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IMPACT CAUSED BY THE PANDEMIC ON ARBOVIRUSES IN THE PERIOD FROM 2017 TO 2024, IN THE STATE OF TOCANTINS

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ABSTRACT

Brazil has a more accentuated environmental complexity compared to other countries due to its diverse fauna and flora. The geographical and climatic variety creates an environment conducive to the spread of arboviruses, such as dengue, zika and chikungunya, which constitute a public health problem in the country. In addition to vector-borne diseases, in 2019 the pandemic of the new coronavirus, called SARS-CoV-2, which causes the disease COVID-19, began. Therefore, arboviruses occurred simultaneously with the active transmission of the SARS-CoV-2 virus in endemic areas such as Tocantins. This fact may have interfered in the notification of cases of arboviruses, since preventive measures against the new disease were prioritized, which resulted in a reduction in the population's demand for medical help, in addition to the lack of preparation of health professionals in the differential diagnosis of these pathologies as well as cases of co-infection. In addition, public health measures aimed at preventing arboviruses were to some degree neglected by the lack of home visits by endemic disease control agents. The present study aims to analyze the changes that occurred in the notifications of arboviruses during the period of the COVID-19 pandemic, in the state of Tocantins, when comparing the pre- and post-pandemic notifications. This is an observational, descriptive, and retrospective study that evaluated reported cases of arboviruses from 2017 to 2024 and COVID-19 from 2020 to 2024. The data were collected on the platform provided by the Department of Informatics of the Unified Health System and analyzed descriptively. When evaluating the seasonality of arboviruses in the period before the pandemic, as well as during and after it, it is verified that there was a significant reduction in cases reported in Tocantins during the most critical period of the pandemic, a fact that suggests underreporting. Understanding the

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epidemiological profile of arboviruses is of fundamental importance, especially in the period of incidence of COVID-19, given that both represent significant challenges to epidemiological surveillance, as it enables decision-making based on their knowledge, as an incentive for prevention and control, especially in pandemic periods.

Keywords: Arboviruses. Pandemic. SARS-CoV-2. Dengue fever. Zika Virus.

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INTRODUCTION

Tropical regions are characterized by great biodiversity and a hot and humid climate, with mild temperatures becoming a favorable environment for the proliferation of arthropod vectors. In Brazil, a country that is located in the tropics and is home to a significant part of the Amazon and vast areas of Atlantic Forest, this environmental dynamic is even more complex, due to its different composition of fauna and flora, as geographic and climatic diversity creates ideal conditions for the transmission of arboviruses, such as dengue, zika and chikungunya. These vector-borne diseases are endemic in many regions of the country, including Tocantins, and according to the World Health Organization (WHO), there was an increase from 505,430 in 2000 to 5.2 million in 2019 (WHO, 2023).

The incidence of dengue, zika, and chikungunya has been a growing public health concern in Brazil and other tropical regions. The main form of transmission of these diseases is through the bite of female *Aedes aegypti mosquitoes*, which have their reproduction influenced by a number of factors, including temperature, humidity, and urbanization (PAHO, 2023).

In Brazil, accelerated urbanization and the lack of adequate infrastructure contribute to the proliferation of mosquito breeding sites, increasing the risk of outbreaks and epidemics. In addition, changes in climate events, including temperature and precipitation, play a crucial and profound role in the distribution of increased vector activity of these arboviruses. Due to the large Brazilian territory, it is necessary to emphasize the fact that there are states that currently have a prominent place in the presence of these arboviruses, as is the case of Tocantins, a region with a high incidence of cases (Paula *et al., 2023).*

Of the various ways to work on the prevention of these pathologies, we have the realization of awareness campaigns to influence behaviors such as the use of repellent, elimination of mosquito breeding sites and the increase of preventive measures by the government, such as the application of the insecticide CIELO™ ULV recommended by the Ministry of Health (MS) (Brazil 2020), composed of pralethrin and imidacloprid, which has high efficacy against mosquitoes, being less aggressive to humans and domestic animals (Prefeitura Municipal de Palmas, 2022).

In addition to dengue, zika and chikungunya, whose behaviors vary between epidemics, outbreaks and endemics, Brazil has been facing the disease caused by the

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new Coronavirus 2019 (COVID-19), an infection caused by a virus of the Coronaviridae family, called Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2), which spread rapidly throughout China, and then reached other continents, the number of infections growing exponentially and causing the deaths of thousands of people around the world (Schneider *et al*., 2020; Singhal, 2020).

