Población y Salud en Mesoamérica

Epidemiological evolution of dengue in the pre-pandemic to post-pandemic periods in the Americas and Brazil

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Epidemiological evolution of dengue in the pre-pandemic to post-pandemic periods in the Americas and Brazil

Evolución epidemiológica del dengue en los periodos prepandémico a postpandémico en América y Brasil

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Abstract: Introduction: Dengue is an asymptomatic infection or present symptoms like low fever to disabling high fever, severe headache, retroocular, muscle and joint pain, in addition to skin rashes, and if associated with COVID-19, it can worsen the illness condition. **Objective**: investigate the epidemiological evolution of dengue in the pre-pandemic, pandemic and post-pandemic periods from an American and Brazilian perspective. **Methodology**: descriptive study, based on the search for information in epidemiological bulletins, data from DATASUS and the Pan American Health Organization/World Health Organization, in addition to articles available in databases provided by SciELO, ScienceDirect and Pubmed. Results: In the period before the pandemic, the high number of notifications was due to the DENV2 serotype, causing a large epidemic. In the years 2020-2021 there was a drop in the number of notifications due to the introduction of social and public health measures, misdiagnosis between the signs/symptoms of dengue and COVID-19, inaccurate serological tests and underreporting. In 2022 and 2023, the epidemiological scenario again points to increasing notification of dengue cases, mainly due to changes in routine vector control during the pandemic, combined with favorable environmental factors, such as increased rainfall. **Conclusion**: the neglect of both dengue fever and other diseases has negatively impacted the population today, since in order to mitigate the damage caused by the pandemic, actions to promote and prevent the health of endemic diseases in our territory, when placed in the background, have caused the underreporting of cases, influenced by changes in the political, economic and health spheres of society.

Keywords: Arbovirus infections, COVID-19, dengue, pandemics

Resumen: Introducción: El dengue es una infección asintomática o presenta síntomas como fiebre baja hasta fiebre alta incapacitante, dolor de cabeza intenso, dolor retroocular, muscular y articular, además de erupciones cutáneas, y si se asocia con COVID-19 puede empeorar el cuadro de la enfermedad. **Objetivo**: investigar la evolución epidemiológica del dengue en los períodos prepandémico, pandémico y pospandémico desde una perspectiva Americana y brasileña. Metodología: estudio descriptivo, basado en la búsqueda de informaciones en boletines epidemiológicos, datos de DATASUS y de la Organización

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Panamericana de la Salud/Organización Mundial de la Salud, además de artículos disponibles en bases de datos proporcionadas por SciELO, ScienceDirect y Pubmed. **Resultados**: En el período previo a la pandemia, el elevado número de notificaciones se debió al serotipo DENV2, provocando una gran epidemia. En los años 2020-2021 hubo una caída en el número de notificaciones debido a la introducción de medidas sociales y de salud pública, diagnósticos erróneos entre los signos/síntomas del dengue y COVID-19, pruebas serológicas inexactas y subregistro. En 2022 y 2023, el escenario epidemiológico vuelve a apuntar a una mayor notificación de casos de dengue, debido principalmente a cambios en el control rutinario de vectores durante la pandemia, combinados con factores ambientales favorables, como el aumento de las precipitaciones. **Conclusión**: el descuido tanto del dengue como de otras enfermedades ha impactado negativamente hoy en la población, ya que para mitigar los daños causados por la pandemia, las acciones de promoción y prevención de la salud de las enfermedades endémicas en nuestro territorio, cuando se colocan en un segundo plano, han provocado el subregistro de casos, influido por cambios en los ámbitos político, económico y sanitario de la sociedad.

Palabras clave: Infecciones por Arbovirus, COVID-19, dengue, pandemias

1. Introduction

Acute febrile diseases such as chikungunya, dengue, yellow fever and Zika are arboviruses well known by the world population and especially by Brazilians. These neglected tropical diseases are defined as a group of poverty-promoting chronic infectious diseases that occur primarily in poor rural and urban areas of low- and middle-income countries (Public Library of Science, 2023). Among them, dengue, even though it is endemic in several territories, there is considerable concern among managers regarding the inherent risks of the disease and possible complications (Souza, 2019).

