

Tropical Diseases and Arboviruses: Perspectives for Surveillance and Control

Doenças Tropicais e Arbovirose: Perspectivas para Vigilância e Controle

Enfermedades Tropicales y Arbovirosis: Perspectivas para la Vigilancia y el Control

RESUMO

O estudo teve como objetivo analisar aspectos epidemiológicos, ambientais e sociais relacionados à disseminação de arbovirose no Brasil, com ênfase nas estratégias atuais e inovadoras de vigilância e controle vetorial. Realizou-se revisão integrativa da literatura, com buscas em bases nacionais e internacionais entre 2010 e 2025. Os achados revelaram crescimento expressivo de epidemias de dengue, zika e chikungunya, associadas a mudanças climáticas, urbanização desordenada e desigualdades sociais. Foram identificadas iniciativas promissoras, como uso de mosquitos infectados com Wolbachia, armadilhas ovitrampas e aplicativos baseados em inteligência artificial, embora persistam desafios como resistência aos inseticidas e baixa adesão comunitária. Observou-se necessidade de abordagens intersectoriais e investimentos em vigilância entomológica e educação em saúde. Conclui-se que o enfrentamento das arbovirose demanda estratégias integradas, tecnologias inovadoras e fortalecimento de políticas públicas para reduzir a morbimortalidade e promover condições saudáveis nos territórios socialmente produzidos.

DESCRITORES: Infecção por Arbovírus; Doenças Negligenciadas; Doenças Tropicais; Vigilância em Saúde; Saúde Pública

ABSTRACT

The study aimed to analyze epidemiological, environmental, and social aspects related to the spread of arboviral diseases in Brazil, with an emphasis on current and innovative strategies for surveillance and vector control. An integrative literature review was conducted, including searches in national and international databases between 2010 and 2025. Findings revealed a significant increase in dengue, Zika, and chikungunya epidemics, associated with climate change, unplanned urbanization, and social inequalities. Promising initiatives were identified, such as the use of Wolbachia-infected mosquitoes, ovitraps, and artificial intelligence-based applications; however, challenges remain, including insecticide resistance and low community engagement. The study highlighted the need for intersectoral approaches and investments in entomological surveillance and health education. It concludes that tackling arboviral diseases requires integrated strategies, innovative technologies, and the strengthening of public policies to reduce morbidity and mortality and promote healthy living conditions in socially produced territories.

DESCRIPTORS: Arbovirus Infections; Neglected Diseases; Tropical Diseases; Health Surveillance; Public Health.

RESUMEN

El estudio tuvo como objetivo analizar los aspectos epidemiológicos, ambientales y sociales relacionados con la propagación de arbovirose en Brasil, con énfasis en las estrategias actuales e innovadoras de vigilancia y control vectorial. Se realizó una revisión integradora de la literatura, con búsquedas en bases de datos nacionales e internacionales entre 2010 y 2025. Los hallazgos revelaron un aumento significativo de las epidemias de dengue, zika y chikungunya, asociadas al cambio climático, la urbanización desordenada y las desigualdades sociales. Se identificaron iniciativas prometedoras, como el uso de mosquitos infectados con Wolbachia, trampas de oviposición y aplicaciones basadas en inteligencia artificial; sin embargo, persisten desafíos como la resistencia a los insecticidas y la baja adhesión comunitaria. Se observó la necesidad de enfoques intersectoriales y de inversiones en vigilancia entomológica y educación en salud. Se concluye que el enfrentamiento de las arbovirose requiere estrategias integradas, tecnologías innovadoras y el fortalecimiento de políticas públicas para reducir la morbimortalidad y promover condiciones de vida saludables en los territorios socialmente producidos.

DESCRIPTORES: Infección por Arbovirus; Enfermedades Desatendidas; Enfermedades Tropicales; Vigilancia en Salud; Salud Pública.