The COVID-19 pandemic has resulted in significant changes in human behavior, public health guidelines, and the environment, which can affect the transmission dynamics of arboviruses. During this challenging time of the pandemic, measures such as social distancing, mask-wearing, and *lockdown* were implemented in response to the emergency to curb the spread of the virus. However, these actions may have directly impacted people's exposure to the arboviral vector, since the increase in time spent indoors may lead to greater exposure to the mosquito that transmits arboviruses (Mascarenhas *et al*., 2020).

During the COVID-19 pandemic, the attention of health systems and government agencies was diverted to confronting the new disease, which may have resulted in underreporting of arbovirus cases. The overload of health services, the reduction of epidemiological surveillance activities, and the population's fear of seeking medical care contributed to the underestimation of the true impact of arboviruses during this period. This underreporting can have serious consequences, impairing the response capacity and the implementation of effective control measures against these diseases (Gomes *et al*., 2021).

It is believed that COVID-19 and arboviruses occur simultaneously in some areas, either as separate infections or co-infections, which represent a greater challenge in the fight against these pathologies, and the possibility of double infection, and the simultaneous occurrence of two outbreaks can lead to a potential collapse of the Unified Health System (SUS) (Sousa *et al*., 2022).

One way to avoid such a collapse is immunization and, therefore, the dengue vaccine was included in the SUS vaccination schedule in 2024 and started in February of the same year, for the public aged 10 to 14 years, being an effective and safe tool in the prevention of this infectious disease in the scenario of the emergence of new variants of the SARS-CoV-2 virus (Brazil, 2022).

It is important, in the current situation, to interpret the data and critically analyze the true incidence of Zika, dengue, and chikungunya throughout the COVID-19 pandemic. These data, properly analyzed and discussed, can corroborate the elaboration of effective

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future policies and improvements in the public health system in Brazil, with a view to preventing and coping with arboviruses.

The present study aims to analyze the changes that occurred in the notifications of arboviruses during the period of the COVID-19 pandemic, in the state of Tocantins, when comparing the pre- and post-pandemic notifications.

METHODOLOGY

This is an observational, descriptive, and retrospective, time-series study analyzing the number of reported cases of dengue, zika, and chikungunya per year from 2017 to 2024, and the number of reported cases of COVID-19 per year from 2020 to 2024 in the state of Tocantins, Brazil. The data of interest were obtained from the Notifiable Diseases Information System (SINAN) and the Hospital Information System (SIH/SUS), made available by the Department of Informatics of the Unified Health System (DATASUS) of the Ministry of Health. The collected data were tabulated using the Microsoft Office Excel software, and presented in the form of tables and figures. As these data are in the public domain, it does not require appreciation and approval by the Human Research Ethics Committee, according to Resolution No. 466 of 2012 of the National Health Council.

RESULTS

The data analysis presents a quantitative description, stratified by months and years, which shows the significant reduction in arboviruses during the period of the COVID-19 pandemic, as shown in the tables extracted from the DATASUS system.

Dengue, the first arbovirus analyzed, is characterized by clinical manifestations such as severe myalgia, fever and retroocular pain. Although this disease is endemic in Tocantins, the lowest epidemiological index was observed only at the height of the COVID-19 pandemic, that is, in 2020, with a total of 1,888 reported cases, as shown in Table 1.

Table 1. Number of dengue cases from 2017 to 2024 in Tocantins, Brazil

Ano 1º S	Jan	Fev	Mar	Abr	Mai	Jun	Jul	Ago	Set	Out	Nov	Dez	Total
2017	575	775	939	865	807	317	136	106	55	94	94	113	4876
2018	188	166	281	429	343	117	52	65	57	82	342	919	3041
2019	2452	2902	2740	2377	1733	484	114	81	49	129	234	247	13542
2020	283	386	379	230	172	140	116	48	38	23	29	44	1888
2021	54	163	270	431	572	552	342	304	273	385	1680	4537	9563
2022	4757	3390	2815	3119	2790	1496	710	398	255	193	380	413	20716
2023	422	442	628	668	443	201	100	70	45	49	93	84	3245
Total	8731	8224	8052	8119	6860	3307	1570	1072	772	955	2852	6357	56871

Source: Ministry of Health/SVSA-Notifiable Diseases Information System-SINAN Net.

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Chikungunya, an arbovirus characterized by intense joint pain - which can persist for up to two years after the acute phase - and low fever, showed a different epidemiological behavior. As observed for dengue, the reduction in the number of cases was more pronounced in 2020 (n=410), and is maintained in 2021, compared to the period before and after the pandemic (Table 2).

