REVIEW
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One Health approach and dengue

Abordagem *One Health* (saúde única) e a dengue

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ABSTRACT

Introduction: Dengue has evolved from a sporadic disease to a major public health problem, becoming one of the most widespread mosquito-borne re-emerging diseases worldwide. In this context, the ideals of a system that integrates human health with nature are rescued through the One Health approach, which is a global strategy that highlights the need for a holistic and transdisciplinary approach and incorporates multisectoral expertise to deal with human, animal and ecosystem health. **Objective:** To describe the proposals based on the One Health concept for coping with dengue globally. **Method:** Literature review based on the PRISMA model, using PubMed and Google Scholar databases. **Results:** Most publications report the importance of the participation of authorities, health professionals and the community in the design and implementation of vector prevention and control measures. Other approaches were also found, such as the importance of: collecting epidemiological data for the detection of virus circulation; creating risk maps based on epidemiological data; designing vector control maps based on environmental variables; and using biocontrol tools and pesticides in the fight against arbovirus vectors. **Conclusions:** Integrating all knowledge and actions to mitigate the advance of dengue is the safest and most effective option. They are sustainable options that depend for the most part on the efforts of the population. In relation to the current scientific scenario, it is possible to observe the growth of the search for sustainable sources of vector control.

KEYWORDS: Dengue; One Health; Arboviruses

RESUMO

Introdução: A dengue evoluiu de uma doença esporádica a um grande problema de saúde pública, tornando-se uma das doenças reemergentes transmitidas por mosquitos mais difundidas em todo o mundo. Neste contexto, os ideais de um sistema que integra a saúde humana à natureza são resgatados por meio da *One Health*, que é uma estratégia global que destaca a necessidade de uma abordagem holística e transdisciplinar e incorpora a *expertise* multissetorial para lidar com a saúde humana, animal e dos ecossistemas. **Objetivo:** Descrever as propostas baseadas no conceito *One Health* para o enfrentamento da dengue no âmbito global. **Método:** Revisão da literatura baseada no modelo PRISMA, utilizando as bases de dados PubMed e *Google Scholar*, no período de cinco anos. **Resultados:** A maioria das publicações relataram a importância da participação das autoridades, dos profissionais de saúde e da comunidade na formulação e no cumprimento das medidas de prevenção e controle dos vetores. Outras abordagens também foram encontradas como: a importância do levantamento de dados epidemiológicos para a detecção da circulação do vírus, a criação de mapas de risco baseados em dados epidemiológicos, a criação de mapas de controle de vetores baseados em variáveis ambientais e o uso de ferramentas de biocontrole e pesticidas no combate aos vetores de arboviroses. **Conclusões:** Integrar todos os conhecimentos e as ações para mitigar o avanço da dengue é a opção mais segura e eficaz, e é um caminho sustentável e que depende, em sua maior parte, dos esforços da população. Em relação ao cenário científico atual, é possível observar o crescimento das buscas por fontes sustentáveis de controle de vetores.

PALAVRAS-CHAVE: Dengue; *One Health*; Arboviroses

INTRODUCTION

Dengue is an arboviral disease caused by viruses from the Flaviviridae family, with four viral serotypes called DENV-1, DENV-2, DENV-3, and DENV-4. It is transmitted by female *Aedes aegypti* mosquitoes and, to a lesser extent, by the *Aedes albopictus* species, which, by ingesting blood multiple times during a single gonadotrophic cycle, increase their capacity to become infected and transmit the viruses. Dengue has evolved from a sporadic disease to a major public health problem with substantial social and economic effects due to the increase in geographical extension, number of cases and severity of the disease, making it one of the most widespread re-emerging mosquito-borne diseases in the world[1,2,3]. Dengue has seen a 30-fold increase in its incidence in recent decades and is currently endemic in 128 countries, mainly in underdeveloped countries, posing a risk to approximately 3.97 billion people annually.[4]

An epidemiological analysis published in 2021 showed that, in the period between 2014 and 2019, 5,867,255 cases of dengue were reported in Brazil, with 2015 being the year in which most notifications were recorded. The highest incidence per 100,000 inhabitants occurred in the Central-West Region and the majority of cases occurred in the Southeast Region[5].

