Funding for research on dengue in Brazil, 2004-2020

Financiamento de pesquisas sobre dengue no Brasil, 2004-2020

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ABSTRACT Dengue represents an important public health problem in Brazil, due to the constant epidemics caused by the disease in the country. This study aimed to analyze the funding of research on dengue by the Department of Science and Technology of the Ministry of Health of Brazil and partners between 2004 to 2020. Was analyzed the trend of the funding by generalized linear regression using Prais-Winster and its distribution between Brazilian regions and Federated Units, research contracting modalities, benefited institutions, and studied themes. Between 2004 and 2020, 232 research studies were funded (R$ 164.03 million), carried out mostly in institutions in the Southeast Region (77.55%), addressing especially the vector control theme (37.93%). The funding trend was stationary in the years studied. The state calls were the main form of contracting modality for the research (65.95%). There was a statistically significant difference in the distribution of the loan amount between the contracting modalities, and in the number of researches funded and loan amount among Brazilian regions. These findings demonstrate the importance of monitoring the research funding on dengue in Brazil and of implementing strategies to evaluate the research funded, to support and improve the policy to combat the disease and its vector.

KEYWORDS Dengue. Neglected diseases. Research financing. Research policy evaluation.

RESUMO *A dengue representa um importante problema de saúde pública no Brasil devido às constantes epidemias causadas pela doença no País. Este estudo objetivou analisar o financiamento de pesquisas sobre dengue pelo Departamento de Ciência e Tecnologia do Ministério da Saúde e parceiros no período de 2004 a 2020. Analisou-se a tendência do financiamento por regressão linear generalizada do tipo Prais-Winster e sua distribuição entre as regiões e Unidades Federadas brasileiras, modalidades de contratação das pesquisas, instituições beneficiadas e temas estudados. Entre 2004 e 2020, financiaram-se 232 pesquisas (R$ 164,03 milhões), realizadas, em sua maioria, em instituições da região Sudeste (77,55%), abordando especialmente a temática controle vetorial (37,93%). A tendência de financiamento foi estacionária nos anos estudados. As chamadas estaduais foram a principal forma de modalidade de contratação das pesquisas (65,95%). Houve diferença estatisticamente significante na distribuição do valor financiado entre as modalidades de contratação, bem como no número de pesquisas financiadas e valor financiado entre as regiões brasileiras. Esses achados demonstram a importância de monitorar o financiamento de pesquisas sobre dengue no Brasil e de implementar estratégias de avaliação das pesquisas financiadas, para subsidiar e aprimorar a política de enfrentamento da doença e de seu vetor.*

PALAVRAS-CHAVE *Dengue. Doenças negligenciadas. Financiamento da pesquisa. Avaliação de políticas de pesquisa.*

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Introduction

Dengue is an acute febrile illness, classified as a Neglected Tropical Disease by the World Health Organization (WHO), which represents one of the most important public health problems in the world[1-3]. It is endemic in more than 100 countries in Africa, the Americas, the Eastern Mediterranean, Southeast Asia and the Western Pacific, and it is estimated that half of the world's population lives in areas at risk for the disease[4,5].

Although dengue has low mortality rates, it has a considerable socioeconomic and health impact, as it influences the loss of healthy years of life by affecting many people, leading to disability during the period of symptomatic infection and, mainly, by causing deaths in children[6]. In addition, unlike other Neglected Tropical Diseases, which mainly affect populations in a situation of socioeconomic vulnerability, dengue affects populations of all social classes, however, its burden is concentrated especially in poor populations, who live in places with precarious structures of sanitation, garbage collection and water supply[7-9].

In Brazil, the transmission vector of the disease is the *Aedes aegypti* mosquito. Between 2013 and 2021, around 6 million cases and 4,300 deaths were recorded, being the highest prevalence of the disease in South America. In 2019, the country ranked 6th in terms of dengue burden in the world (18.74 DALY per 100,000 inhabitants)[10,11]. The high number of cases in Brazil is explained by climatic conditions, population size and failure of measures to control the disease[9].

In addition to the impacts caused by dengue on the socioeconomic and health system, the disease poses challenges to technological Research and Development (R&D) due to its rapid expansion around the world, lack of specific treatments (mainly for severe dengue) or rapid and inexpensive diagnostic tests, as well as ineffective vector control methods.

In this way, encouraging R&D in the area is essential for the advancement of knowledge, development and improvement of technologies aimed at reducing cases. Brazil is among the ten countries that most study and publish on dengue[12-14], however, there is a lack of information on research fundings for the subject. This information is relevant to direct priorities and actions to control dengue and, consequently, other arboviruses, such as yellow fever, zika or chikungunya, which have the same vector.

