

**Mapping of externalities caused by recent dengue epidemics in the accounts of the Municipality of Ribeirão Preto**

*Mapeo de externalidades provocadas por las recientes epidemias de dengue en las cuentas del Municipio de Ribeirão Preto*

*Mapeamento das externalidades provocadas pelas recentes epidemias de dengue nas contas da Prefeitura Municipal de Ribeirão Preto*

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**Abstract**

The main was to map the externalities caused by the recent dengue epidemics in the accounts of the Municipality of Ribeirão Preto and estimate the partial costs related to the disease from the perspective of the SUS. This is a retrospective study, analyzing the costs related to dengue epidemics through the components: human resources, medicines, supplies, and hospitalizations related to the disease in the city of Ribeirão Preto and subsequent comparison between the epidemic years (2016 and 2019) and endemic diseases (2017 and 2018) and assessment of the economic and budgetary impact. The partial cost estimate and budget impact compared to the epidemic and endemic years was 15,484,446.83 BRL, the excess expenditure on NS1 kits in the epidemic years 2016 and 2019 was 142,549.97 BRL, epidemic years an average of 1,623% more was spent on hospital beds and indirect costs generated an additional cost of 354,624.24 BRL. This initial economic assessment provided information on the costs of the priority components related to dengue and, consequently, support for managers' decision-making and better planning of disease control and prevention activities, as well as guidance for better allocation of budgetary resources.

**Descriptors:** Dengue; Costs; Epidemic; Economic Impact; Budget.

**Resumén**

El objetivo fue mapear las externalidades causadas por las recientes epidemias de dengue en las cuentas del Municipio de Ribeirão Preto y estimar los costos parciales relacionados con la enfermedad desde la perspectiva del SUS. Se trata de un estudio retrospectivo, que analiza los costos relacionados con las epidemias de dengue a través de los componentes: recursos humanos, medicamentos, insumos y hospitalizaciones relacionadas con la enfermedad en la ciudad de Ribeirão Preto y posterior comparación entre los años de epidemia (2016 y 2019) y las enfermedades endémicas. (2017 y 2018) y evaluación del impacto económico y presupuestario. La estimación parcial de costos y el impacto presupuestario en comparación con los años epidémicos y endémicos fue de R\$ 15.484.446,83, el exceso de gasto en kits NS1 en los años epidémicos 2016 y 2019 fue de R\$ 142.549,97, en los años epidémicos se gastó en promedio un 1.623% más en camas de hospital y costos indirectos. generó un costo adicional de R\$ 354.624,24. Esta evaluación económica inicial proporcionó información sobre los costos de los componentes prioritarios relacionados con el dengue y, en consecuencia, apoyo a la toma de decisiones de los gestores y una mejor planificación de las actividades de prevención y control de enfermedades, así como orientación para una mejor asignación de los recursos presupuestarios.

**Descriptoros:** Dengue; Costos; Epidemia; Impacto Económico; Presupuesto.

**Resumo**

Objetivou-se mapear as externalidades provocadas pelas recentes epidemias de dengue nas contas da Prefeitura Municipal de Ribeirão Preto e estimar os custos parciais relacionados a doença sob a perspectiva do SUS. Trata-se de um estudo retrospectivo, com análise dos custos relacionados a epidemias de dengue por meio dos componentes: recursos humanos, medicamentos, insumos e internações relacionados à doença no município de Ribeirão Preto e posterior comparação entre os anos epidêmicos (2016 e 2019) e endêmicos (2017 e 2018) e avaliação do impacto econômico e orçamentário. A estimativa de custo parcial e o impacto no orçamento em comparação a anos epidêmicos e endêmicos foi de R\$ 15.484.446,83, o gasto excessivo com kits NS1 nos anos epidêmicos de 2016 e 2019 foi de R\$ 142.549,97, anos epidêmicos gastou-se em média 1.623% a mais com leitos de internações e os custos indiretos geraram um custo adicional de R\$ 354.624,24. Essa avaliação econômica inicial forneceu subsídios sobre os custos dos componentes prioritários relacionados à dengue e, em consequência, subsídios para a tomada de decisão dos gestores e melhor planejamento das atividades de controle e prevenção da doença bem como a orientação para melhor destinação dos recursos orçamentários.

