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ORIGINAL ARTICLE

EFFECTS OF THE COVID-19 PANDEMIC ON THE ACTIONS OF THE DENGUE CONTROL PROGRAM IN A METROPOLITAN AREA IN THE SOUTHEAST REGION OF BRAZIL

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ABSTRACT

The COVID-19 pandemic represents a challenge for health systems, straining available material and personal resources, interfering with other surveillance and control programs. Dengue is epidemiologically the most relevant urban arbovirus of Latin America, being endemic in the metropolitan municipality of Contagem in Minas Gerais State, southeast region of Brazil. This is an ecological study that aimed to analyze the effects of the COVID-19 epidemic on dengue control and surveillance in Contagem in the year of 2020. In 2020, the municipality presented more dengue cases than expected for non-epidemic years, with a sharp decline from epidemiological week 11 onwards, coinciding with the increase in COVID-19 cases. There was also a reduction in vector control, with the national suspension of the second Survey of Rapid Infestation Index of *Aedes aegypti* and a significant decrease in the installation of oviposition traps, properties visited for monitoring and that received focal treatment. Our results and the difficulties observed in different instances of dengue control corroborate the hypothesis of weakening of the surveillance program and possible underreporting of dengue cases as a result of the COVID-19 emergency.

KEY WORDS: COVID-19; dengue; epidemiology; syndemic; public health surveillance.

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INTRODUCTION

SARS-CoV-2, the etiological agent of COVID-19, was first identified in the bronchoalveolar lavage fluid of hospitalized patients with pneumonia in Wuhan, China (Tan et al., 2020). The official taxonomy of SARS-CoV-2 is due to the virus' genetic proximity to the coronavirus responsible for the outbreak of Severe Acute Respiratory Syndrome (SARS-CoV) in 2003 (WHO, 2020). The Public Health Emergency of International Concern (PHEIC) of COVID-19 was declared on January 30, 2020. The first suspected case of COVID-19 in Brazil was reported on January 27, 2020. In April, important trends of interiorization from the metropolises in all regions of the country were noticed, with a growing concern due to availability and capacity health services to attend the severe patients (Fiocruz, 2020a; Fiocruz, 2020b).

In addition to requiring international action towards disease control, these events are also highly demanding on professionals and health systems. Therefore, they can bring consequences for the surveillance and control of the local endemics, mainly those historically neglected, known as Neglected Tropical Diseases (NTDs) (Hotez, 2015; Ribacke et al., 2016). The population affected by these emergencies may experience effects such as reduced availability of health services, fewer health visits, failures in the diagnostic chain, decrease in vaccination, and increased incidence or underreporting of notifiable diseases (Ribacke et al., 2016; de Araújo et al., 2023).

Mosquito-borne arboviruses are high burdens for the public health systems around the world, with dengue being the most epidemiologically relevant urban arbovirus in the Americas (Ministério da Saúde, 2017). The two decades following 1995 marked the continent with more than 18 million cases, of which 14 million occurred in South America and 55% of the total were in Brazil (Nunes et al., 2019). Dengue is a neglected arbovirus with four known serotypes: DENV-1, DENV-2, DENV-3, DENV-4 (Culshaw et al., 2017). Despite having vertical and transfusional transmission routes, the most important of them is vectorial. The vector-human-vector cycle is maintained by female hematophagous dipterans from the genus *Aedes*, being the *Aedes aegypti* (Linnaeus, 1762) (Diptera: Culicidae) the main vector in the Americas. The species is also responsible for the vectorial transmission of Chikungunya virus (CHIKV) and Zika virus (ZIKV), in addition to transmitting yellow fever in urban regions (Ministério da Saúde, 2017).

In June 2020, the Pan American Health Organization (PAHO) reported that more than 1.6 million cases of dengue were registered in the continent in the first five months of the year. Of these, Brazil was responsible for 65% of the notifications, having notified the circulation of the four viral types (PAHO, 2020a). The municipality of Contagem, the third most populous in the State of Minas Gerais, is endemic to dengue, with the four viral serotypes circulating in different frequencies over the last decade (Andrade et al., 2016). The Rapid

Index Survey for *Aedes aegypti (Levantamento Rápido de Índices para Aedes aegypti,* LIRAa), held in January 2020 (unpublished data) in the municipality, presented the building infestation index (*Índice de Infestação Predial*, IPP) at alert level (SES-MG, 2020).