Table 2. Number of chikungunya cases from 2017 to 2024 in Tocantins, Brazil

Ano 1º S	Jan	Fev	Mar	Abr	Mai	Jun	Jul	Ago	Set	Out	Nov	Dez	Total
2017	636	821	1139	1046	1294	806	327	199	93	91	86	77	6615
2018	118	133	129	190	144	63	52	55	42	67	122	236	1351
2019	386	347	324	168	137	78	37	30	32	36	60	47	1682
2020	65	55	57	60	30	24	18	28	16	14	21	22	410
2021	26	46	69	65	145	130	87	92	50	46	151	324	1231
2022	472	490	795	1672	2294	1537	776	364	167	130	169	275	9141
2023	1707	2967	2475	1921	1119	455	197	126	101	107	136	124	11435
Total	3410	4859	4988	5122	5163	3093	1494	894	501	491	745	1105	31865

Source: Ministry of Health/SVSA-Notifiable Diseases Information System-SINAN Net.

The Zika virus, known for its association with cases of microcephaly in infected pregnant women, presented an epidemiological pattern similar to other arboviruses, with a decline during the pandemic period, maintaining the frequency of cases in accordance with the pattern observed for chikungunya, namely fewer cases in 2020 and 2021, compared to the pre- and post-pandemic period, as shown in Table 3.

Table 3. Number of Zika cases from 2017 to 2024 in Tocantins, Brazil

Ano 1º S	Jan	Fev	Mar	Abr	Mai	Jun	Jul	Ago	Set	Out	Nov	Dez	Total
2017	264	407	542	556	743	328	115	89	43	45	60	54	3246
2018	86	68	92	139	135	62	45	52	52	82	154	367	1334
2019	639	725	409	222	172	73	35	23	20	31	41	58	2448
2020	49	36	45	43	30	20	14	15	15	14	14	17	312
2021	24	43	41	45	69	56	45	55	32	40	119	257	826
2022	250	174	206	321	542	295	132	67	35	45	44	69	2180
2023	468	699	753	522	220	111	68	55	42	40	51	50	3079
Total	1780	2152	2088	1848	1911	945	454	356	239	297	483	872	13425

Source: Ministry of Health/SVSA-Notifiable Diseases Information System-SINAN Net.

The analysis of COVID-19 revealed a unique epidemiological behavior, characterized by an upward curve from its emergence to partial control from 2023 onwards, as evidenced in Table 4.

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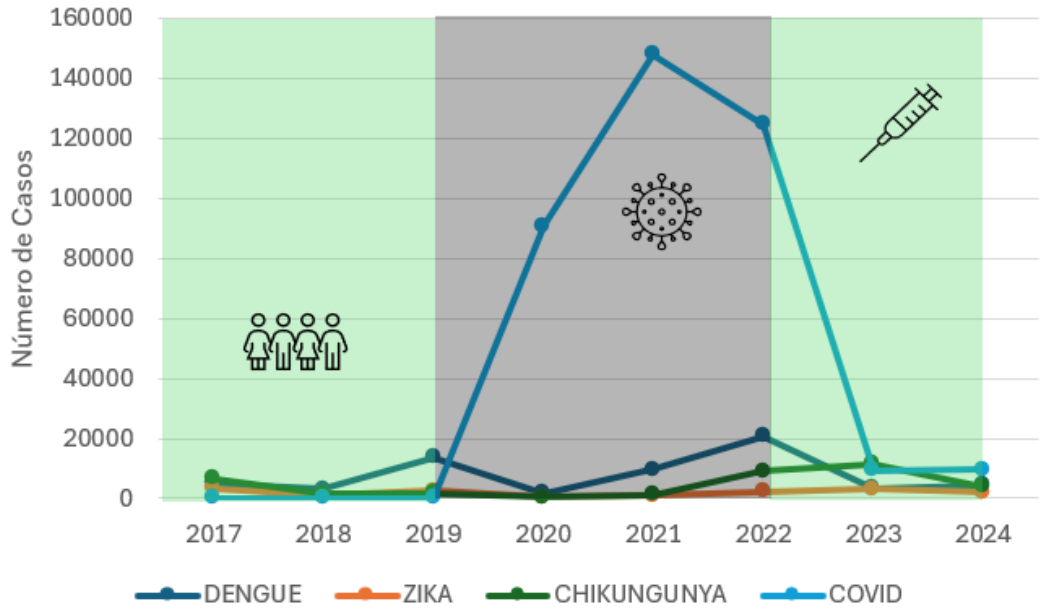
Table 4. Number of COVID-19 cases in the period 2020 to 2024 in Tocantins, Brazil