**Descriptoros:** Dengue; Custos; Epidemia; Impacto Econômico; Orçamento.



## Introduction

Dengue has become one of the most widespread diseases in recent decades. The incidence of dengue has increased 30 times in the last 50 years. It is currently endemic to 128 countries, most of them developing, representing a threat to approximately 3.97 billion individuals per year<sup>1</sup>, exposing nearly a third of the global human population to the risk of infection<sup>2</sup>.

Dengue is a disease caused by one of the four serotypes of the DENVs 1-4 virus, whose main vector is *Aedes aegypti*, and is transmitted to humans through the bite of infected female mosquitoes<sup>3</sup>. The disease is mainly concentrated in subtropical and tropical regions<sup>2</sup> and represents a major public health problem associated with mortality, morbidity, and significant economic cost, particularly in developing countries<sup>4</sup>. It is a compulsory notification disease, that is, health professionals or managers of public or private services that provide patient care must, by obligation, notify the suspicion or confirmation of the disease<sup>5</sup>.

The financial impact of therapeutic intervention protocols for the disease in Brazil is relevant<sup>6</sup>, and, therefore, it is expected that this research can contribute to the research agenda in the country to guide both public policymakers and public health managers, to reduce the spread of the disease and, consequently, reduce the budgetary impact on public accounts.

The severity of the disease and the hospitalization rate are increasing and negatively interfering with the growth and development of countries, especially in Latin America<sup>7,8</sup>. The Americas have been suffering from the proliferation of dengue fever in recent decades. In 2015, more than 2 million cases were reported, of which 1.65 million were registered in Brazil<sup>9,10</sup>. Dengue is among the 5 main neglected diseases on this continent, generating a cost between 2000 and 2007 of US\$2.1 billion<sup>11</sup>.

In five countries in the Americas (Venezuela, El Salvador, Guatemala, Panama, and Brazil), and three countries in Asia (Malaysia, Cambodia, and Thailand), annual expenses were identified that could exceed US\$1.8 billion imposed by dengue-related costs in the health sector and economy, considering disease treatments<sup>10</sup>, vector surveillance and control.

In Brazil, outbreaks and epidemics are increasingly significant and have occurred with less time between them and with the co-circulation of viral serotypes. This fact is responsible for the increase in the number of serious cases, deaths, and the difficulty of combating the vector, generating a worrying epidemiological scenario<sup>3</sup>. The economic and social impact of combating arbovirus disease in Brazil, with quantification of direct medical expenses related to disease management in the Unified Health System (SUS), has generated indirect costs related to absenteeism, resulting in approximately 2.3 billion BRL in 2016<sup>9</sup>.

The costs that epidemics transmitted by *Aedes aegypti* cause for society make clear the need for investment in efficient prevention. When it comes to combating dengue fever alone, which costs Brazil US\$1.35 billion per year in

treatment, around US\$1 billion per year is spent on controlling the vector. As a result, a considerable part of the investment, however, focuses on actions to combat the mosquito in its adult stage, especially during periods of epidemics<sup>3</sup>.

In this sense, there are few studies on the economic impact of dengue from the perspective of society, dengue has become a serious public health problem and despite its growing expressiveness, the economic literature is quite scattered<sup>6</sup>, with few studies and application of controllership tools on the assessment and economic impact of this disease on municipal public coffers.

Given this scenario, this work aimed to map the externalities caused by recent dengue epidemics in the accounts of the Municipality of Ribeirão Preto and estimate the partial costs related to the disease from the perspective of the SUS.

## Methodology

This is a retrospective study, with an analysis period from 2016 to 2019, considering the epidemic years of disease transmission in 2016 and 2019 and endemic years 2017 and 2018, in the city of Ribeirão Preto, located in the interior of the state of São Paulo, characterized as an endemic region for dengue, as it has already experienced several epidemics and currently has a high incidence rate of the disease. The *Aedes aegypti* mosquito was first identified in the municipality in 1986. Since 2005, the municipality has recorded suspected and confirmed cases of dengue in every month of the year, alternating periods of high and low transmission<sup>12-14</sup>.