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INTRODUÇÃO

Different human activities impact natural environments, transforming them into socially produced territories that favor the presence of vectors of sanitary importance, such as arthropods that transmit arboviruses, including dengue, chikungunya, and Zika, classified as neglected diseases¹. Environmental degradation accentuates the proliferation of these vectors, especially mosquitoes of the genus *Aedes*, posing serious threats to public health and unequal costs to society².

Historically, arboviruses have been linked to environmental determinism, with a predominance of the biomedical model focused on vector control, which has led to significant technical and financial investments but little emphasis on social mobilization processes and addressing the social determinants of health³. These determinants include the conditions in which people are born, live, and work, highlighting the need for intersectoral and integrated approaches³.

The use and occupation of environments, such as deforestation, agricultural expansion, poor sanitation, and migratory processes, have contributed to the circulation and persistence of arboviruses. In addition, migratory birds and the forced movement of

animals intensify the spread of these pathogens across different territorial scales⁴. Studies indicate that socially constructed territory is not only the setting for disease, but also a strategic space for implementing prevention and control policies, considering the multiple causes of health and disease processes⁵.

Recent research highlights that factors such as climate change, rapid urbanization, and social inequality contribute to the expansion of risk areas and the vulnerability of exposed populations⁶⁻⁷. In this context, a broader understanding of health surveillance, articulating local knowledge, community participation, and intersectoral strategies, is essential to promote more effective responses⁸⁻⁹.

Arboviruses, a term derived from arthropod-borne virus, represent a global threat to public health because they cause urban arboviral diseases, including dengue (Orthoflavivirus denguei – DENV), Zika (Orthoflavivirus zikaense – ZIKV), and chikungunya (Chikungunya virus – CHIKV)¹⁰. In Brazil, the main vectors of these arboviruses are mosquitoes of the Culicidae family, belonging to the genus *Aedes*, especially *Aedes aegypti*, which is widespread in all states and widely distributed in urban areas¹¹.

The three arboviruses can be transmitted to humans by vector,

vertical, and transfusion, with vector transmission being the most relevant, through the bite of infected mosquitoes, in the human-vector-human cycle¹³. Although vertical transmission of DENV, CHIKV, and ZIKV has been documented, ZIKV deserves special attention because it can cause severe fetal malformations and miscarriage at different gestational ages, in addition to being transmitted sexually, even in asymptomatic individuals¹⁴.

Between 2015 and 2024, Brazil recorded five major epidemics of dengue and chikungunya, with a decreasing reduction in the intervals between periods of low transmission. The Midwest, South, and Southeast regions had the highest incidences in 2022 and 2023¹⁵. The largest dengue epidemic in history occurred in 2024, with more than 6.5 million probable cases and 5,815 confirmed deaths by epidemiological week 46, with a case fatality rate of 3.2% in severe cases¹⁶.

In 2023, the World Health Organization warned about the health impacts of the El Niño phenomenon, including an increase in vector-borne diseases¹⁷. The period between May 2023 and May 2024 saw record high global temperatures, according to the Copernicus Climate Change Service climate observatory¹⁸.

The WHO considers dengue to be the most important arbovirus affecting

humans, due to its high morbidity and potential for fatal progression¹⁹. Tropical and subtropical regions account for the majority of cases, due to environmental conditions favorable to the vector²⁰⁻²¹. The etiological agent is the DENV virus, which has four distinct serotypes (DENV-1 to DENV-4)². Studies also point to the possible existence of a fifth serotype identified in samples from Malaysia, although detailed information has not yet been published in peer-reviewed articles²⁻³.

In Brazil, the National Dengue Control Program guides entomological and epidemiological surveillance actions, such as surveys of building infestation indices and Breteau indices²⁻⁴. However, research indicates that methodologies such as ovitraps may be more sensitive in detecting the vector²⁻⁴. Vector control is based mainly on the use of chemical insecticides and, to a lesser extent, biological insecticides. However, there is evidence of *Aedes aegypti* resistance to substances such as temephos, which has led to the introduction of alternatives such as biological larvicides and growth regulators²⁻⁷.