ANO/MÊS	JAN	FEV	MAR	ABR	MAI	JUN	JUL	AGO	SET	OUT	NOV	DEZ	TOTAL
2020	0	0	31	449	4.177	8.838	15.295	23.389	17.448	5.654	8.157	7.325	92.783
2021	11.919	12.531	28.039	16.280	22.068	17.500	13.022	7.286	4.825	4.593	3.749	6.096	149.929
2022	42.292	22.009	1.496	342	1.855	13.136	21.932	2.852	360	111	5.202	13.122	126.731
2023	1.759	838	883	1.396	2.026	1.208	187	103	153	223	243	344	11.386
2024	3.068	4.538	1.035	158	62	65	97	160	253	20	7	7	11.494

Source: Center for Strategic Information on Health Surveillance/SES-TO.

The analysis of the 2017-2024 period reveals a complex epidemiological dynamic, characterized by significant variations in the incidence of the four viral pathologies under study in Tocantins (Figure 1).

Figure 1. Longitudinal epidemiological analysis: trends and dynamics of viral diseases in Tocantins, Brazil (2017-2024)



Source: Authors (2024).

The COVID-19 emergency stands out, with approximately 150,000 cases recorded in 2021, establishing a historical milestone in the time series. This magnitude, significantly higher than the other pathologies analyzed, demonstrates the unprecedented impact of the pandemic on the epidemiological context in the period.

The interval analyzed shows a marked epidemiological transition, characterized by the introduction and subsequent predominance of COVID-19 in the health scenario. From 2020 onwards, a significant change in the epidemiological profile was observed, with an exponential growth in COVID-19 cases, surpassing the previously established arboviruses

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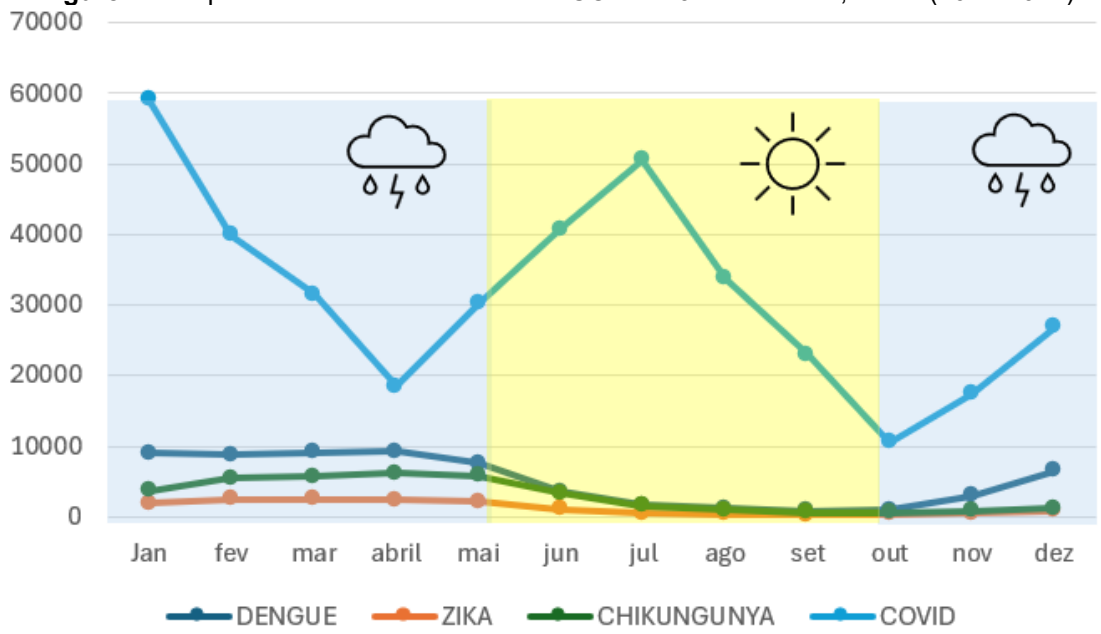
in magnitude. This phenomenon demonstrates the potential of emerging pathogens to significantly modify the preexisting epidemiological landscape.

The analysis of recent trends, specifically in the period 2022-2024, suggests a possible normalization of the epidemiological picture of COVID-19. This trend may be associated with multiple factors, including vaccination, the implementation of effective preventive measures, the development of population immunity, and the improvement of epidemiological surveillance and control strategies.

Figure 2. Temporal trend of arboviruses and COVID-19 in Tocantins, Brazil (2017-2024)



Source: Authors (2024).