Within the scope of the Ministry of Health, the financing of R&D in health is coordinated by the Department of Science and Technology (DECIT) which aims to contribute to solving problems of the Unified Health System (SUS) and to the health of the Brazilian population[15].

In view of the epidemiological relevance and impacts caused by dengue in Brazil, it is necessary to understand the financing of dengue research by the DECIT of the Ministry of Health over the years, in order to obtain subsidies for the formulation, evaluation and monitoring of public policies to face the disease and for the direction and optimization of R&D efforts in the area.

This study analyzed the financing of research on dengue by DECIT of the Ministry of Health and partners, in relation to its evolution in the period from 2004 to 2020, its distribution among the research contracting modalities, regions and Federated Units (UF) of Brazil and of beneficiary institutions.

Materials and methods

Context of the study

Science, Technology and Innovation in Health (CTIS) is among the competences and attributions of the SUS, defined in the Federal Constitution of 1988 and in the Health's Organic Law nº 8.080/1990[16,17]. In

2000, DECIT was created to coordinate R&D actions at the Ministry of Health, which operates in partnership with national, state and international development agencies, with other departments of the Ministry of Health and with other federal government agencies, oriented towards by the National Agenda of Health Research Priorities (ANPPS), a guiding document that contains priority R&D themes for the SUS, including dengue[15,18,19].

The DECIT of the Ministry of Health finances health research through three contracting methods[18]: a) national calls, in which public notices are issued for the public selection of research, usually in partnership with the National Council for Scientific and Technological Development (CNPq) or other national and international agencies for scientific promotion; b) state calls, operated by the Research Program for the SUS (PPSUS), in which public notices are launched at the state level, in partnership with CNPq, State Research Support Foundations (state-level funding agencies), State Departments of Health, Science and/or Technology for public selection of research aimed at the needs of Brazilian Federal Units (FUs); and c) Direct Hiring, a modality in which researchers or research groups are hired without public selection, directed to themes and strategic demands of the Ministry of Health or emergency situations in public health.

Study design

This is a descriptive, retrospective study, with a quantitative approach, in order to analyze the financing of research on dengue by DECIT of the Ministry of Health and partners in the period from 2004 to 2020. This time frame was used for two reasons: a) in 2004 started the managing of Science and Technology at DECIT based on the ANPPS; and b) 2020, because of to the availability of data in Pesquisa Saúde, a public repository of research funded by DECIT, available at https://pesquisasaude. saude.gov.br/.

Data source and variables

Data collection took place in June 2022 in the Pesquisa Saúde repository. Data extracted from the repository were organized in a Microsoft Excel® spreadsheet. The screening of research occurred by reading titles and abstracts, using the descriptors: dengue, DENV and Aedes aegypti. Searches that contained the descriptors in the title or abstract were included; and those that were not related to the theme of dengue were excluded from the sample (12 research).

Investigations considered eligible for the study were stratified by: year of contracting, financed amount, research contracting modality, region of Brazil and FU where the institution responsible for carrying out the research is headquartered.

Studies were also classified by theme: a) Vector Control: research that develops new mechanisms for vector control of the dengue mosquito or evaluates existing technologies; b) Health Surveillance: surveys that evaluate the implantation, implementation or formulation of new actions for dengue surveillance and control; c) Diagnosis and Treatment: research that seeks therapeutic alternatives, new diagnostic methods for dengue or research that evaluates existing technologies; d) Immunology and Virology: research that evaluate the immunological mechanisms, the specificities of dengue viruses and their behavior in vitro, in animals and humans.

Both the screening and classification of research by theme occurred in pairs, and disagreements were decided by consensus.

Data analysis

The database of research on dengue was transferred from Microsoft Excel® to the statistical software R, version 4.1.3, for statistical analysis of the data, adopting a significance level of 5%.

The values financed by research were adjusted by the Extended National Consumer Price Index of the Brazilian Institute of

Geography and Statistics, for updating according to inflation in Brazil, using the month of December 2021 as a reference for standardization.

The temporal trend analysis of the number of funded studies and the financed amount was carried out using the Prais-Winster generalized linear regression model, to calculate the Annual Percent Change (APC), with the respective Confidence Intervals (CI) of 95%, considering the year in which the financing was carried out as the dependent variable. A positive APC indicates an increasing trend in the amount of research contracted or invested amount, a negative one indicates a decreasing trend, and when there is no statistically significant difference, the trend is considered stationary, that is, it indicates that there was no growth or reduction[20].