Data from the World Health Organization (WHO) point to a scenario in which the incidence of dengue will increase in all regions in the coming years, especially in parts of the Americas, highlighting that half of the world's population is at risk of dengue, with an estimated 100 to 400 million infections occurring each year. This is mainly justified by the geographic expansion of the mosquito vector, Aedes aegypti, currently found in more than 130 countries (Pan American Health Organization, 2023a)

Even before the COVID-19 pandemic, caused by the SARS-CoV-2 virus, was established, dengue already raised many concerns globally, whether because it had greater growth, over the years, than any other communicable disease (Wong et al., 2022), and because it depends, in most contexts, on the man-nature imbalance. Other aspects refer to the overlap of dengue and COVID-19 during the pandemic, which may have had a negative impact on the evolution of cases, whether due to the

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notoriety and notification of only more evident and serious cases of dengue, or due to the exclusive care given to COVID-19 without testing or clinical diagnosis of dengue (Cardona-Ospina et al., 2020).

In this sense, there is a need to understand the epidemiological scenario of possible pandemic impacts, and this supports dengue prevention and mitigation strategies. Thus, this study aimed to investigate the epidemiological evolution of dengue in the pre-pandemic, pandemic and post-pandemic periods from an American and Brazilian perspective.

2. Theoretical reference

The occurrence of arboviruses is closely related to social determinants of health, which in turn influence environmental ones. In the historical records of societies, events of great impact related to health have always been present, most of which resulted from the relationship between communities and the environment. In his work "Airs, waters and places", Hippocrates, already detailing concepts of what we now know as One Health, associates the direct influence of the environment on the physical constitution and health of human beings, always maintaining the focus on disease and at the same time, consolidating health as social well-being. Still in this context, Hippocrates was certain that data collection for health must consider the triad of territory, natural environment and people (Sironi et al., 2022).

As a classic example of a neglected tropical disease, dengue, an acute febrile disease with viral etiology, with clinical forms ranging from asymptomatic to severe cases that can lead to death, is established mainly in Africa, Asia and Latin America thanks to the conditions existing in these locations, posing a risk to the health of these most vulnerable populations (Pan American Health Organization, 2023a).

Going further, it is understood that health is a social product, influenced by urban space and that local determinants provide opportune means for the spread of the arthropod vector of urban arboviruses, Aedes aegypti (Almeida et al., 2020). This adaptation to the urban environment is inextricably related to the increase in population density combined with disorderly urbanization, lack of basic sanitation, inefficient garbage collection and minimum hygiene conditions. Additionally, migration, as well as facilitated air travel and the inefficient functioning of healthcare systems (Benelli & Duggan, 2018).

Brazil is made up of five regions (north, northeast, center-west, southeast and south), which are divided into 26 states and two districts (Brasília and Fernando de Noronha). It is known as a tropical country with high temperatures, abundant rainfall and significant humidity with variations between dry and humid weather, favorable to the proliferation of dengue vectors (Brazilian Institute of Geography and Statistics, 2023). Dengue is typical of tropical and subtropical areas, with most cases recorded in peripheral regions and in municipalities where there is no urban planning and basic sanitation (Almeida et al., 2022).

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3. Methodology

3.1 Approach

This is an observational, ecological, exploratory and quantitative study, based on dengue notifications in the Americas, Brazil, Central-West and Mato Grosso, via the Notifiable Diseases Information System (SINAN) by DATASUS and epidemiological bulletins from the Ministry of Health for data from the national territory, and the Pan American Health Organization/World Health Organization for data in an international context (Americas). The study followed the protocol REporting of studies Conducted using Observational Routinely-collected health Data (RECORD).

3.2 Study population

The study sample was a census, including all reported cases of dengue, regardless of sex and age group, in the period from 2019 to 2023. As an exclusion criterion, cases imported from other continents (notifications that occurred on other continents).

3.3 Collection techniques

Data collection occurred manually, by two PhD researchers with experience in the area of epidemiology and arboviruses, using a structured script constructed by the research team itself, with the variables: period of occurrence, place of occurrence, classification and confirmation criteria, with this script being pre-tested and considered suitable.

The three months with the highest dengue incidence rates in the national historical series prior to the pandemic were selected (Brazil, 2023; Pan-American Health Organization, 2023c), ranging from the eleventh to the twenty-first epidemiological week. This period was used for both contexts (Americas and Brazil).