Dengue epidemics have a significant impact on the health system and the economy. Between 2005 and 2017, the estimated costs of the disease ranged from US\$ 516.79 million to US\$ 1.68 billion, not including the social impact of school and work absenteeism²⁻³. The simultaneous circulation of arboviruses, different serotypes, and population vulnerability contribute to the worsening of the epidemiological scenario, with an increase in severe forms and lethality.

Reports of dengue cases and deaths have been on the rise in recent decades, especially in tropical and subtropical countries^{3- 1}. Given this scenario, it is essential to discuss vector control interventions and incorporate complementary technologies into the National Dengue Control Pro-

gram, such as larvicide dissemination stations, the use of *Wolbachia*-infected mosquitoes, and irradiated sterile mosquitoes³⁻².

The participation of the Ministry of Health with investments in research and updating control strategies is essential to adapt public policies and reduce morbidity and mortality caused by dengue, chikungunya, and Zika in Brazil³⁻².

Thus, studies and research on arboviruses and tropical diseases should consider how social practices and land occupation processes determine the emergence and spread of these diseases, as well as identify populations at risk and demand flows that impact public health services. Therefore, the study aims to: Analyze the main epidemiological, environmental, and social aspects related to the spread of arboviruses in Brazil, with an emphasis on current and innovative strategies for surveillance and vector control.

METHOD

This is an integrative literature review developed with the objective of gathering, analyzing, and synthesizing scientific publications on arboviruses and tropical diseases in Brazil, emphasizing epidemiological aspects, socio-environmental determinants, and vector surveillance and control strategies. This study was conducted following the methodological steps proposed by Whittemore and Knafl²², including the definition of the research problem, the establishment of inclusion and exclusion criteria, the collection and critical evaluation of the selected studies, the analysis of the results, and the final presentation of the review.

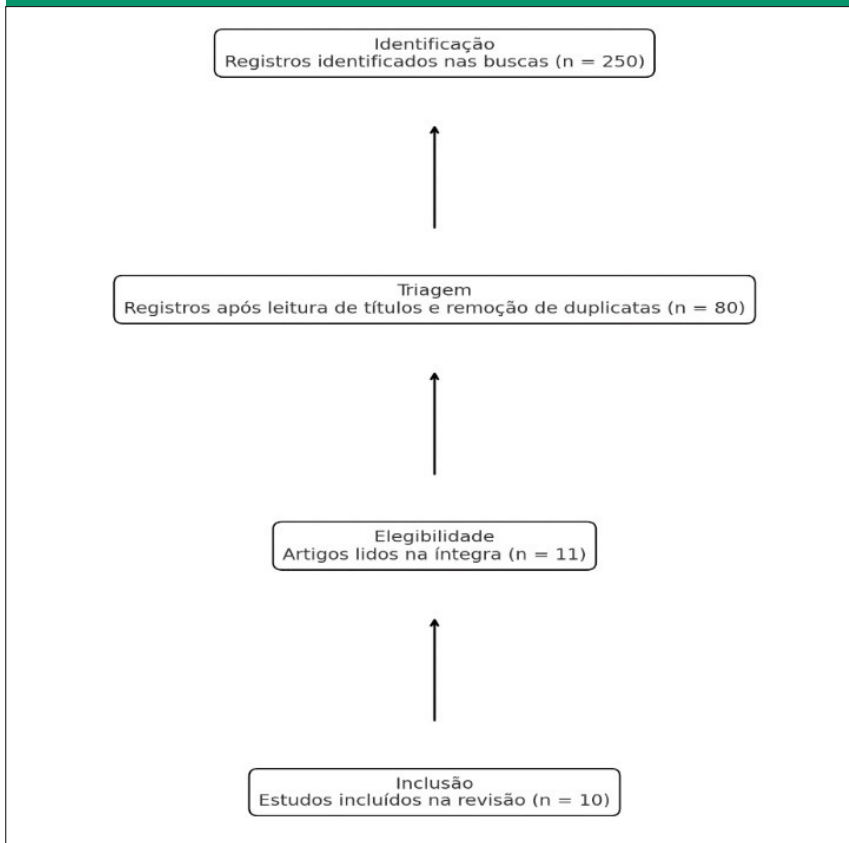
The guiding question defined was: What scientific evidence is available on surveillance, vector control, and determinants related to arboviruses

