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ARBOVIRUSES IN BRAZIL: CHALLENGES FOR PUBLIC HEALTH AND THE CRUCIAL ROLE OF BASIC SANITATION

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ABSTRACT

Introduction: Brazil, with its vast territorial extension and high population density, has a significant occurrence of arboviruses, such as dengue, zika and chikungunya. These diseases, which are widely reported in different regions, share similar symptoms, which makes diagnosis and control difficult, negatively impacting the public health system. The main vector of these diseases is the Aedes aegypti mosquito, making its population control a priority in prevention strategies. Objective: This review article aimed to analyze the main arboviruses circulating in Brazil, discuss the factors associated with the increase in their incidence, and highlight the relevance of basic sanitation as a prevention tool. Methodology: For the preparation of this work, an integrative literature review was carried out in scientific databases, including articles published between 2000 and 2023. Studies that address the epidemiology, vectors, risk factors, impact on public health, and control measures of arboviruses in Brazil were selected. Data on public policies for basic sanitation and their relationship with the incidence of these diseases were also analyzed. Results and Discussion: The analysis revealed that the high incidence of arboviruses is associated with factors such as inadequate sanitation conditions, water storage practices in areas with limited access to regular supply, and climate change. Studies indicate that regions with lower basic sanitation coverage have a higher prevalence of mosquito vector foci. The review also highlighted the importance of integrated control measures, such as environmental management, the use of biological and chemical technologies, and public

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Revista ARACÊ
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awareness, as strategies to reduce the proliferation of Aedes aegypti and the number of cases. Conclusion: The fight against arboviruses in Brazil requires investments in basic sanitation infrastructure, targeted public policies and educational actions that encourage the elimination of mosquito breeding grounds. The implementation of integrated strategies can minimize the impact of these diseases on public health and improve the quality of life of the population.

Keywords: Arboviruses. Sanitation. Public health.

Revista ARACÊ
ISSN: 2358-2472

INTRODUCTION

Arboviruses (Arthropod-Borne Viruses) pose a risk in several regions of the world. This group encompasses several viruses transmitted mainly by hematophagous mosquitoes, especially vectors of the genus *Aedes*, which have the greatest impact on human health (Weaver; Reisen, 2010; Vasconcelos, 2010).

These vectors are often associated with the transmission of arboviruses, where the high proliferation rate may be associated with basic sanitation issues and the absence of more efficient public policies, in addition to other factors, which together contribute to the high number of cases in Brazil (Queiroz *et al*., 2020).

In this context, the arboviruses that present the greatest risks of epidemic in Brazil today are Dengue, Chikunguya and Zika, although there are other arboviruses in different Brazilian regions (Lopes *et al*., 2015). These symptoms are similar, making treatment difficult, and are at greater risk for pregnant women, the elderly, and children (Ebel *et al*., 2004). These viruses have caused several damages to the health of thousands of Brazilians, congesting public health systems, which has shown the need for efficient control and prevention measures, since they are widely distributed in the country (Weaver *et al*., 2016; Rodriguez-Morales *et al*., 2016).

Several factors influence the increase in cases of arboviruses, including the modification of ecosystems by humans, in addition to the phenomenon of rural exodus, the increase in international trade and climate change in recent years (McMichael *et al*., 2008). The need to seek better living conditions, leisure, health issues and refuge causes population movements to increase the risks of spreading pathogens to exempt regions, causing the emergence and reemergence of diseases (Aagaard-Hansen *et al*., 2010).

The symptoms caused by arboviruses range from mild fever to neurological complications and hemorrhages, which happens more frequently in times of disease outbreaks, impacting morbidity and mortality with the increase in the number of people affected, affecting health systems (Donalisio *et al*., 2017).

Dengue is caused by a virus of the Flaviviridae family and occurs predominantly in tropical regions such as Brazil. With four distinct serotypes (DENV-1 to DENV-4), it can cause from mild to severe forms, such as hemorrhagic dengue and shock syndrome. Symptoms include high fever, headaches, muscle and joint pain, nausea, vomiting and skin spots, which can progress to serious complications.