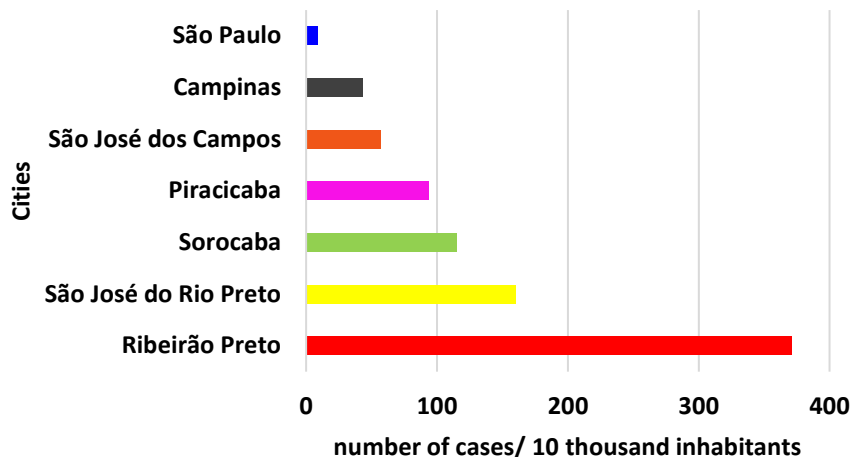
According to the Epidemiological Bulletin of the São Paulo State Department of Health and population data from the Brazilian Institute of Geography and Statistics (IBGE), among the cities in the State of São Paulo with the highest number of dengue cases and with a population greater than 300 thousand inhabitants, Ribeirão Preto leads and appears as the city with the highest number of notifications (suspects)<sup>13,14</sup>, as shown in Figure 1.

The estimated cost calculations are under the Guidelines recommended by the Ministry of Health; therefore, they were based on reported cases of the disease<sup>15</sup>. In this sense, it was considered that from the moment of notification, patients have already been subjected to care protocols, regardless of the result of the final exam obtained, often after a few days.

The cost components analyzed were human resources, medicines, supplies, and hospitalizations. Concerning human resources, the cost of dengue reference teams stationed in all Health Units was estimated, as well as the difference in the number of shifts of employees directly related to dengue in epidemic and endemic years, such as combating endemic diseases, doctors, and nurses. In laboratory tests to diagnose the disease, NS1 blood reagent kits were used. To calculate the costs of this item, the value of the kit used at the time of the Bidding and the number of exams carried out were considered.



Figure 1. Graph of reported dengue cases between January and April 2020. Ribeirão Preto, SP, Brazil, 2023



Source: Epidemiological Bulletin of the Ribeirão Preto Health Department, 2020<sup>16</sup>.

Medication quantification was carried out based on output control reports from the Pharmacy and Diagnostic Support Division for health units, as well as through medication dispensing reports extracted from the Hygia Web System. To calculate cost values unit, an average was made considering the prices charged at the time of the medicine's Tender, also available in the same report. Medicines indicated by the Ministry of Health Guidelines were considered<sup>17</sup>.

Furthermore, the compilation of data obtained through Contingency Plans to Combat Human Arboviruses, Epidemiological Bulletins, and other administrative and financial reports were the basis for calculations and partial assessments of expenses involved with the disease in the years 2016 to 2019<sup>12-14</sup>.

Finally, to map externalities, the averages of the components used in epidemic and endemic years were

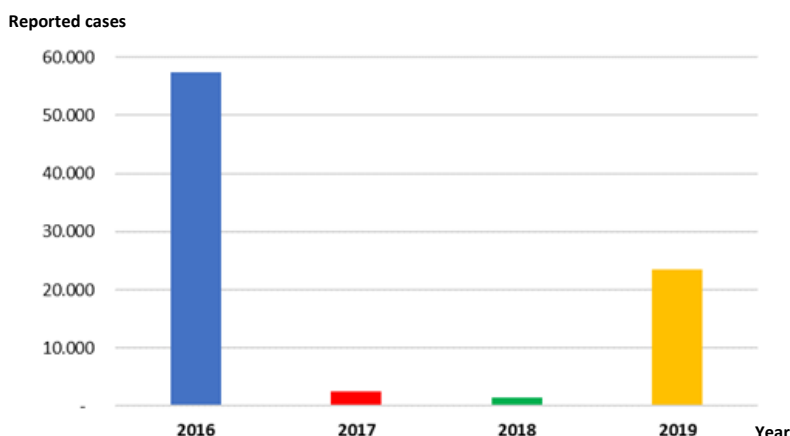
calculated and the excess value (difference) obtained in these years was determined.