in Brazil? Data collection was carried out between June and July 2025 in the electronic databases Virtual Health Library (BVS), PubMed, SciELO, and Google Scholar, using the Health Sciences Descriptors (DeCS) and Medical Subject Headings (MeSH), associated with the Boolean operators "AND" and "OR," using the following descriptors: Arbovirus Infection; Neglected Diseases; Tropical Diseases; Health Surveillance; Public Health.

Original articles, systematic reviews, official documents, and technical reports available in full, published between 2010 and 2025, in Portuguese, English, or Spanish, addressing surveillance, vector control, and epidemiological aspects related to arboviruses in the Brazilian context were included. Duplicate studies, letters to the editor, event abstracts, dissertations and theses not published in indexed journals, and articles whose central theme did not address the proposed objectives were excluded.

The selection of studies took place in three stages: reading of titles and abstracts, full reading of potentially eligible articles, and application of the previously established eligibility criteria. The extracted data were organized in a spreadsheet containing information on the author, year of publication, objective, methodological design, main results, and limitations. Data analysis and synthesis were performed by two reviewers independently, and any discrepancies were resolved by consensus. Finally, the presentation of the findings followed the recommendations of the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) model, with a view to ensuring the transparency and reproducibility of the methodological process adopted.

Figure 1 – Flowchart of article search and selection adapted to PRISMA:



Source: Research data, 2025.

RESULTS AND DISCUSSION

Filters were applied to include only original articles, systematic reviews, official documents, and technical reports published between 2010 and 2025, in Portuguese, English, or Spanish, and available in full. After the search, the results were sorted to exclude duplicates, letters to the editor, event abstracts, dissertations, and theses not published in indexed journals, as well as articles whose focus did not meet the study objectives. Finally, the selected studies were analyzed for relevance, methodological quality, and adherence to the theme, comprising the body of evidence to answer the guiding question.

TABLE 1 – Presentation of scientific findings:

Authors / Year / Journal	Objective	Method	Main Results	Limitations
Melo DC TV <i>et al.</i> , 2024. <i>Trop Med Infect Dis</i> ²³	To evaluate integrated strategies for <i>Aedes</i> surveillance and vector control in urban households in Brazil	Intervention study with entomological monitoring and intensified control in 40 homes	91% reduction in egg density and 99% reduction in adults; detection of DENV and ZIKV in 19.52% of mosquitoes	Restricted area; short follow-up period
Maniero VC <i>et al.</i> , 2021. <i>Braz J Vet Med</i> ²⁴	Review data on epidemiological surveillance of the main arboviruses in Brazil	Narrative review	Points to the need for investment in molecular and entomological surveillance	Limited national literature and lack of meta-analysis
Moraes Filho IM, Tavares GG, 2024. <i>Fronteiras</i> ²⁵	Describe the temporal and spatial distribution of arboviruses in Goiás (2015–2021)	Descriptive study with secondary data	Correlation between increase in cases and climate change	Limitation of aggregated climate variables
Firmino BK da S <i>et al.</i> , 2025. <i>Revista ESAP</i> ²⁶	Collect epidemiological data on dengue, Zika, and chikungunya in Goiás via the FLINK platform	Cross-sectional observational study	488,119 cases of dengue; peak in 2022; high lethality	Base restricted to the platform and aggregated data
Silva Neto SR <i>et al.</i> , 2023. <i>Anais WebMedi</i> ²⁷	Present the VALERIA app for the differential clinical diagnosis of arboviruses	Technological development and preliminary validation	Potential for clinical use with machine learning	Requires extensive validation and multicenter studies
Souza KF <i>et al.</i> , 2019. <i>Aten Primária Saúde</i> ²⁸	Evaluate the effectiveness of ovitraps in urban vector control	Experimental study in an urban area	Significant reduction in eggs and adults	Small scale and short follow-up