3.4 Analysis processing

The epidemiological data collected generated graphs using Microsoft Excel® 2021 tools. The study respected all ethical aspects in research of this nature, based on secondary and public domain data, in accordance with Resolution 510/2016 of the National Council of Health (CNS).

4. Results

In the Americas, in 2019, just over 3.1 million cases of dengue were registered in 47 countries, of which 28 thousand were serious and 1.8 thousand deaths. In the following year, in which the WHO officially declared the beginning of the pandemic, there was a reduction, with 2.3 million cases being registered in 46 countries, including 6.100 serious cases and 1.031 deaths. In the second pandemic year, in 2021, there was a substantial drop in the number of dengue records, with 1.2 million cases, of which 3.2 thousand were severe and 437 deaths. In 2022, these records rose again, even during the pandemic period, reaching 2.8 million cases, 4.6 thousand of which were serious and 1.2

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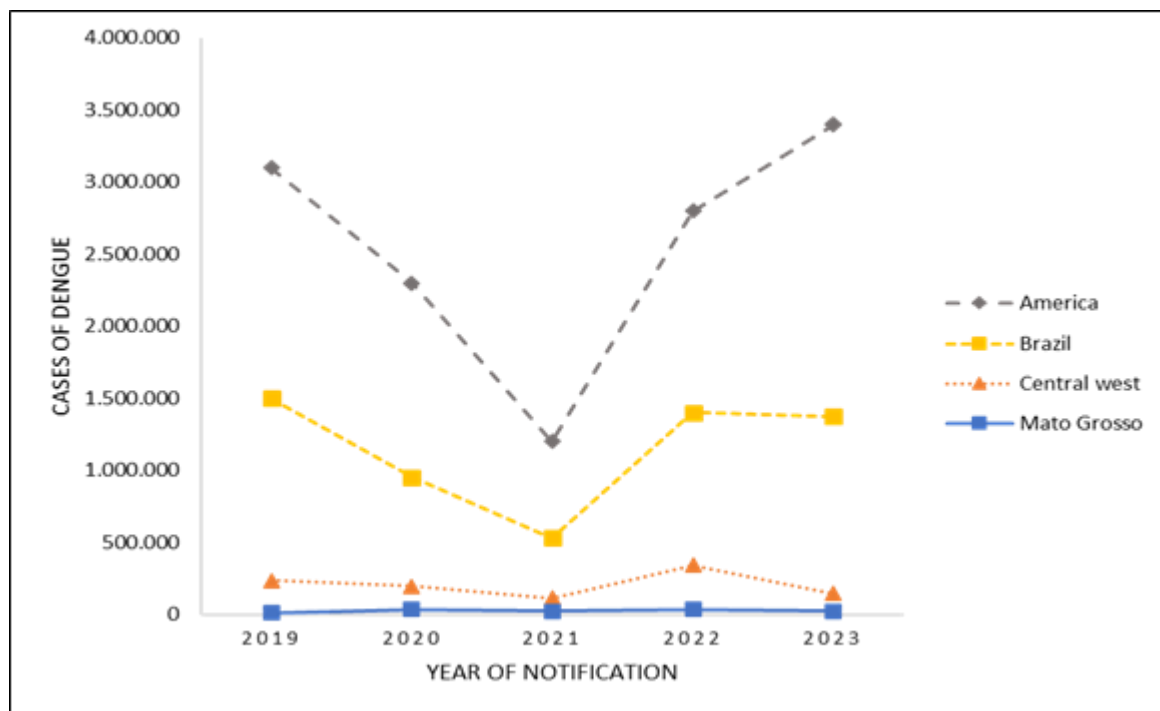
thousand deaths. 2023, the year in which the WHO declared the end of the pandemic, has so far presented 3.4 million cases of dengue, of which 4.7 thousand are serious and 1.6 thousand deaths (Pan American Health Organization, 2023c).

It is evident that in 2023, however, the Americas recorded a substantial increase in dengue cases, surpassing the numbers from 2019, the year with the highest number of recorded cases of the disease. When checking the records of the Notifiable Diseases Information System (Sinan Net), for 2019, 1.5 million cases were reported, 1.5 thousand serious cases and 851 deaths. In 2020 and 2021, there was a reduction in notifications, with 952 thousand and 531 thousand cases, 925 and 440 cases of severe dengue, 580 and 276 deaths respectively. The year 2022 presented data very similar to 2019, with 1.4 million cases, 1.5 thousand severe cases and 1.016 deaths. Data from January to July point to 1.3 million cases, 1.2 thousand serious cases and 774 deaths (Brazil, 2023).