Revista ARACÊ
ISSN: 2358-2472

Similarly, the virus that causes Chikungunya fever belongs to the Togaviridae family and the Alphavirus genus, being initially described in East Africa, it causes symptoms such as high fever, headache, nausea, vomiting, as well as joint pain (Kucharz *et al*., 2012). *Aedes aegypti* and *Aedes albopictus are reported as vectors of the virus in Brazil* , which makes the latter a disease of great concern in the Brazilian territory (Vega-Rúa *et al.,* 2014).

The virus that causes Zika, on the other hand, belongs to the Flaviviridae family and the genus *Flavivirus*, being initially reported in Uganda, being isolated from the rhesus monkey, while in humans the first report happened in Nigeria (Hayes, 2012). The first cases in Brazil date back to 2015, where the infection is through the bite of infected females of the genus *Aedes*, with *Ae. aegypti being* the main vector in the country (Campos *et al*., 2015). Characteristic symptoms are fever, joint pain, myalgia, headaches, conjunctivitis, and red spots on the body (Duffy *et al*., 2009).

Of lesser occurrence in Brazil, the virus that causes West Nile Fever is part of the Flaviviridae family and the genus *Flavivirus*, being initially reported in Uganda, Africa, and spreading to other continents (Pauvolid-Corrêa *et al*., 2011). The characteristic symptoms are fever, headaches, nausea and vomiting, however, most infected people are asymptomatic. In severe cases (less than 1%), the occurrence of meningitis and encephalitis can still occur, with the possibility of progressing to death (Murray *et al*., 2010; Sejvar *et al*., 2014). The virus has equine hosts and humans, in Brazil the first report in humans occurred in 2014, in Piauí (Ometto *et al*., 2013).

The *Aedes Aegypti vector* is associated with the transmission of several arboviruses and is widely distributed in Brazil, being interconnected to the urban environment and to human beings, which makes contact between them conducive and frequently occurring, increasing the chances of epidemics (Pancetti *et al*., 2015). *Aedes albopictus, on the other hand,* is disseminated in the country in almost all national territory (Pancetti *et al*., 2015), being found in rural and suburban environments.

The control of these arboviruses is related to the reduction of the population of mosquito vectors, which is difficult throughout the country, as it requires the collaboration of the entire population, which often does not have access to information and/or living conditions without basic sanitation structures, which facilitates the proliferation of mosquitoes (Dupont-Rouzeyrol *et al*., 2014). In addition, the unbridled increase in cities, pollution of rivers and the opening of ditches contribute to the formation of artificial

Revista ARACÊ
ISSN: 2358-2472

oviposition sites, causing the proliferation and dissemination of vectors (Meason *et al*., 2014). Therefore, the objective of this article is to analyze the main arboviruses in circulation in Brazil, discuss the factors associated with the increase in their incidence, and highlight the relevance of basic sanitation as a prevention tool.

METHODOLOGY

The present study is a systematic review carried out with the objective of addressing the main arboviruses of occurrence in Brazil and the impacts on public health.

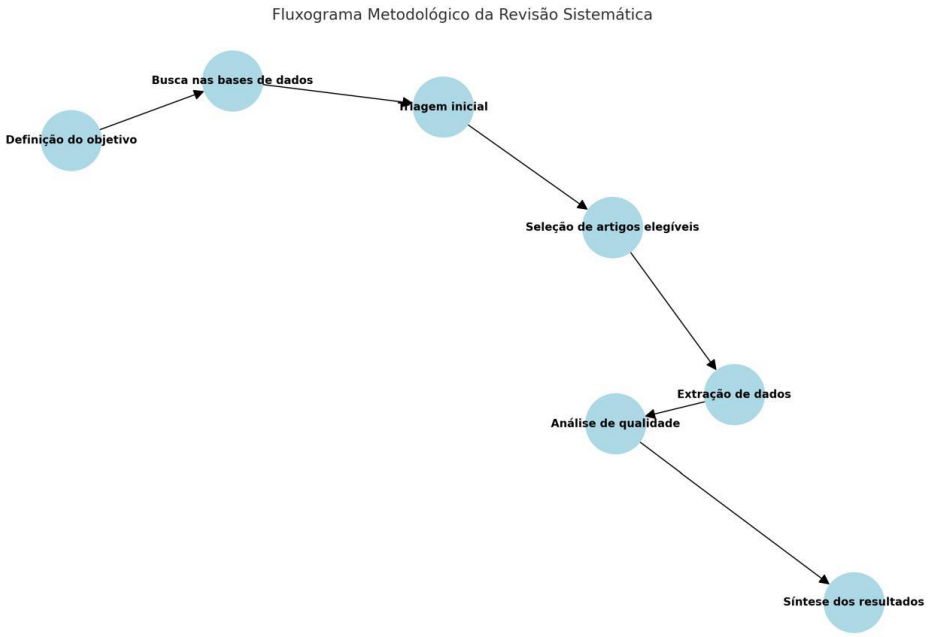
For the preparation of this systematic review, articles published between 2000 and 2023, in English, Portuguese, and Spanish, which addressed relevant arboviruses in Brazil, such as Dengue, Zika, and Chikungunya, as well as aspects related to vector control and basic sanitation, were included. Studies with populations outside Brazil, publications without peer review, and studies whose theme did not meet the objectives of the study were excluded.