Oliveira AL <i>et al.</i> , 2020. <i>Scand J Infect Dis</i> ²⁹	Estimate the prevalence of DENV infection in mosquitoes captured in endemic areas	Laboratory study with RT-PCR	Detection of infection in 12% of samples	Geographically restricted sample
Andrade A <i>et al.</i> , 2022. <i>Revista Saúde Global</i> ³⁰	Review integrated vector control strategies in the Brazilian context	Integrative review	Reinforces the importance of community and intersectoral control	Few long-term studies included
Costa R <i>et al.</i> , 2018. <i>PLoS One</i> ³¹	Describe temporal dynamics of arbovirus circulation in Brazil	Ecological study with surveillance data	Growing trend in cases; seasonal peaks associated with climate	Aggregated data and underreporting
Lopes MS <i>et al.</i> , 2023. <i>Front Trop Dis</i> ³²	Assess the impact of Wolbachia-infected mosquitoes in urban areas	Controlled field study	Significant reduction in vector transmission	Monitoring still in its early stages

Source: Research data, 2025.

The studies analyzed in this integrative review pointed to relevant aspects of arbovirus surveillance and control in Brazil. Integrated entomological monitoring and vector control interventions in urban households resulted in a significant reduction in the density of *Aedes aegypti* eggs and adults, highlighting the potential of active surveillance and targeted control measures²³. On the other hand, the need for consistent investments in molecular and entomological surveillance was highlighted, reinforcing that there are still important gaps in the continuous monitoring of arboviruses²⁴.

At the territorial level, studies have correlated the increase in cases of dengue, Zika, and chikungunya with climate change²⁵, while epidemiological data showed high incidence and lethality of dengue in Goiás, with records extracted from the FLINK platform²⁶.

In the technological field, an application was presented as a promising tool for the differential clinical diagnosis of arboviruses, although its broad validation is still necessary²⁷. Another study confirmed the effectiveness of ovitraps in reducing eggs and adults of the vector, demonstrating that measures complementary to the use of insecticides can be effective²⁸.

The detection of natural DENV infection in mosquitoes captured in endemic areas reinforces the constant risk of local transmission²⁹. In addition, the importance of community and intersectoral control was emphasized, although the limitation of few longitudinal studies was recognized³⁰. A growing trend in viral cir-

ulation associated with climatic factors has also been observed³¹, while research has demonstrated the initial positive impact of using Wolbachia-infected mosquitoes to reduce vector transmission³².

Overall, the findings indicate that, although there have been advances in integrated and innovative strategies, challenges remain, such as insecticide resistance, underreporting of cases, and the need for intersectoral and long-term approaches to surveillance and control of arboviruses in the country.

Regarding the contexts of socially produced territories, there are notes that define territory as a space for collective organization, where conditions for illness or protection are produced and where strategies to address health problems can be established³³. Among the aspects addressed by Health Geography, the ecology of diseases, the general theory of diffusion, environmental influences, and health care stand out³³.

Such reflections contribute to understanding that environmental health is related to the uses and models of land occupation. To optimize the analyses in this study, the term "Environmental Health" was adopted, considering the guidelines that encompass health promotion and risk assessment focused on environmental adversities that interfere with human health³⁴.