In recent years, the health system has been confronted with new issues that directly affect the evolution of diseases and the emergence of epidemics. Climate change, population growth, rapid urbanization, ecosystem invasion, globalized trade, and traffic accompany the main health problems. In this context, researchers have begun to revive the ideals of a system that integrates human health with nature[6].

Certain zoonoses, such as avian flu and the viral epidemics of Ebola and Zika, and more recently COVID-19, have illustrated to the world the interdependence of human, animal, and ecosystem health. Building on the One Medicine concept, which advocates a combination of human and veterinary medicine in response to zoonoses, the One World, One Health concept was created in 2004, also incorporating ecosystem health, including wildlife[7,8].

Considering the growing interdependence between humans, domestic, and wild animals mainly due to food derived from animal products and human-animal interactions, medical services and veterinary professionals have been directed to work together in a collaborative effort to promote well-being and health. As a result, this approach encouraged studies so that sustainable partnerships between groups from different regions and continents could be realized to achieve health for people, plants, animals, and the environment[9].

The One Health approach therefore constitutes a global strategy and a scientific and multidisciplinary approach to the health and well-being of humans and animals in a balanced environment, showing that everything is intrinsically connected. It highlights the need for a holistic approach that incorporates expertise from veterinarians, doctors, public health professionals, educators, anthropologists, environmentalists, and many other professions interconnected with communities to address human, animal, and ecosystem health[7,9].

Environmental interventions based on the One Health approach have been used to mitigate the risks of vector-borne diseases, where better living conditions, piped drinking water, waste management, and extinction of standing water sources can reduce the incidence of dengue. Risk factors must be addressed through intersectoral collaboration to implement biological controls and warning systems to detect changes in vector numbers[10].

In view of this, the aim of this study was to describe the proposals based on the One Health concept for tackling dengue at a global level.

METHOD

This study is a literature review based on the Preferred Reporting Items for Systematic Reviews and Meta-analysis (PRISMA) model[11]. The PubMed and Google Scholar databases were used to collect the publications, using the descriptors One Health, dengue, and arboviruses. The research was carried out over a five-year period (2017-2022). This study included original articles, opinion pieces, editorials, letters to the editors, and reviews that addressed One Health as a health surveillance strategy in the context of dengue. Duplicate articles that were not related to the research topic and publications in languages other than English and Portuguese were excluded from the study (Figure).

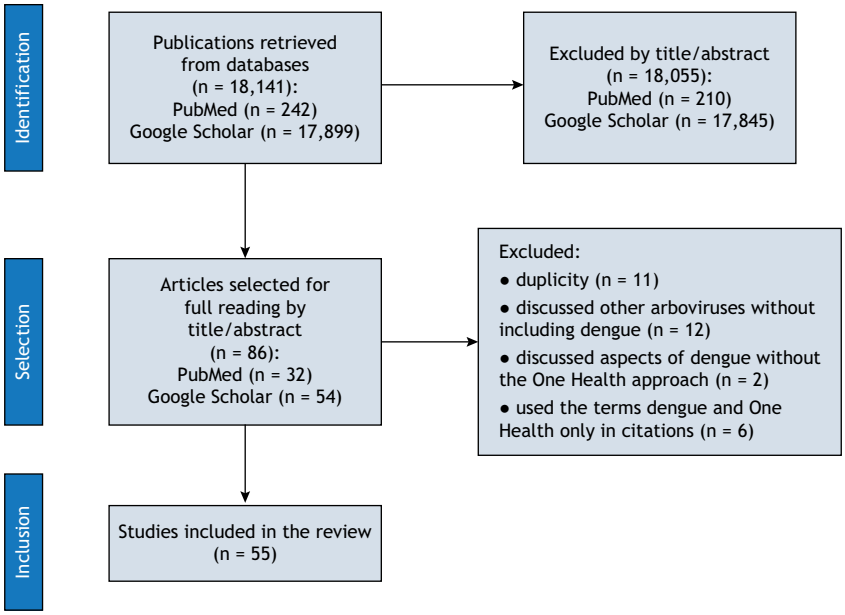
RESULTS AND DISCUSSION

The articles eligible for research are characterized in terms of the type of study, year of publication, country of origin of the data, and One Health actions (Table).