The search was carried out in the PubMed, SciELO, Web of Science and LILACS databases, using combinations of keywords such as "arboviruses" "vector control", "basic sanitation" and "public health in Brazil". Two independent reviewers performed the initial screening based on titles and abstracts. Eligible articles were selected for full reading and detailed analysis. Disagreements were resolved by a third reviewer.

The extracted data included: title, authors, year of publication, purpose of the study, methodology, main findings, and implications for public health. The results were synthesized in a narrative way, highlighting the risk factors, control strategies and the relationship with the sanitary infrastructure. As this is a literature review, this study did not require ethical approval, as it did not involve primary data collection with humans or animals.

Revista ARACÊ
ISSN: 2358-2472

Figure 1 - Flowchart of the process of identification, selection, eligibility and inclusion of published scientific articles



RESULTS AND DISCUSSION

The initial survey resulted in 150 publications. After reading the titles and abstracts, 60 documents were selected for complete reading. Of these, 30 met the established criteria and were included in the review. The information was grouped into thematic categories: main arboviruses, vectors and risk factors, basic sanitation, and control and prevention measures. The collected data were analyzed qualitatively, with the objective of identifying the challenges and effective strategies in the management of arboviruses in Brazil, as well as highlighting the importance of public policies and intersectoral actions to reduce their incidence and impact on public health. The 30 articles found are shown in Table 1, informing Authors, study title, theme, and year of publication.

Table 1 — Articles selected for review

Authors	Article Title	Year	Thematic Category
Aagaard-Hansen J, Nombela N, Alvar J	Population movement: a key factor in the epidemiology of neglected tropical diseases	2010	Emerging arboviruses and epidemiology
Aleixo B, Pena JL, Heller L, Rezende S	Infrastructure is a necessary but insufficient condition to eliminate inequalities in access to water	2019	Basic sanitation and control and prevention measures
Brazil. Ministry of Health (MS), National Health Foundation (FUNASA)	Dengue instructions for vector control personnel: manual of technical standards	2001	Vector control and prevention