In the Brazilian Center-West, 236,687 cases were reported in 2019, decreasing in 2020 to 197.984 cases. In 2021, 112.244 cases were reported, with notifications rising in 2022 to 341.205 cases and in 2023, from January to July, 144.823 cases. Among the states that make up this region, Mato Grosso between 2019 and 2023 contributed respectively with 11.176, 35.023, 22.365, 35.371 and 23.979 cases of dengue (Brazil, 2023) (Figure 1).

Figure 1

Distribution of dengue cases in America, Brazil, Central-West and Mato Grosso in the years corresponding to pre-pandemic, pandemic and post-pandemic.

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In addition to the data, it is possible to carry out several analyzes related to the decrease in dengue cases in the years 2020 and 2021, both in the data provided for the Americas and for Brazil, since there is a lack of linearity and patterns previously observed.

Over the past two and a half years, the world has been dealing with an unprecedented situation. The current epidemiological scenario of dengue causes some discomfort for public health in general. Looking back, in the 2015 epidemic, serotype 1 predominated, and 4 years later, in 2019, it was replaced by DENV2, causing almost 1.7 million cases. It is believed that the dominance of this serotype allowed the general susceptibility to serotype 1 to increase, allowing a complete shift to DENV1 by 2022, resulting in a large-scale epidemic (Souza & Romano, 2022).

Oneda et al. (2021), when determining the epidemiological profile of dengue in Brazil between the years 2014 and 2019, demonstrated, as confirmed by the bulletin released by the WHO in 2020, in the epidemiological update of dengue and other arboviruses, that the high rainfall for the period studied was well such as the predominance of serotype 2 of the virus, which circulated timidly in 2018 and gained strength since then, became prevalent and responsible for the explosion of cases in the pre-pandemic period (Pan American Health Organization, 2020b). In this same bulletin, when it comes to the Americas, the highest proportions of dengue cases were in Brazil, with 65% of cases, Paraguay, 14%, Bolivia and Argentina with 5% each and Colombia with 3%.

In a pandemic period, 2020 and 2021 infers different perspectives and reflections are proposed to reduce the number of notifications. Firstly, the mobilization that epidemiological surveillance teams and health professionals carried out during the pandemic emergency. Respecting information note nº. 08/2020, the Agents for Combating Endemic Diseases had their activities postponed and interrupted during the period of the coronavirus emergency, directly reflecting on their role of surveillance and control in combating the transmission of arboviruses.

Many of these professionals, in addition to those who verified epidemiological data, were relocated to other sectors aimed at combating the pandemic (Brasil, 2020; Wilder-Smith, 2021). Thus, their impediment to monitoring homes, health education to residents about the transmitting agent, symptoms, risks and prevention measures for arboviruses, in addition to forwarding suspected cases to the basic health unit, brought negative impacts on the pandemic moment that left a legacy in which more individuals could be infected by arboviruses in the post-pandemic period, due to the fact that they are more exposed to risk and vulnerable (Nacher et al., 2020).

Another important fact concerns the decrease in cases as well as possible underreporting. Considering that the years 2020 and 2021 were the most affected by the COVID-19 pandemic, it is understood that there was a fear among this population with suspected arbovirus disease in seeking care in a basic health unit and consequently, having the possibility of becoming infected with the SARS-CoV-2 virus, which could create an overload on the health system and a shortage of resources (Rodriguez-Morales et al., 2020).

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As mentioned by Brady & Wilder-Smith (2021) and Wilder-Smith (2021), the impact of the lockdown must be included in this panorama, not only on underreporting, but on the accuracy of data reported on dengue, especially for non-serious cases and the increase in deaths from severe dengue, resulting from this fear of mass contamination (or co-infection).

This behavior was also verified by Cardona-Ospina et al. (2021), who reported a coincidence in the decrease in the number of arbovirus cases at a time when they would tend to increase, a reflection of health professionals completely focused on confronting the pandemic and which subsequently resulted in a scenario of neglected and underreported dengue.

In the Brazilian scenario, some authors draw attention to the same focus: the comparison of epidemiological weeks that previously showed peaks in dengue notifications, in years prior to the COVID-19 pandemic and which show a decline, assuming a possible movement of underreporting of cases (Leandro et al., 2020; Mascarenhas et al., 2020; Neto et al., 2023).