In face of an already complicated epidemiological scenario, it is necessary to evaluate the effects of the local epidemic of COVID-19 on the surveillance and control of dengue in a syndemic perspective. The analysis of these effects can be considered an important tool for the development of new protocols that can better respond to future crises.

MATERIAL AND METHODS

Ethical aspects

This study has been approved by the Ethics Committee in Research of the *Universidade Federal de Minas Gerais* (CAAE 46251021.6.0000.5149) and it was carried out in accordance with the Resolution of the National Health Council (CNS) number 466/2012, of December 12, 2012, which provides the guidelines and regulatory standards for research involving human beings (Ministério da Saúde, 2012).

Study area

The municipality of Contagem is part of the health regional and polarizing nucleus of urban and economic activities in the Metropolitan Region of Belo Horizonte, capital of the State of Minas Gerais, southeast region of Brazil. Situated in the central region of the State, the municipality has an area of 194,746 km² and a population of 621,865 inhabitants in 2022 (IBGE, 2022).

Study design and data source

An ecological study was carried out using secondary notification databases and municipal vector control indicators, made available by the Municipal Health Department of Contagem in July 2021. Dengue cases were provided for the years of 2018 to 2020 and the total of COVID-19 cases for 2020 was obtained by the sum of recorded cases from two different data sources: (1) COVID-19 database for outpatients, and (2) SARS database for hospitalized COVID-19 cases.

The entomological data included the total number of properties that were visited by the community health workers and that received or refused focal treatment with insecticides, the number of deposits that received larval treatment, and the amount of *Aedes* oviposition traps installed. These analyses were considered in six cycles with two months for each year from 2018 to 2020.

The years of 2018 and 2019 were considered, respectively, non-epidemic and epidemic for dengue, and provided a basis of comparison for the behavior of arbovirus and its indicators during the year of 2020.

Data analysis

The annual incidence of dengue, COVID-19, and SARS-COVID-19 per 100,000 inhabitants of the municipality was calculated according to Gordis (2017) considering the population annual estimates. Case fatality rate was calculated based on the number of deaths among probable cases.

The incidence of confirmed dengue cases per epidemiological week (EW), as well as the *Aedes* oviposition traps installed monthly, during the three years of study, were evaluated for normality by the Shapiro-Wilk test and by the Kruskal-Wallis (H) and Dunn's tests. The total number of properties that were visited and that had focal treatment performed or refused, as well as deposits treated with larvicides, for two-month cycles, were compared using Repeated-measures one-way ANOVA (F) and Tukey's test.

For correlation analysis, COVID-19 cases were added to SARS-COVID-19, since they are caused by the same etiological agent, although notified through different databases. Considering the year of 2020, Spearman test was used for correlation analysis between both diseases. Pearson was applied for correlation between both the domiciles and deposits that received insecticide treatment, and total incidence of COVID-19. The correlation between the variables was considered significant for p values less than or equal to 0.05 and its strength was measured by the r value, which varies between -1 and 1, indicating stronger correlations the further away from zero (Ayres et al., 2007). For this study, values below 0.30 were considered weak, 0.40 to 0.60 moderate and 0.7 to 1.0 strong (Filho & Júnior José, 2009).

In all performed tests, the significance level adopted to reject the null hypothesis was 5%. The databases were worked on using Microsoft 365 software 2019 version (CA, USA) and data analyzes were performed using the statistical package GraphPad Prism version 5.03 (La Jolla, CA, USA).

RESULTS

Dengue, COVID-19 and SARS-COVID-19

In the studied years, 2018 had an incidence rate of 62.36 per 100,000 inhabitants, 2019 of 5,655.30 and 2020 of 109.57 (Table). The gross number of hospitalizations in 2020 was the lowest when compared to other years, but higher than that of 2019 when considering the proportion between outpatients and hospitalized patients (1.18% in 2019 against 2.46% in 2020). There were

no deaths caused by dengue in 2020, a case fatality rate of 0.03% (12 patients) in 2019 and 0.24% (one patient) in 2018.

Table. Distribution of dengue, COVID-19 and SARS-COVID-19 cases, by classification, confirmation criteria and evolution, Contagem, 2018-2020.