Revista ARACÊ
ISSN: 2358-2472

Brazil. Ministry of Health (MS)	National Guidelines for the Prevention and Control of Dengue Epidemics (DNPCED)	2009	Dengue control and prevention measures
GS fields, AC flag, Sardi SI	Zika Virus outbreak, Bahia, Brazil	2015	Emerging arboviruses in Brazil
Donalisio MR, Freitas ARR, Zuben APBV	Emerging arboviruses in Brazil: challenges for the clinic and implications for public health	2017	Emerging arboviruses and public health
Duffy MR, Chen TH, Hancock WT, et al.	Zika virus outbreak on Yap Island, Federated States of Micronesia	2009	Zika virus and emerging arboviruses
Dupont-Rouzeyrol M, et al.	Co-infection with Zika and Dengue viruses in 2 patients, New Caledonia, 2014	2015	Zika and Dengue Co-infection
Ebel GD, Carricaburu J, et al.	Genetic and phenotypic variation of West Nile virus in New York, 2000-2003	2004	West Nile virus and epidemiology
Hayes EB	Zika virus	2009	Zika virus and its global impact
Cook EJ, Cebula-Byrska I	Chikungunya fever	2012	Chikungunya and clinical aspects
Lopes N, Nozawa C, Linhares REC	General characteristics and epidemiology of emerging arboviruses in Brazil	2014	Emerging arboviruses in Brazil
McMichael AJ, Woodruff RE	Climate change and infectious diseases	2008	Climate change and infectious diseases
Meason B, Paterson R	Chikungunya, climate change, and human rights	2014	Chikungunya and climate change
Mol MPG, Queiroz JTM, Gomes J, Heller L	Adequate management of solid waste as a protective factor in the occurrence of dengue	2020	Sanitation and dengue control
Murray KO, Mertens E, Desprès P	West Nile virus and its emergence in the United States of America	2010	West Nile virus and its emergence
Olliaro P, et al.	Improved tools and strategies for the prevention and control of arboviral diseases: A research-to-policy fórum	2018	Arbovirus control strategies
Oliveira RM, Valla VV	Living conditions and life experiences of working-class groups in Rio de Janeiro: rethinking dengue control	2001	Dengue control and popular mobilization
Ometto T, Durigon EL, Araújo J, et al.	West Nile virus surveillance, Brazil, 2008-2010	2013	Arbovirus surveillance in Brazil
Pancetti FGM, Honório NA, Urbinatti PR, et al.	Twenty-eight years of Aedes albopictus in Brazil: a rationale to maintain active entomological and epidemiological surveillance	2015	Surveillance and control of the Aedes albopictus vector
Pauvolid-Corrêa A, et al.	Neutralising antibodies for West Nile virus in horses from Brazilian Pantanal	2011	Neutralizing antibodies to West Nile virus
Queiroz JTM, Silva PN, Heller L	New assumptions for sanitation in the control of arboviruses in Brazil	2020	Sanitation and control of arboviruses
Rivera AH, Rodriguez AP	Update on epidemiological and clinical aspects of Dengue	2010	Epidemiology and Dengue Clinic
Rodriguez-Morales AJ, Villamil-Gomez WE, Franco-Paredes C	The arboviral burden of disease caused by co-circulation and co-infection of dengue, chikungunya and Zika in the Americas	2016	Arbovirus co-infection in America

Revista ARACÊ
ISSN: 2358-2472

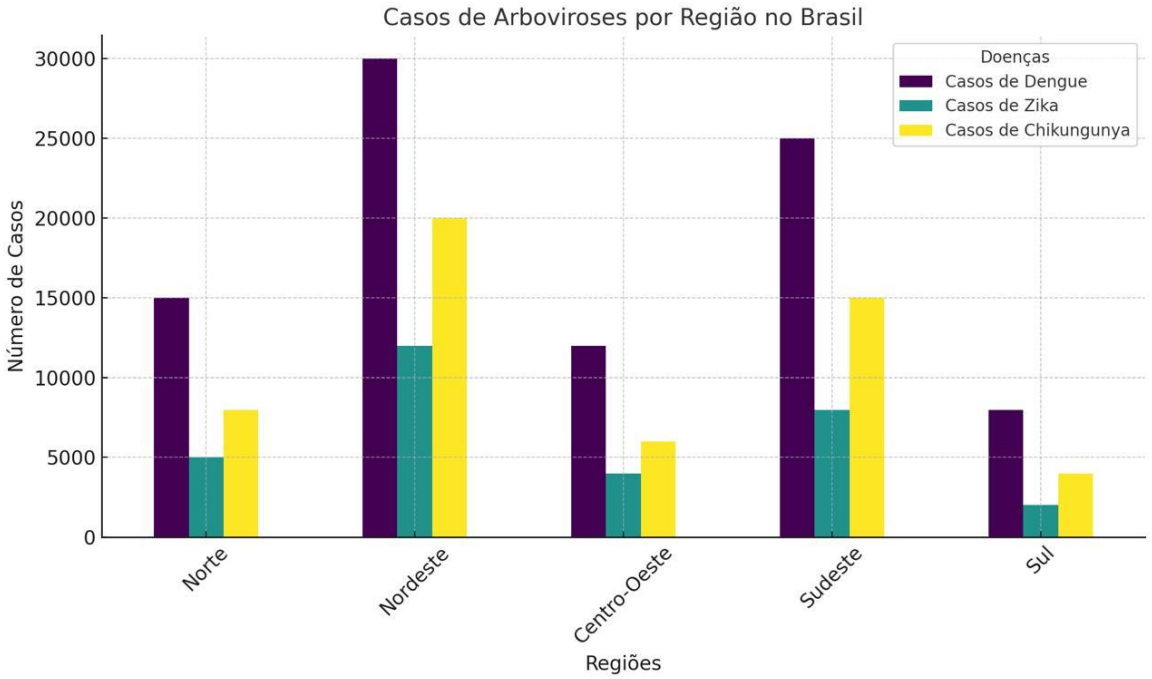
Sejvar JJ	Clinical manifestations and outcomes of West Nile virus infection	2014	Clinical aspects of West Nile virus
Valley D	No magic bullet: citizenship and social participation in the control of Aedes aegypti	2016	Social participation in the control of Aedes aegypti
Vasconcelos PFC	Yellow fever in Brazil: thoughts and hypotheses on the emergence in previously free áreas	2010	Yellow fever and its emergence in Brazil
Vega-Rúa A, Zouache K, Girod R, et al.	High vector competence of Aedes aegypti and Aedes albopictus from ten American countries as a crucial factor of the spread of Chikungunya	2014	Vector Competence and Chikungunya Spread
Vilcarromero S, Casanova W, et al.	Lessons learned in the control of Aedes Aegypti to face dengue and the emergence of Chikungunya in Iquitos, Peru	2015	Control of Aedes aegypti and arboviruses in Peru

