such as proper waste disposal and safe water storage, is directly related to the level of education, access to information and trust in public institutions. Therefore, authors such as Donateli and Campos (2023) advocate the strengthening of continuous educational strategies, based on cultural

dialogue, use of social media and participation of schools, churches and local leaders.

The literature also points to the importance of decentralizing the management of control actions, allowing municipalities to adapt strategies to territorial realities. However, this decentralization requires continuous technical and financial support from the federal government, in addition to mechanisms for performance evaluation and accountability. Intersectoral action, although advocated in official documents, still faces practical obstacles such as fragmentation between the health, sanitation, environment and education departments, making long-term structural interventions difficult (Fernandes et al., 2024; Ministry of Health, 2024).

Thus, it is observed that, although there are public policies and strategies that are well outlined on paper, their implementation lacks regularity, stable funding and political commitment. The effective fight against urban arboviruses in Brazil therefore demands a transformation of specific actions into structural policies, supported by scientific data, active social participation and continuous investment in urban infrastructure and health services (Macêdo; Bispo Júnior, 2024).

This integrative review has some limitations that should be considered when interpreting the findings. First, the inclusion criteria were limited to studies published between 2018 and 2025, which, although recent, may have excluded relevant older works that contributed foundational insights into arbovirus transmission dynamics. Second, only articles published in English, Portuguese, and Spanish were considered, potentially excluding valuable studies in other languages. Third, despite efforts to ensure a comprehensive search using major databases, publication bias may still have occurred, as gray literature and unpublished reports were not included. Additionally, the diversity of study designs made it challenging to perform comparative assessments across findings. The categorization of themes was based on narrative synthesis, which involves a degree of subjectivity. Lastly, the dynamic and rapidly evolving nature of arboviral transmission in Brazil, influenced by climatic and urban transformations, underscores the need for continuous monitoring, which cannot be fully captured in a static literature review.

URBANIZATION FACTORS

- •- Rapid urban growth
- Poor sanitation
- Inadequate water supply
- High population density

ENVIRONMENTAL CONDITIONS

- •- Rainfall patterns
- Temperature rise
- Climate change
- Waste accumulation

VECTOR DYNAMICS

- •- Aedes aegypti proliferation
- Increased breeding sites
- Expanded geographic range

ARBOVIRUS TRANSMISSION

- •- Dengue, Zika, Chikungunya outbreaks
- Seasonal peaks
- Co-circulation of serotypes

Fig. 2. Conceptual diagram representing the dynamic interactions between arboviruses, environmental factors, and urbanization processes influencing the transmission and persistence of Aedes aegypti-borne diseases in Brazil

4. CONCLUSION

This review revealed an epidemiological reality marked by a high burden of morbidity, recurrent outbreaks, simultaneous circulation of different viruses, and chronic control challenges. The studies analyzed showed worrying epidemiological patterns, with successive peaks in incidence and mortality, aggravated by the concomitant circulation of the four dengue serotypes and the persistence of Zika and chikungunya at endemic levels. The direct association between precarious environmental conditions, climate change, and disorderly urbanization processes reinforces that the causes of the expansion of arboviruses are rooted in historical structural inequalities.

In addition, it was observed that technological advances, such as georeferenced information systems, interactive panels, and prediction models based on artificial intelligence, have contributed to modernizing epidemiological surveillance, although their practical impact is still limited by the lack of institutional continuity, precarious infrastructure, and inequality in access to technology among municipalities. From a clinical perspective, arboviruses have demonstrated a great capacity to produce serious outcomes and long-term sequelae, especially in vulnerable populations such as pregnant women, children and the elderly.

In the field of public policies, although there are well-structured national guidelines and state contingency plans, the effectiveness of control actions is compromised by operational difficulties, political instability, underfunding and limited community participation. The persistence of fragmented, specific and reactive strategies in the face of outbreaks demonstrates the need for an integrated and continuous approach that considers the social determinants of health and promotes intersectoral action.

In view of this, it is imperative to rethink the way in which urban arboviruses are addressed in Brazil, consolidating structural, evidence-based, territorial and sustainable public policies. Success in controlling these diseases depends not only on immediate health measures, but also on promoting healthy cities, reducing social inequities and strengthening the Unified Health System. Investing in modern epidemiological surveillance, health education and urban infrastructure means investing in the quality of life of the population and in preventing future health emergencies.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

COMPETING INTERESTS

Authors have declared that they have no known competing financial interests or non-financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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