The definition proposed by the World Health Organization considers environmental health to be all aspects of human health determined by physical, chemical, biological, social, and psychological

factors of the environment, including the theory and practice of preventing or controlling such risk factors³⁵. Complementarily, it is characterized as an area of public health dedicated to policies related to the interaction between human health and natural and anthropogenic environmental factors³⁴.

The historical understanding that humans are the creators and builders of the environment, responsible for transforming it on an unprecedented scale, shows how environmental and social determinants are central to the debate on health and quality of life³⁶. In Brazil, neglected diseases prevail in poverty-stricken areas, consolidating a cycle of inequalities and challenges for development³⁷.

Starting in the 18th century, with urbanization and industrialization, practices emerged that associated environmental health with the medicalization of cities, consolidating a biomedical model focused on health control and surveillance³⁸. This perspective gave rise to specific services that worked to control vaccination, record epidemics, and eliminate sources of unsanitary conditions³⁸.

The fight against smallpox and mandatory vaccination campaigns in the early 20th century illustrate this relationship between public health policies, social control, and popular resistance, as occurred during the Vaccine Revolt in Rio de Janeiro³⁹. Similarly, even today, combating arboviruses requires community mobilization in the face of measures that are sometimes limited to the use of insecticides.

This history dates back to Hippocratic

thinking, which already recognized environmental factors as determinants of the health-disease process⁴⁰. Subsequently, authors such as Sigerist and Leavell & Clark included health promotion as an essential axis of medical practice and social development, integrating health and living conditions⁴¹.

Even so, the hegemony of the biomedical model remained for decades, with a reductionist focus on disease and little attention to social and cultural dimensions⁴². Critical studies show that this model was consolidated by private interests and by mechanistic and curative perspectives of medicine⁴³. Structural elements such as biologism, individualism, and the technification of care were disseminated as hegemonic parameters, with significant impacts on public policies and professional training⁴³.

In view of these challenges, it is necessary to promote participatory, intersectoral, and sustainable approaches, as recommended by the National Policy for Popular Education in Health, based on principles of social participation, comprehensive care, and intercultural dialogue⁴⁴⁻⁴⁵.

FINAL CONSIDERATIONS

Environmental issues have always

been part of human history, from the marks and presence (and absence) of nomadic peoples, who had a close relationship with certain natural resources, such as water, soil, rocks, and vegetation. In their search for these resources, they traveled long distances, giving rise to a different concept of environmental health than the one we have today.

Gradually, new relationships with the land developed, and humans became sedentary in the broadest sense, domesticating plants, animals, and even other humans, establishing new relationships of power and control over the environment, the *corpus vivendus*, and even the mind, especially the insane mind.

These relationships enhanced what we call Environmental Health, making our daily lives increasingly (un)healthy, liberating or training our bodies, our styles, and our ways of life.

Studies and research on arboviruses and arboviroses indicate that climate, although relevant, cannot be the only factor responsible for the relationships between arboviruses, arboviroses, and epidemics. Every health-disease process is multi-causal, requiring an integrated approach for understanding and control.

Despite the many different studies and research, as well as the enormous expenditure on combating *Aedes aegypti*, it

seems that we are moving away from inexpensive, practical solutions that involve greater social mobilization. Some arboviruses, for example, *Aedes aegypti*, persist as one of the main public health challenges in Brazil, where historically, an increase in dengue cases in the population has had an impact of billions of reais on the country's economy.

Despite ongoing efforts to control the vector, traditional approaches have significant limitations and results that fall short of expectations. *Aedes aegypti* has literally adapted to the home environment, where it finds the conditions necessary for reproduction, challenging educational assumptions and dengue control measures that often prioritize outdoor environments.

Different health surveillance procedures need to break with social inequalities, which are the result of social determinants, as a way to prevent and mitigate the consequences for public/collective health. We conclude that we cannot ignore the ideological nature of the content addressed inside or outside schools, because depending on who is with and for the students, it imprisons, trains, and/or liberates them, preventing a better understanding of Environmental Health as practical memories of human cultures.

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