	Dengue						COVID-19		SARS-COVID-19	
	2018		2019		2020		2020		2020	
	Total	%	Total	%	Total	%	Total	%	Total	%
Confirmation Criteria										
Laboratorial	306	74.5	10,420	27.8	280	38.2	17,739	96.3	1,992	87.0
Clinical-epidemiological	105	25.6	27,123	72.3	453	61.8	679	3.7	296	12.9
Outcome										
Hospitalization	21	5.1	444	1.2	18	2.5	100.00	100.0	2,288	100.0
Information not available	123	29.9	13,068	34.8	289	39.4	0.00	0.0	0	0.0
Deaths	1	0.2	12	0.0	0	0.0	4	0.0	651	28. 5
Information not available	26	6.3	2,638	7.0	9	1.2	4,994	27.1	153	6.7
Confirmed cases	411		37,543		733		18,418		2,288	
Incidence rate (per 100,000 inhabitants)	62.36		5,655.30		109.57		2,753.27		342.03	
Lethality (%)	0.2		0.0		0.0		0.0		28.5	

SARS-COVID-19: Severe Acute Respiratory Syndrome caused by COVID-19. Source: Municipal Health Department of Contagem, Minas Gerais, Brazil.

The distribution of dengue varied significantly during the period from 2018 to 2020 ($p < 0.001$) (Table, Figure 1), with 2019 having higher incidence of cases than 2018 ($p < 0.001$) and 2020 ($p < 0.001$). Although the incidence in 2020 was higher than in 2018, there was no significant difference between the two years ($p = 0.2176$).

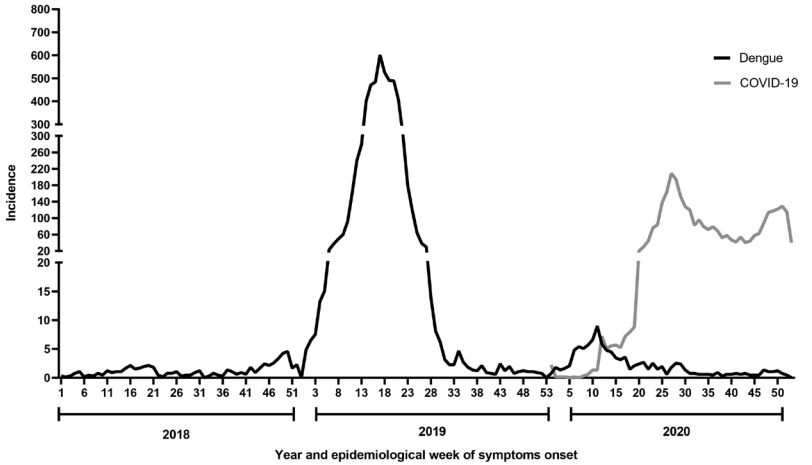

Figure 1. Time series of dengue and total COVID-19 incidence, Contagem, 2018 to 2020.

The same analysis was performed considering separately the first and second semesters of each year of analysis. Regarding the first semesters ($p < 0.001$), the year of 2019 had a statistically higher incidence than 2020 ($p < 0.001$), which was statistically higher than 2018 ($p = 0.0038$). In relation to the second semesters ($p = 0.0012$), 2019 had a statistically higher incidence than 2020 ($p = 0.0007$), with no significant difference between 2018 and 2020 ($p = 0.2912$).

For 2020, the analysis considering the incidence of dengue and COVID-19 showed a significant, moderate, and negative correlation ($r = -0.4743$; 95% CI -0.6646 to -0.2263; $p = 0.0003$). Considering the possibility of erroneous clinical-epidemiological diagnoses due to the similarity of symptoms, the same correlation analysis was performed considering the incidence of only laboratorial confirmed cases. The presented correlation was also significant, moderate and negative ($r = -0.5262$; 95% CI -0.7015 to -0.2909; $p < 0.001$).

Vector control

The number of oviposition traps installed monthly in the municipality varied significantly during the years from 2018 to 2020 ($p = 0.0170$). While there was no significant variation between 2018 and 2019 ($p > 0.999$), the year of 2020 had a significant lower number of traps installed when compared to 2018 ($p < 0.047$) and 2019 ($p = 0.0360$).