Most of the publications brought as the One Health proposition for dengue the importance of entomological surveillance for predicting risk areas and the participation of authorities, health professionals, and the community in formulating and complying with vector prevention and control measures[13,15,16,25,28,35,42,43,44,45,46,51,53,55,56,58,59,60,64,65].

The importance of collecting epidemiological data to detect the circulation of the virus, creating risk maps based on epidemiological data, creating vector control maps based on environmental variables, using biocontrol tools and pesticides to combat arbovirus vectors, conserving natural areas and fauna, and the possible role of non-human reservoirs in endemic diseases were also proposed[12,13,17,18,19,20,21,24,23,24,25,26,29,30,32,33,36,37,39,41,47,48,50,54,56,62,66].

Dengue is listed in the World Health Organization (WHO) report as a neglected tropical disease, and is the most frequently found



Source: Prepared by the authors (2022).

Figure. Flowchart of selection and inclusion of articles in the research based on the PRISMA method.

arbovirus worldwide. Understanding the complex interaction between the disease, its vector, and the environment is crucial in the development of assessment strategies and risk mitigation. For a complete approach, it is also necessary to build strong intersectoral collaboration and integrate surveillance mechanisms to improve early warning of the transmissibility of the virus[67,68].

The first step towards building a holistic approach is getting to know the challenges of the community in which one lives. Identifying the limitations through the knowledge of community professionals, promoting training courses for health workers to help them understand the risks of transmission and epidemiology, as well as incorporating educational materials in schools with an integrated approach are some of the One Health actions that can be promoted in a simple way in the context of dengue[15,46].

Understanding and estimating how environmental variables such as humidity, rainfall, temperature, and soil cover influence vector reproduction, infection rates, and transmission through risk mapping based on remote sensing - which is a technology that combines sensors that produce spectral characterization *in situ* and sensors that produce the well-known satellite images, from which information can be extracted from the earth's surface that allows for a rapid search for areas most suitable for the spawning of the transmitting mosquito - can help in the early detection of virus circulation. This generates more robust data collection reports or surveillance indicators for the implementation of an integrated early warning system, in order to inform local authorities about the establishment of preventive measures and vector control for the protection of human health[33,53,62].

It can be seen that the increase in temperature and humidity directly influences the reproduction of vectors. Therefore, in a context of climate change on the globe, it is possible to suggest that the increase in the incidence of dengue, both in countries that previously did not suffer from the disease and in those that already did, may be related, in addition to travel patterns, to climate change[21,24,29,50,52,56,66].

The use of technology to obtain images of vectors and the environment, using drones and satellites to create databases that integrate meteorological factors, notification of dengue cases, and circulating virus serotypes, is a strong ally in the construction of early warning systems, which may be able to prepare the health system, as well as predict cases that will require hospitalization[13,20,26,39,46,50,62] .

The technology used to publicize risk areas, in addition to integrating the population into vector elimination efforts, also has the power to provide knowledge and act by changing the perception of risk. Human patterns can slow down or speed up the spread of the disease, so bringing society together is a powerful control tool[37,43,45,52,55].

In addition, another One Health approach is based on reducing the susceptibility of humans to mosquito-borne viral diseases. This can be achieved through the use of repellents and mosquito nets, as well as new biocontrol tools, such as the use of entomopathogens. Sugar toxic to mosquitoes has also been explored, as well as secondary metabolites for the preparation of pesticides such as the essential oils of the species *Xylopia aromatica* with larvicidal action, *Campomanesia adamantium* and *Blepharocalyx salicifolius* with adulticidal action, and *Eugenia dysenterica* which acts as a repellent, as well as the use of copepods and larvivorous fish and genetically modified mosquitoes for the control of mosquito vectors of arboviruses[12,19,26,31,48,56,69].

Table. Descriptive characteristics of dengue studies included with One Health proposals.