Source: Authors

Thus, the three major axes that became the themes of this analysis and discussion were relevant arboviruses in Brazil, such as dengue, zika and chikungunya, as well as aspects related to vector control and basic sanitation. Brazil, with its vast territorial extension and high population density, has a significant occurrence of arboviruses, such as dengue, zika and chikungunya. These diseases, which are widely reported in different regions, share similar symptoms, which makes diagnosis and control difficult, negatively impacting the public health system. Based on the analysis of the figure presented, it is possible to observe that dengue is the most prevalent arbovirus in all regions of Brazil, followed by chikungunya and, to a lesser extent, zika. The Northeast and Southeast regions stand out with the highest numbers of arbovirus cases, while the South region has the lowest rates. The relationship between the high prevalence of these diseases and factors such as inadequate basic sanitation conditions and water storage practices is evident. Regions with lower sanitation coverage are more vulnerable to the formation of mosquito vector foci, which reinforces the need for integrated and specific preventive actions for each region.

Revista ARACÊ
ISSN: 2358-2472

Figure 2 – Distribution of the main arboviruses by region of Brazil.

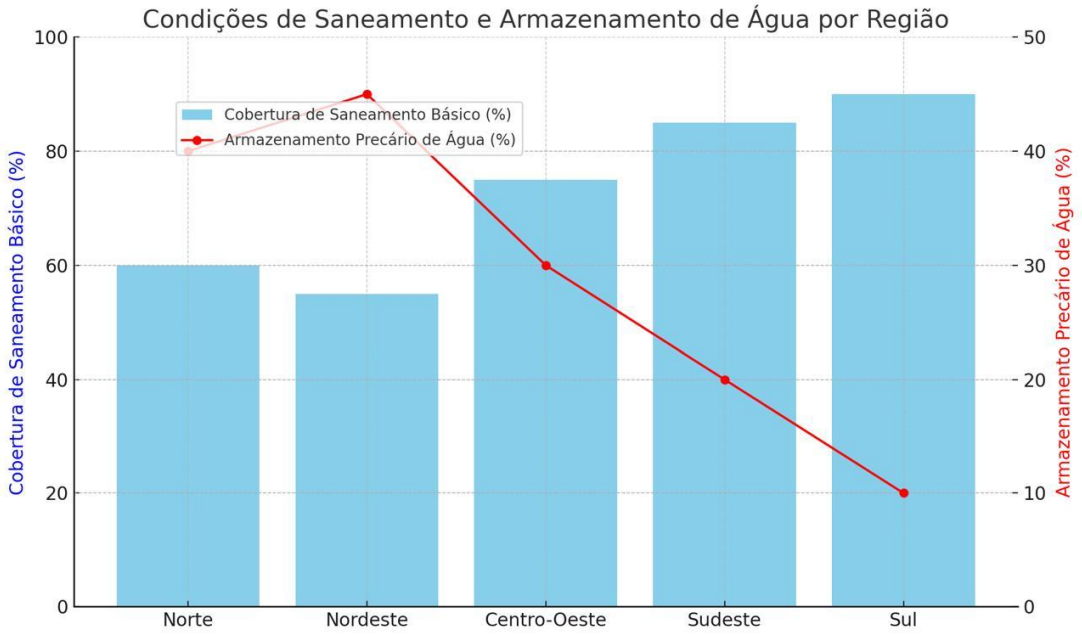


Source: Authors

The articles, in general, also point out that social vulnerability favors the increase in mosquito foci and consequently the occurrence of dengue and other arboviruses. Researchers have demonstrated the importance of the association between arboviruses and the population's access to basic sanitation, where the scarcity of these is linked to the incidence and prevalence of these diseases. (Oliveira *et al*., 2001; Vilcarromero *et al*., 2015). However, it is necessary to emphasize that health variables alone do not justify the heterogeneity of diseases, since it is a set of factors that explain the occurrence of arboviruses (Aleixo *et al*., 2019). The graph below shows the relationship between basic sanitation coverage (blue bars) and precarious water storage (red line) in the regions of Brazil. It is observed that regions with lower sanitation coverage, such as the North and Northeast, have a higher percentage of inadequate water storage practices. These factors contribute to the formation of breeding sites for the mosquito vector of arboviruses, such as dengue, zika and chikungunya, justifying the high rates of these diseases in these areas.

Revista ARACÊ
ISSN: 2358-2472

Figure 3 – Sanitation and water storage conditions by region of Brazil.



Source: Authors

It is of paramount importance to survey the residential areas, and what are the conditions of these places, in order to locate the incidence of mosquito foci, and thus develop control and prevention measures according to the reality and conditions of the place, because in these situations sanitation can be crucial for the incidence and predominance of arboviruses, which is often not taken into account as a strategy in combating the outbreak of cases (Queiroz *et al*., 2020).