When comparing the number of properties visited per year by the community health workers, a statistically significant difference was found ($p = 0.0024$), with 2018 ($p = 0.00284$) and 2019 ($p = 0.002$) having a higher number of visits than 2020. The refusal to receive these workers for inspection and treatment ($p = 0.0194$) was higher in 2020 than in 2018 ($p = 0.0218$). Therefore, there was a significant difference among the properties that actually received focal treatment ($p < 0.001$), with the years of 2018 ($p < 0.001$) and 2019 ($p < 0.001$) having higher successful focal treatments than 2020 (Figure 2).

The number of deposits that received larval treatment also had significant differences ($p < 0.001$) (Figure 2), with the years of 2018 ($p = 0.0007$) and 2019 ($p < 0.001$) having higher number of treated deposits than 2020.

Considering only the year of 2020 there was a negative, significant and strong correlation between the number of properties that received focal treatment ($r = -0.8446$; 95% CI -0.9826 - 0.1051; $p = 0.0343$) and deposits that received larval treatment ($r = -0.9008$; 95% CI -0.9892 to -0.3319; $p = 0.0143$) in relation to the total incidence of COVID-19 in the municipality (Figure 2).

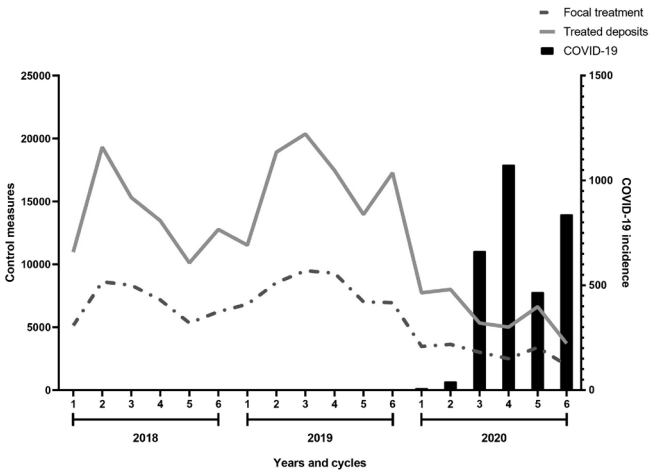

Figure 2. Number of properties that received focal treatment and deposits that received larval treatment for dengue control and total COVID-19 incidence, Contagem, 2020.

DISCUSSION

As a reflection of the increasingly significant epidemiological situation in the rest of the continent and country (Nunes et al., 2019), the municipality of Contagem, located in the Metropolitan Region of Belo Horizonte, has had important epidemic dengue episodes for the last decade.

It should be noted that laboratorial confirmed notifications were majority only in the non-epidemic year of 2018, with 74.3% of cases. Between 2019 and 2020, confirmations by clinical-epidemiological criteria reached, respectively, 72.2% and 61.8% of cases. The Brazilian Ministry of Health recommend that, during an epidemic, the confirmation trough clinical-epidemiological criteria can be utilized except of the first cases in the area, which must have laboratorial confirmation, a protocol followed by the State of Minas Gerais (Ministério da Saúde, 2009). Additionally, serology should be performed in at least 10.0% of suspected patients, except those with severe dengue and pregnant women, which necessarily require laboratorial confirmation (Ministério da Saúde, 2009; FUNED, 2020). The year of 2020, followed the same confirmation criteria and parameters of an epidemic year, indicating the overload of the health professionals and system.

Nationally, dengue cases tend to be concentrated at the first five months of the year, when the weather is hot and rainy, which benefits the reproduction and spread of the vector (Gomes et al., 2012; Rodrigues et al., 2016). The year of 2020 had a rapid increase of cases during the first EWs, with higher incidence rates than what would be expected for a non-epidemic year. At EW 11, when COVID-19 cases were rising in notifications, dengue took a sharp decrease, earlier than expected for the season, lowering the incidence to non-epidemic levels. The correlation analysis showed a significant, moderate, and negative association, indicating that the decrease in dengue cases coincided temporally with the increase of COVID-19 total cases. It should be noted that, even with the downward trend observed from EW 11 onwards, Brazil was the second country in the Southern Cone in the classification of highest cumulative incidence rates for dengue in 2020 (PAHO, 2020b).