The study was developed to ensure compliance with the precepts of Resolution No. 466/12 and Resolution No. 510/16, on ethics in research in Brazil, according to Article IV "[...] all research involving human beings must be submitted for consideration by a Research Ethics Committee [...]", with studies that deal with secondary data analysis, with aggregated information, without the possibility of individual identification being exempt.

### Results and Discussion

The studies began with defining the period to be investigated. According to Figure 2, it was found that in 2016 and 2019 there were epidemic crises of the disease in the city of Ribeirão Preto and, to have comparison parameters, it was defined as an epidemic in 2016 and 2019 and endemic in 2017 and 2018<sup>16</sup>.

Figure 2. Graph of the number of cases reported in Ribeirão Preto from 2016 to 2019. Ribeirão Preto, SP, Brazil, 2023



Source: Epidemiological Bulletin of the Ribeirão Preto Health Department, 2020<sup>16</sup>.

Initially, the number of NS1 exams performed was analyzed. According to the Municipal Health Laboratory of Ribeirão Preto, NS1 tests to detect dengue are carried out on all suspected patients, except for different guidelines and

protocols in cases of outbreaks, as occurred in 2016. According to information from the Epidemiological Surveillance Division (DVE), the number of tests carried out in 2019 was much higher than in 2016, since due to the



epidemic outbreak in 2016, the positivity of the tests was greater than 80%. In these situations, it is already considered that there is a high viral circulation, characterizing an epidemic. Under these conditions, collection is suspended, and these tests will only be carried out in serious cases and for pregnant women.

In this way, calculating the expenses with NS1 kits in the endemic and epidemic periods, we obtained an average of 159,041.15 BRL for the epidemic years and 16,491.17 BRL for the endemic years. Thus, excessive spending on NS1 kits in the epidemic years of 2016 and 2019 was 142,549.97 BRL.

Furthermore, in each Primary Care Health Unit there is a reference team made up of a doctor and nurse focused on dengue. This team develops both the role of technical and assistance supporter and is also responsible for multiplying educational and training actions within the respective health units. Therefore, considering the 6 months with the highest number of cases in the epidemic years, the cost of human resources directly involved with dengue in health units was estimated, which was approximately 10,808,486.37 BRL.

When there are outbreak and epidemic situations, it is necessary to form specific reference teams also in the Emergency Care Units. This cost was calculated for 6 months in the epidemic year since, in both 2016 and 2019, the largest number of cases were concentrated in 6 months. It should be noted that this calculation is an estimate to compose the direct costs involved with dengue using as a reference the values practiced by the City of Ribeirão Preto as in 2018 Management Contracts were signed between the City Hall and the Santa Lydia Hospital Foundation for 3 Units of Emergency Care of the total of 4 that were in the municipality at that time.

Still concerning human resources, the costs of the shifts of agents to combat endemic diseases (ACE) were estimated, which are those employees whose duties are: inspecting residences, vacant lots, commercial establishments, inspecting water tanks, roofs, and gutters seeking to eliminate dengue outbreaks. In addition, they apply larvicides and insecticides and guide the population.

It was observed that the ACEs carried out more shifts in the epidemic years, as there were more actions in the field to raise public awareness, prevention, mobilization, and chemical and biological management, as well as the "dengue dragnets", which are joint efforts for cleaning and elimination of potential breeding sites for dengue mosquitoes, especially in regions with the most notifications. There was an additional difference in the cost of shifts worth 28,214.39 BRL between the epidemic and endemic years. Regarding hospitalization beds, it was found that in epidemic years, an average of 1,623% more was spent on hospitalization beds for patients with dengue fever than in endemic years, which is equivalent to 144,642.37 BRL for the coffer municipal. The bed values considered the type of bed, days of hospitalization, and procedures performed per patient.

Regarding pharmaceutical assistance, in epidemic years there was an increase in the consumption of medicines

recommended by the Ministry of Health Guidelines, and which are generally prescribed to alleviate dengue symptoms<sup>17</sup>, they are salts for oral rehydration, dipyrone (drops and tablets), paracetamol (drops and tablets) and 0.9% saline solution.

The drug dipyrone in the pharmaceutical form of a 500 mg tablet was included and standardized by the Municipal Health Network of Ribeirão Preto at the end of 2017. Thus, the prescription and dispensing of dipyrone oral solution was directly affected from the moment it became available in a new pharmaceutical form. Therefore, the cost of all pharmaceutical forms of dipyrone was analyzed only in the years 2018 (endemic) and 2019 (epidemic).