Type of study	Year of publication	Country of origin of data	One Health actions	Reference
Review	2017	Not applicable	Use of botanical pesticides, green synthesis of nanoparticles with larvicidal, ovicidal, and insecticidal properties to control mosquitoes that vector arboviruses.	Benelli et al.12
Original article	2017	Puerto Rico	Design of surveillance systems for real-time estimation of cases, epidemiology of each region, and identification of circulating dengue virus serotypes.	Scarpino et al.13
Original article	2017	Cuba	Control dengue through spraying and insecticide-treated mosquito nets.	Toledo et al.14
Original article	2017	Dominican Republic	Reformulation of national policies that aim for active community participation in the management, prevention, and control of the disease.	Veras-Estévez et al.15
Review	2018	Not applicable	Multisectoral collaborative efforts such as surveillance, early warning (risk assessment, modeling, etc.), among others, to control arbovirus infections, analysis of the national situation to describe local situations, and available resources, guidance on prioritization and support to the operationalization of One Health.	Dente et al.16
Review	2018	Not applicable	Arbovirus treatments involving the development of vaccines. New technologies for *Aedes* mosquito control (self-dissemination, *Wolbachia*, sterile insect techniques and the release of insects carrying a dominant lethal gene - RIDL).	Suman et al.17
Review	2019	Not applicable	Alternative strategies for controlling arbovirus vectors with entomopathogenic fungi, pyriproxyfen, self-dissemination, spatial repellents, traps, attractive targeted sugar bait products, insecticide-treated materials, insect sterilization technique, release of insects with dominant lethality, *Wolbachia*, and genetic units.	Achee et al.18
Editorial	2019	Not applicable	Reducing the excessive use of synthetic pesticides with the development of new biocontrol tools, such as entomopathogens and the exploitation of botanical secondary metabolites for pesticide preparation. Research and programs related to integrated surveillance of arbovirus diseases.	Benelli et al.19
Original article	2019	Mexico and Colombia	Creation of an early warning and response system for arboviruses through the Special Program for Research and Training in Tropical Diseases (TDR-WHO) tool.	Cardenas et al.20
Original article	2019	Brazil	Mathematical model demonstrating the role of environmental seasonality in the incidence of dengue.	Duarte et al.21
Review	2019	Not applicable	Comparison between conventional diagnostic methods and new biosensors and their clinical applications in dengue.	Eivazzadeh-Keihan et al.22
Review	2019	Not applicable	Analysis of the arbovirus-vector-host interaction as a predictor to assist in understanding the transmissibility and pathogenicity of arboviral diseases.	Huang et al.23
Original article	2019	Paquistan	Geospatial control model for predicting the presence or absence of mosquito breeding sites and its association with meteorological indices.	Imran et al.24
Original article	2019	Asia, Africa, Australia, America (including Brazil)	Mathematical model in outlining the possible distribution of *Aedes* in space-time based on the life cycle and its dependence on climate.	Liu-Helmersson et al.25
Original article	2019	Brazil	Use of convolutional neural networks with image recognition to identify adult *Aedes* mosquitoes.	Motta et al.26
Original article	2019	Malaysia	Use of Wolbachia bacteria as a biocontrol strategy for the dengue virus in the *Aedes* mosquito.	Nazni et al.27
Original article	2019	Brazil	Entomological surveillance on *Aedes* mosquitoes in an endemic urban area.	Reis et al.28
Review	2019	Not applicable	Mathematical model of the influence of climatic factors on the reproduction of *Aedes* mosquitoes, on the transmissibility and infection by the dengue virus.	Rocklöv et al.29
Original article	2019	Ecuador	Seasonal pattern of dengue based on disease diagnoses and the impact of climate on vector reproduction.	Sippy et al.30
Original article	2019	Mali	Use of toxic sugars for *Aedes* mosquitoes as a vector biocontrol strategy.	Sissoko et al.31
Review	2020	Not applicable	Use of *Wolbachia* bacteria as a biocontrol strategy for the dengue da virus in the Aedes mosquito.	Alkuriji et al.32