The temporal study reveals distinct epidemiological patterns between arboviruses and COVID-19. There is marked seasonality of arboviruses, with predominant peaks in the early months of the year, coinciding with the rainy season and high temperatures. COVID-19 has different dynamics, with oscillations less dependent on seasonal factors, but with evidence of episodic outbreaks of significant magnitude.

DISCUSSION

With the ease of dissipation of COVID-19, it arrived in Brazil generating a worsening in health services, causing a shortage of supplies, lack of beds, overload on health professionals, generating total collapse (Sales *et al.,* 2021). The first officially confirmed case of COVID-19 in Brazil was registered on February 26, 2020, in the city of São Paulo,

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and by the end of December, the country already had 8,319,654 infected and 195,411 deaths from the disease. In Tocantins, the first case was registered on March 18, 2020, in the capital Palmas. The first case was registered in the interior of the state was in the city of Araguaína on March 27, as reported on the federal government's website.

The integrated analysis of epidemiological data from Tocantins, for the period 2017-2024, reveals a complex and dynamic scenario in local public health, especially during the months of highest incidence (January to March), with relevant implications for local health systems. The simultaneity of different viral pathologies imposes significant challenges for the differential diagnosis and clinical management of cases, suggesting the need for integrated strategies for epidemiological surveillance and adaptive capacity of health services, discussed in the article presented by Gomes. *et.al*. (2021).

The epidemic cycles of arboviruses demonstrate periods of greater transmission followed by intervals of significant reduction in incidence, a characteristic evidenced mainly in dengue and chikungunya. This variability can be attributed to multiple factors, including climatic conditions, vector density, population immunity, and effectiveness of the control measures implemented.

The temporal analysis presented here has significant implications for public health planning and management. The relative predictability of arbovirus transmission peaks allows for the development of early preventive strategies, while the less predictable dynamics of COVID-19 demand greater flexibility and rapid response capacity from the health system (Souza, *et. al.,* 2022).

The coexistence of endemic arboviruses with the emergence of COVID-19 demonstrated the difficulty in the adaptive capacity of the health system in the face of multiple simultaneous challenges. In the present study, a possible interference of COVID-19 control measures in the epidemiological surveillance of arboviruses was identified, evidenced by the change in notification patterns, since there was a significant reduction in cases during the most critical period of the pandemic. These data corroborate those of Neto, *et.al*., (2023), who evaluated the totality of cases of arboviruses reported in the five Brazilian regions, between 2017 and 2022, finding that in 2020 and 2021 there was a decrease in relation to the period before (2017 to 2019) and after (2022) the pandemic, attributing the fact to the underreporting of arboviruses.

Therefore, the data suggest a possible influence of the control measures implemented for COVID-19 on the transmission of other viral diseases, including: (1)

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reorganization of health services for priority care for COVID-19 cases; (2) the population's fear of seeking medical care during the pandemic; and (3) possible difficulty in the differential diagnosis between arboviruses and COVID-19, given the *overlap* of initial symptoms (Aquino, *et.al*., 2020).

This phenomenon highlights the importance of integrated epidemiological surveillance strategies and the need to maintain robust and flexible monitoring systems. The pandemic triggered one of the greatest challenges in the history of the SUS, requiring a reassessment of health management and reinforcement to deal with the significant increase in demand for medical care, without further burdening the already saturated health system (Nascimento, 2020).

Understanding the temporal patterns and the interaction between different viral pathologies provides essential subsidies for strategic planning in public health, allowing the optimization of resources and the development of more effective responses to future epidemiological challenges.

CONCLUSION

The investigation showed that the arboviruses maintained their characteristic seasonal pattern, with peaks in the early months of the year, coinciding with periods of higher rainfall and high temperatures. On the other hand, COVID-19 presented a distinct epidemiological behavior, with oscillations less dependent on seasonal factors and marked by episodic outbreaks of significant magnitude, reaching approximately 150,000 cases in 2021.

The temporal analysis in the context of COVID-19 suggests a trend towards normalization of the epidemiological picture in the 2022-2024 period, possibly related to the implementation of effective preventive measures, development of population immunity, and improvement of epidemiological surveillance strategies. This scenario provides important subsidies for public health planning, highlighting the need to strengthen surveillance systems and maintain integrated control strategies, even in contexts of concomitant health emergencies.

The findings underscore the importance of maintaining and improving epidemiological surveillance systems, ensuring their robustness and flexibility to respond adequately to multiple simultaneous health challenges. It is recommended that additional

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studies be developed to assess the long-term impact of the pandemic on epidemiological surveillance systems and control strategies for endemic arboviruses.

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