From a clinical-medical perspective, the potential for erroneous clinical diagnoses is a factor to be considered as both arboviruses and COVID-19 present great similarity in pathophysiological events, in addition to non-specific signs and symptoms, including fever, malaise, myalgia, headache and asthenia, which makes the clinical outcome a major challenge (Benavidez et al., 2020).

Thus, the priority nature given to COVID-19 culminated in some non-compliant approaches, mainly in individuals with symptoms common to these two diseases, who were negative in relation to COVID-19 and not tested for other diseases, including arboviral ones, generating a contingent of underreported patients, without proper monitoring of the evolution of symptoms and at increased risk of unfavorable clinical outcomes, since both viruses can lead to serious complications (Dinnes et al., 2020).

The probable reactivity between rapid tests must also be considered, since in dengue endemic areas, there are reports of false-positive results for serological tests targeting dengue (IgG and IgM) and that when retesting patients using molecular techniques (RT-PCR) observed positivity for SARS-CoV-2. This related problem culminates in the contamination of healthy individuals by these, wrongly diagnosed, increasing the number of those infected by SARS-CoV-2 (Nath et al., 2021; Ochani et al., 2021; Yan et al., 2020). Another point to be highlighted relates to the reduced availability of laboratory tests for dengue, since the financial demands and supplies were all directed to the pandemic.

Some researchers also expose the phenomenon of viral interference as likely responsible for the drop in dengue cases during the pandemic period, considering that in this case, SARS-CoV-2, due to its high virulence, pathogenicity and tropism towards endothelial cells would cause a competitive inhibition of the dengue virus. In this case, individuals could be becoming infected with SARS-CoV-2 at a different rate compared to the dengue virus (Wilder-Smith et al., 2019).

Taking into account the environmental factors that contribute massively to the spread of the vector, it is important to remember that the incidence of dengue fever is concentrated in months with high