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Continuation

Type of study	Year of publication	Country of origin of data	One Health actions	Reference
Review	2020	22 non-European Union countries from the Mediterranean, Black Sea, and Sahel regions	Strengthening the collection of surveillance data (indicators) and filling gaps for the implementation of an integrated early warning system for arbovirus infections.	Amato et al.[33]
Original article	2020	Colombia	Establishment of the susceptibility profile of *A. aegypti* to insecticides.	Cantillo-Barraza et al.[34]
Opinion article	2020	Europe	Entomovigilance programs to predict risk areas.	Caputo et al.[35]
Original article	2020	Brazil	Spatio-temporal dynamics and definition of risk areas based on dengue case notification.	Carmo et al.[36]
Original article	2020	Mexico	Influence of socio-environmental determinants on the population's knowledge and practices in preventing arboviruses.	Causa et al.[37]
Systematic review	2020	Africa	Adoption of appropriate action plans to increase population awareness through interdisciplinary efforts, and adequate education based on One Health concepts.	Chauhan et al.[38]
Original article	2020	Ecuador	Machine learning to predict the need for hospitalization in individuals with suspected arboviral infection.	Sippy et al.[39]
Original article	2020	Indonesia	Cost-effectiveness analysis of the dengue vaccination program, associated with the entomopathogen *Wolbachia*, and health education programs.	Suwantika et al.[40]
Original article	2021	Colombia	Use of surveillance data from collaborating health units to predict arbovirus cases through mathematical models.	Carabali et al.[41]
Original article	2021	Colombia	Analysis of arboviruses circulating in Aedes mosquitoes present in community homes.	Carrasquilla et al.[42]
Review	2021	Colombia, United States, Brazil, Guatemala, Peru, Mexico, El Salvador, Honduras, Dominican Republic, Guatemala, Nepal, Singapore, Sri Lanka, India, China, Malaysia, Pakistan, Kenya, Madagascar, Fiji, and Spain	Digital tools (cell phones) for intervention in the control and prevention of arboviruses.	Carrillo et al.[43]
Review	2021	English-speaking Caribbean	Assistance from local authorities and a multisectoral and integrative approach that promote practical applications for monitoring and sustained control of diseases caused by neglected insect vectors.	Francis et al.[44]
Original article	2021	Nicaragua	Use of the “Dengue chat” platform to increase the community’s contribution to measures to reduce *Aedes* rates.	Holston et al.[45]
Original article	2021	Brazil	Free and open source geographic database with an information system that allows the production of updated maps. Training courses for health agents that helped understand the risks of transmission and epidemiology. Incorporation of educational materials in schools with an integrated approach and emphasis on One Health actions.	Leandro et al.[46]
Original article	2021	Mexico	Use of remote sensing and environmental temperature changes to predict risk areas.	Mendoza-Cano et al.[47]
Review	2021	Not applicable	Reducing the susceptibility of humans to contracting viral diseases transmitted by mosquitoes, with the use of vaccines and chemoprophylaxis, the use of insecticides, mosquito repellents, preventive measures, how to ensure good cleaning of the environment and a good drainage system to avoid water stagnation during rains, biological control methods such as using copepods and larvivorous fish, genetically modified mosquitoes and intracellular endosymbionts, for example, *Wolbachia*, for control purposes .por exemplo, *Wolbachia*, para fins de controle.	Ogunlade et al.[48]
Review	2021	Thailand	Mapping the spatial distribution of Aedes using machine learning.	Rahman et al.[49]