Even with the increase in the water supply index in Brazil, the National Water Agency has presented a coverage rate above 90% in recent years, where regions with lower family incomes have a greater lack of supply, which often leads to alternative water storage measures, measures that can contribute to the formation of mosquito foci (ANA, 2019).

Public health has a fundamental role, because to control and monitor the vectors, the Endemic Control Agents (ACE) and Community Health Agents (ACS) are designated, who follow rules and recommendations in order to combat the mosquito (Funasa, 2001; DNPCED, 2009).

The main control measure should be around Aedes *aegypti*, since it is the main vector of dengue, zika and chikungunya (Olliaro *et al*., 2018), and in the case of diseases linked to basic sanitation issues, control should be related to water management, in addition to other measures aimed at affecting the mosquito focus (Valle, 2016).

Revista ARACÊ
ISSN: 2358-2472

A series of joint measures are necessary for an efficient control of mosquito vectors, for which equipment and inputs are used, as well as well-defined and efficiently executed action plans, such as through education and urban cleaning (DNPCED, 2009). The set of measures consists of an integrated management, such as the application of other forms of control in addition to those related to sanitation, such as chemical control (Funasa, 2001; DNPCED, 2009), with the use of insecticides, which require the use of trained labor and the use of equipment such as motorized backpacks and nebulizers to be applied. Another measure that has been used is biological control, which seeks to reduce damage to the environment (Funasa, 2001), and is reported as the biological control agent *Bacillus thuringiensis israelis* (DNPCED, 2009).

Among the control measures, a promising option is to know the housing territories in depth, and, in addition, the cultural and social practices in order to know the best approach to be applied, since recurrently the policies of the sanitation sector do not usually consider the health situations of the localities and the connection with intervention and control measures that can be applied (Queiroz *et al*., 2020).

In places where the population stores water, mainly in containers such as buckets and drums, the risk of dengue is higher (Rivera, Rodríguez, 2010), since clean and stagnant water is favorable to the multiplication of the vector mosquito. Another risk factor for the occurrence of arboviruses is the accumulation of solid waste, which is linked to the increase in dengue cases (Mol *et al*., 2020).

CONCLUSION

Arboviruses affect the population and cause negative impacts on public health, due to different etiological agents, similarity of symptoms and difficulties in controlling insect vectors, which leads to the need to develop and adopt control and prevention measures, from raising awareness of the population about its role in control, to increasing inspection, especially in places more prone to the occurrence of outbreaks of the disease, and even greater investments in basic sanitation in the country.

Revista ARACÊ
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