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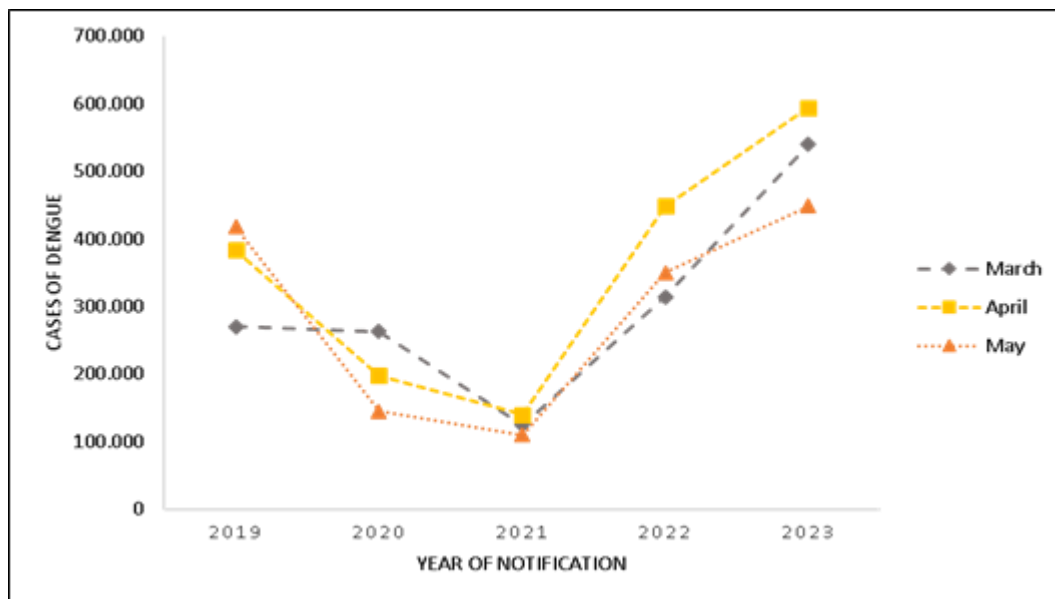ISSN-1659-0201
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rainfall and temperature, which in Brazil corresponds to the months of November to May (Brazil, 2013). However, during the pandemic biennium, marked by months of intense and prolonged rain, there was an above-average incidence at the beginning of 2020, with the drop in the number of cases in the subsequent months attributed to the beginning of social and public health measures (late March to early April) (Chen et al., 2022).
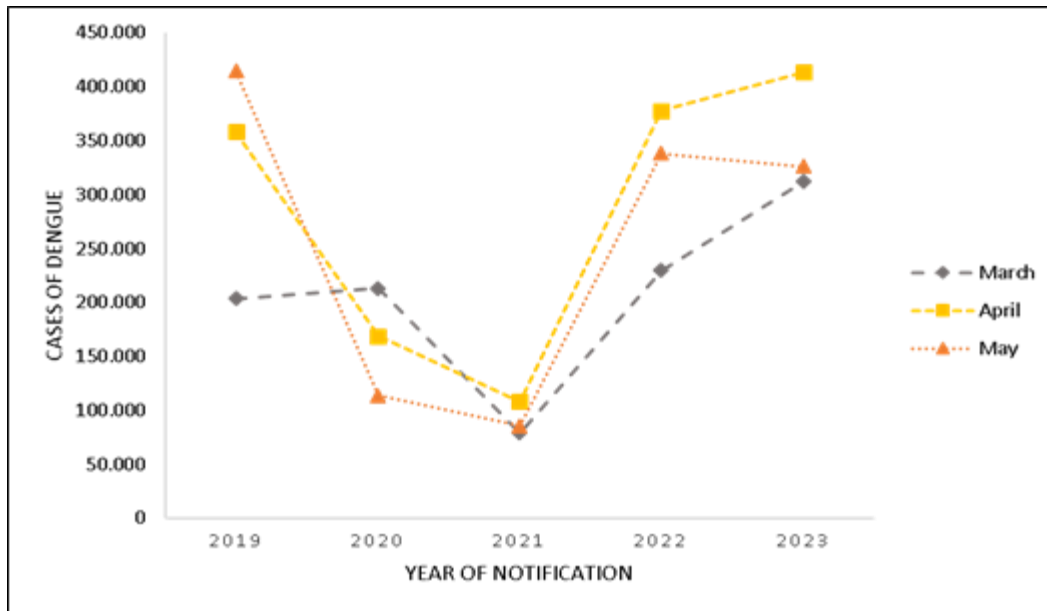
This change in human behavior aimed at the movement of people may have influenced the rate of contact between populations and areas where mosquitoes would generally proliferate, such as public spaces, workplaces or schools, not to mention the reduction in national/international travel, capable of to reduce the risk of importing new genotypes of the dengue virus (Brady & Wilder-Smith, 2021).

When analyzing data from the Notifiable Diseases Information System - Sinan Net, made available by the Ministry of Health, in the years 2019-2023, it was observed that in Brazil, the months with the highest number of reported cases comprised March, April and May (Brazil, 2023). Compiling available data from the Americas, also corresponding to the same period, it is noted that the Southern Cone of America has the highest number of cases, with Brazil being the country with almost all records (Pan-American Health Organization, 2023). (Figure 2)

Figure 2

Distribution of dengue cases in the Americas (first graph) and Brazil (second graph), in the months with the highest case notification, in the years corresponding to pre-pandemic, pandemic and post-pandemic.

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In the study by Almeida et al. (2022), it was evident that months of higher rainfall in Brazil are correlated with the spread of Aedes, although in different regions of the country and that in Mato Grosso, the epidemic peaks were correlated with rainfall. Santos et al. (2019), observed the correlation between rainfall and the occurrence of dengue and that the number of cases increased in the first months after the rainy season. In Rio de Janeiro, most cases occur in the first semester, mainly between the months of March and May, as in the review presented by Xavier et al. (2021) which confirms the premise that the highest dengue incidence rates coincide with the rainy and hottest months of the year in the country. Ferreira et al. (2020) in the Central-West region of Brazil showed the temporal distribution and influence of rainfall and humidity as a preponderant factor that contributes to the presence of the Aedes aegypti vector.

Despite the surprising number of cases observed in Brazil in the post-pandemic period, the hypothesis of a serotype change that occurred in 2019 cannot be ruled out, but other factors certainly influenced the outcome of the current epidemiological scenario (Souza & Romano, 2022). These include interference with routine vector control, lack of discernment between the signs/symptoms of dengue and COVID-19 on the part of health professionals, inaccurate serological tests and underreporting.