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Type of study	Year of publication	Country of origin of data	One Health actions	Reference
Original article	2021	Brazil	Prototype system for spatiotemporal prediction of arbovirus case distribution based on weather conditions, health notifications, and machine learning.	Silva et al.[50]
Letter to the editor	2021	Not applicable	Multi-professional collaboration in developing a global response to vector control and immediate inclusion of vector-borne diseases on the One Health agenda.	Tajudeen et al.[51]
Original article	2021	Colombia, Ecuador, and Argentina	Density of the Aedes mosquito population in homes and its correlations with seasonality, sanitation, and human behavior.	Talbot et al.[52]
Review	2021	Croatia	Early detection of virus circulation through reports with the purpose of informing local authorities to establish preventive measures and vector control to protect human health.	Vilibic-Cavlek et al.[53]
Review	2022	Latin America	Creation of predictive models for dengue outbreaks in Latin America through machine learning.	Cabrera et al.[54]
Original article	2022	Puerto Rico	Perception of risk of exposure to arboviruses and involvement of the population in preventive measures against mosquito vector bites.	Dussault et al.[55]
Original article	2022	Brazil	Analysis of environmental indicators – urban infrastructure, rainfall indices – in relation to the incidence of arboviruses.	Gomes et al.[56]
Original article	2022	Thailand	*MosHouse® A. aegypti* mosquito trap sticky trap.	Kittayapong et al.[57]
Original article	2022	Brazil	Traps for detecting arboviruses in mosquito vectors in endemic urban areas.	Krokovsky et al.[58]
Original article	2022	Brazil	Sampling of adult *Aedes* mosquitoes as entomological indicators associating the probability of dengue risk in the population.	Leandro et al.[59]
Original article	2022	Brazil	Entomological surveillance and active serological profile in symptomatic individuals to identify foci of early arbovirus transmission.	Leandro et al.[60]
Review	2022	Not applicable	Environmental management methods (environmental modification and manipulation, human behavior) in the fight against dengue.	Mahmud et al.[61]
Review	2022	Zambia	Risk mapping based on remote sensing to estimate how environmental variables such as humidity, precipitation, temperature, and soil cover influence vector reproduction, infection rates, and transmission.	Mubembai et al.[62]
Review	2022	Kenya	Protection of blood and transfusion blood components through the implementation of dengue infection control tools in the population.	Mulakoli et al.[63]
Review	2022	Not applicable	Collaborative, multisectoral, and transdisciplinary approach at local, regional, national, and global levels, recognizing the interconnection between people, animals, plants, and their shared environment. Vector control, arbovirus vaccines, and access to diagnostic testing and appropriate medical care.	Socha et al.[64]
Original article	2022	Brazil	Entomological surveillance and spatio-temporal distribution of dengue cases.	Souza et al.[65]
Original article	2022	Brazil	Mathematical model for projecting the risk of transmission of temperature-dependent arboviral diseases.	Wyk et al.[66]

In Brazil, the Ministry of Health recommends that the population mechanically remove possible environmental reservoirs by checking roofs, clogged gutters, swimming pools, bottles, tires, and other places that store water. It also promotes home visits and the identification of outbreaks, as well as distributing the biolarvicide Espinosade to the states and training health workers to use this product in homes[70].

In view of the whole situation, the Pan American Health Organization (PAHO) considers ten actions to be priorities for control when planning the response to dengue: establish a multisectoral dengue action committee; formalize an emergency action plan; intensify integrated disease surveillance; carry out laboratory diagnostic tests to confirm viral circulation and genotype, if possible; intensify vector surveillance and control; protect special populations and reduce the impact of environmental determinants; ensure adequate patient care; involve the community and relevant groups of dengue control professionals in prevention and control activities; investigate and systematize the response to each epidemic and communicate to the media, according to the new scenario, and define the corresponding spokespeople[71].

CONCLUSIONS

Integrating all knowledge and actions to mitigate the spread of dengue is the safest and most effective option while there are no vaccines or pharmacological treatments available on the market. It is the role of the authorities to formulate preventive measures and public policies, including managing the disease, preparing the health system for the seasonality of the disease, and encouraging the population's participation in vector control.

Currently, most efforts are focused on controlling and eliminating vectors, but there is still a lot to know about dengue. The role of possible non-human reservoirs, urbanization in the epidemiological profile, the role of the vector itself in the transmissibility of the virus, the protection that areas of native forest and fauna provide in cases of dengue (dilution effect - greater biodiversity and less likelihood of parasite-host-environment-vector interactions and the emergence of diseases for a given population), are still sources of active research to help control dengue.

In Brazil, there are some studies that integrate environmental and socio-epidemiological factors and that reinforce the transdisciplinary nature of the efforts but the One Health approach in the context of dengue still needs to be strengthened.

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Authors' Contribution

Machado GS - Conception, planning (study design), acquisition, analysis, data interpretation, and writing of the work. Rubens RS - Data analysis and writing of the work. Dalmolin TV - Conception and writing of the work. All the authors have approved the final version of the work.

Conflict of Interest

The authors inform that there is no potential conflict of interest with peers and institutions, political or financial, in this study.