The amount of dipyrone dispensed was higher in 2019, as expected. Furthermore, the values used to estimate the cost were those practiced by the City Hall after bidding for the medicine and made available through reports from the Pharmacy and Diagnostic Support Division. An additional 130,027.17 BRL was spent on dipyrone in 2019.

For the other medicines, after quantifying dispensing, the average costs of the epidemic (2016 and 2019) and endemic (2017 and 2018) years were calculated. There is a difference in the cost of medicines of 1,423,006.80 BRL between the years 2016 and 2019 and the years 2017 and 2018.

Concerning indirect costs, that is, those not directly linked to operational activities, a forecast was made of input costs for assistance in a year with a dengue epidemic, such as syringes, needles, gloves, and collection tubes, among others<sup>13,14</sup>. The difference obtained between a year with a dengue epidemic and a year without an epidemic was 354,624.24 BRL.

After compiling the data, it was possible to map the externalities caused by the recent dengue epidemics in the accounts of the Municipality of Ribeirão Preto, which is shown in Table 1.

Although notifications were greater in some months of the year, the calculations of most components were based on the entire year, only data from the shifts of the reference teams in the Health Units, the shifts in the Emergency Care Units, and the inputs were estimated for 6 months. This fact is justified by the decrease in cases in the other months of the year, characterizing behavior like endemic years. The estimated incremental cost of dengue in epidemic years was 15,484,446.83 BRL for public coffers.

NS1 tests to detect dengue are carried out on all suspected patients, except different guidelines and protocols in cases of outbreaks, as occurred in 2016, in which the positivity of the tests was greater than 80%. On the other hand, in 2019 there was no such interruption, as despite the increasing number of collections, the results did not reach more than 70% positivity. Most likely due to the circulation of a new DENV-2 variant of the virus.

After mapping the externalities caused by dengue epidemics in the municipality of Ribeirão Preto, the partial cost estimate and the impact on the municipality's budget obtained in dengue epidemic years (2016 and 2019) compared to the endemic years (2017 and 2018) was 15,484,446.83 BRL.



**Table 1.** Partial cost estimate for dengue epidemic years in the city of Ribeirão Preto. Ribeirão Preto, SP, Brazil, 2023

Components	Cost
NS1 Kits	142,549.97 BRL
Reference teams	10,808,486.37 BRL
Inpatient beds	144,642.37 BRL
Medicines	1,553,033.97 BRL
Teams in Emergency Care Units	2,452,895.52 BRL
ACE shifts	28,214.39 BRL
Supplies	354,624.24 BRL
<b>TOTAL COST</b>	<b>15,484,446.83 BRL</b>

The Department of Health Surveillance is responsible for the permanent analysis of the population's health conditions and one of its main objectives is to control and prevent the occurrence of epidemics and deaths. In this way, through the promotion and execution of practices that aim to protect the health of the community, it is capable of confronting, preventing, and controlling existing diseases

and illnesses. Controlling dengue, for example, is one of its main challenges. Therefore, to analyze the representativeness of this cost in the budget planning of the Department's expenses, the budget available in the Annual Budget Law (LOA) for the financial years of the years in question was verified, as shown in Table 2.

**Table 2.** Budget for the Health Surveillance Department. Ribeirão Preto, SP, Brazil, 2023

Health Surveillance Department Budget	
2016	43,749,575.00 BRL
2017	47,353,575.00 BRL
2018	52,225,811.20 BRL
2019	59,302,669.67 BRL

Source: LOA – Ribeirão Preto City Hall.

When calculating the average of the epidemic years, the value of 51,526,122.34 BLR was obtained, thus the partial cost estimate obtained in epidemic years (2016 and 2019) of 15,484,446.83 BRL cost, approximately, 30% of budgetary and financial resources allocated to the Department.

### Conclusion

Although the clinical picture and symptoms are often severe and the disease causes sequelae (liver, heart, neurological, respiratory problems), the low mortality may

be related to the scarcity of studies as well as the fact that it is a neglected disease. and spread, mainly, in less developed countries.

The study showed that despite all the complications, obtaining an estimate of the partial cost of dengue is important data for decision-making and better planning of disease control and prevention activities. It is believed that it can be considered the beginning of a broader study to obtain mutual action between interested parties, that is, population, managers, and researchers and to better direct public resources in the municipality.

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