That said, in the absence of a vaccine accessible to the population and specific treatment for dengue, vector control is an effective intervention method, but it still lacks the population's adherence and support from competent entities for the correct and efficient dissemination among the masses. about accurate information about dengue (Brady & Wilder-Smith, 2021; Leandro et al., 2020; Neto et al., 2023; Ochani et al., 2021; Wilder-Smith, 2021).

In September 2023, the Pan American Health Organization and the WHO issued an alert for South American countries to maintain surveillance, early diagnosis and timely treatment of cases of dengue

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and other arboviruses, and reiterate prevention for complications and deaths associated with these diseases as an increase in dengue cases is already observed in countries and territories in Central America and the Caribbean. In this information, they reinforce that 2022 was the third largest year in terms of the number of dengue cases, surpassed only by 2016 and 2019. Furthermore, an alert is given for Brazil, where until epidemiological week (EW) 35, the highest number of dengue cases was observed with 2.569,746 cases, followed by Peru, with 235.014 cases (up to EW 32) and Bolivia, with 137.110 cases (Pan American Health Organization, 2023b)

In view of this significant increase in case notification as the start of the summer season approaches in South America, this alert highlights the importance of continued training of health workers for timely clinical diagnosis, early identification of warning signs and the appropriate management and treatment of patients as one of the main measures to avoid complications and save lives.

Given this scenario, it is essential that health management acts in all spheres in the face of emergencies of communicable diseases such as arbovirus epidemics and others that have a seasonal nature. For this reason, epidemiological surveillance based on constant monitoring of these diseases is crucial, even so that new outbreaks can be predicted. However, for this to be possible, it is necessary to improve data analysis to generate evidence, automate routines and procedures with innovative technologies that ensure more robustness and reliability in results.

The following limitations of the present study need to be taken into consideration: in a scenario in the Americas, the unavailability of data regarding notifications by some countries culminates in the loss of quality of the analyzes as well as the real panorama, with evident underreporting of cases. Situations like this are capable of compromising monitoring mechanisms relevant to public health emergencies.

From the Brazilian perspective, which was monitored more closely, the "data blackout" resulting from a cyber-attack on December 10, 2021, may have caused a delay between the notification of injury records, (in notification forms), and the subsequent entry of information into the databases, not obtaining reliable information on the scenario, not only of dengue and COVID-19, but of other diseases which, due to the lack of real information, interfere with epidemiological surveillance and its consequences as well as well as in scientific analytical productions generated based on data from these systems.

5. Conclusions

Dengue is a growing concern in the Americas, affecting countries differently due to climatic, environmental, socioeconomic and infrastructure factors; Transmitted by mosquitoes, the main culicidae aedes aegypti vector, which has become a growing problem and has been affecting various parts of the world, especially in tropical and subtropical regions. A pandemic dengue scenario refers

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to a situation where this wide and simultaneous dissemination of the disease in many countries or continents result in a high number of cases and significant pressure on often fragile health systems by uncontrolled advancement and decompensator of the epidemiological vector attack.

The pandemic scenario, dengue required a coordinated and multifaceted response, combining vector control, vaccination, public education and strengthening health systems, education and awareness and new evaluations the ability to respond to health systems, joining international cooperation to share Information, resources and effective strategies to combat the dissemination of the disease, often related to dengue cases underground, which can be exacerbated by the similarity of dengue symptoms with other febrile diseases, such as COVID-19, in this sense to improve the ability to Diagnosis and notification are essential.

The World Health Organization (WHO) estimates that about 390 million dengue infections each year, of which approximately 96 million have clinical manifestations, with varied symptoms and severe cases, and may evolve into their most severe form called hemorrhagic dengue or syndrical Dengue shock, which can be fatal.

Dengue epidemiological surveillance is a crucial activity to monitor and control the spread of the virus, prevent outbreaks and mitigate impacts on public health. It involves a set of systematic actions designed to collect, analyze, interpret and disseminate data on the disease, to inform public health decisions and guide control strategies. Identification of different dengue virus serotypes (DENV-1, DENV-2, DENV-3, DENV-4), become essential to predict outbreaks and guide the public health response.

6. Author´s contributions

VKVO (leader) and VFN idealized the work, conceived the study, interpreted the data and performed the writing of the manuscript. DPLJ interpreted the data and performed the writing of the manuscript. All the others performed the critical review of the written work.

7. Acknowledgements

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