The success of vector control is an essential factor for dengue surveillance and management. The National Dengue Control Program (*Programa Nacional de Controle da Dengue*, PNCD) reinforced the vector control pillar by predicting within surveillance the need to obtain data in real time. It is possible to use different indicators focused on the vector, and the ones related to eggs and larvae are free from the difficulties of working with the adult form, therefore, they are more practical and easily reproducible in surveillance programs (Ministério da Saúde, 2009).

Vector control analysis show that 2020 was an atypical year for entomological surveillance actions in Contagem, Minas Gerais. Some activities that remained relatively stable during the years 2018 and 2019, such as oviposition traps installation and focal and deposits treatment, had significant decreases during the year of 2020, with numerous factors that may have influenced their performance.

In March 2020, the national General Coordination of Arbovirus Surveillance (*Coordenação-Geral de Vigilância Arboviroses*, CGARB), along with the Ministry of Health, released informative notes suspending the second LIRAa, scheduled for April, recommending that the visit of community health workers should be limited to the peridomicile and discouraging visits if there were elderly people at the domicile at the time of the inspection, among other indications (Ministério da Saúde, 2020a; Ministério da Saúde, 2020b). Such recommendations extended to malaria and leishmaniasis control activities (Ministério da Saúde, 2020c).

Refusal of focal treatment in private properties occurred mainly during the first four cycles of the year and decreased between the fifth and sixth cycles in Contagem, Minas Gerais. Although not documented, it is suggested that the refusal was related to the fear of contamination, especially at home (Dantés et al., 2020), which would explain the decrease in refusal during the last cycles of the year, when isolation measures were mitigated. The increase in total cases of COVID-19 presented a negative, significant and strong correlation with the decreased number of properties that received focal treatment and deposits that received larval treatment, indicating a significant reduction in these control measures during the advance of the epidemic.

The decrease in the entomological surveillance and control activities can promote direct and indirect effects capable of significantly affecting the course of current and future dengue epidemics. As the decrease in control promotes a general increase of dengue cases, the lockdown directs this increase to residential areas instead of public spaces (Aborode et al., 2022). In addition, the main vector density indicators are obtained with LIRAa, which was discontinued in 2020. Therefore, vector control during the first year of COVID-19 epidemic was carried out based on indicators provided by a weakened surveillance, which contributes to an increase of vector population, a fact already observed in an entomological survey in India (Reegan et al., 2020).

As a limitation of the study, it is necessary to consider that the initials symptoms of COVID-19 can easily be mistaken for dengue, and vice versa. Therefore, do not rule out the role of co-infections, cross-reactions and diagnosis errors in the official prevalence data for both diseases. Shared symptoms, such as fever and joint pain, and even respiratory symptoms for severe dengue, and laboratorial parameters such as lymphopenia, leukopenia, thrombocytopenia and increased transaminases can mislead the diagnosis (Suryana, 2020). Another important limitation is the quality of data for COVID-19 outpatients, since the database has a higher number of professionals accredited for notifications. These limitations were addressed during the correlation analysis by considering only laboratorial confirmed cases, since erroneous diagnosis could impact the statistical analysis. The lack of follow-up for outpatients also limits the investigation of health predictors.

This study expands the understanding of how factors associated with PHEIC impact on notifiable diseases surveillance and control programs, going beyond health systems and exposing socioeconomic inequity as a determinant within the affected populations. Despite the indisputable need to control PHEIC, the resources and attention of health authorities reallocated to the new emergency can lead, over time, to the weakening of health systems, causing the population to lose years of healthy life and requiring expensive future investments by governments. Regarding the relationship between COVID-19 and dengue, there was a correlation between both diseases, with a higher-than-expected proportion of dengue cases presenting a sharp decline from epidemiological week 11 onwards, coinciding with the rise of COVID-19 cases. There was also a reduction in vector control, with the national suspension of the second LIRAa and a significant decrease in the installation of oviposition traps, properties visited for monitoring and that received focal treatment.

Our results and the difficulties observed in different instances of dengue control corroborate the hypothesis of weakening of the surveillance program and possible underreporting of dengue cases as a result of the COVID-19 emergency. The analysis of these effects can be considered an important tool for the development of new protocols that can better respond to future crises and, therefore, it is expected that the understanding acquired by these results can be applied to different realities that present similar contexts.

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CONFLICT OF INTEREST

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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