In order to analyze the differences in the distribution of the number of financed research and the amounts financed between the research contracting modalities and between the regions of Brazil, the Kruskal-Wallis test was used. For statistically significant Kruskal-Wallis test results (p value <0.05), the *post-hoc* Nemeyi test was subsequently applied, which allowed to identify which research contracting modalities and regions of Brazil were different from each other.

For all variables, the calculation of absolute and relative frequencies was performed, and the descriptive results were presented in tables and graphs.

Ethical aspects of the study

This study is part of the investigation entitled 'Evaluation of the Impacts of Research on Neglected Tropical Diseases in Brazil' and was approved by the Research Ethics Committee of the Faculty of Ceilândia, University of Brasília (CAEE nº 46003821.0.0000.8093).
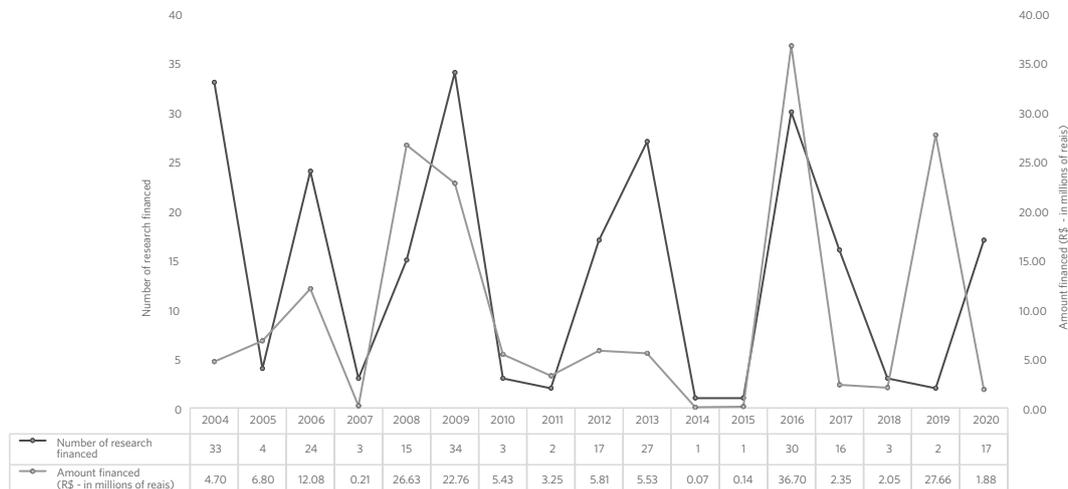
Results

From 2004 to 2020, DECIT and partners funded 232 studies on dengue, totaling an investment of R$ 164.03 million.

Historical evolution of research funding on dengue

In the years 2009, 2004 and 2016, the largest number of studies were contracted (34, 33 and 30 respectively). The largest investments were made in 2016 (BRL 36.70 million), 2019 (BRL 27.66 million) and 2008 (BRL 26.63 million). The contracting of research and the financing were continuous over the years, with low and high peaks, however, the number of financed research and the investment destined for those showed a stationary trend, with APC of -3.45% (CI95 %:-6.77;0.0004) and 0.71% (CI95%-0.001;1.42) respectively (*graph 1*).

Graph 1. Historical evolution of funding for research on dengue financed by the Department of Science and Technology of the Ministry of Health and partners. Brazil, 2004 to 2020

	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Number of research financed	33	4	24	3	15	34	3	2	17	27	1	1	30	16	3	2	17
Amount financed (R$ - in millions of reais)	4.70	6.80	12.08	0.21	26.63	22.76	5.43	3.25	5.81	5.53	0.07	0.14	36.70	2.35	2.05	27.66	1.88

Source: Own elaboration, based on data from the Pesquisa Saúde repository[21].

Distribution of funding for research on dengue by research contracting method and regions of Brazil

The state-level calls, operated by the PPSUS, financed the largest number of dengue research (65.95%), through 85 public notices. However, most financial resources were concentrated in national calls (41.54%), through 12 public notices for science promotion (*table 1*).

Despite having funded only seven research, the direct contracting modality had the highest average value used in research on dengue. It is worth noting that 36.36% of the resources for this type of contract were allocated to four surveys related to the World Mosquito Program project, which studies the implementation of the Wolbachia method in Brazil, aimed at controlling the *Aedes aegypti* mosquito (*table 1*).

Regarding the difference in the distribution of the number of funded researches between the hiring modalities, using the Kruskal-Wallis test, it was verified that there was no statistically significant difference (p value>0.05). However, with regard to the distribution of resources between the research contracting modalities, a statistically significant difference was observed between, at least, one of the contracting modalities (p value <0.05). Thus, the Nemenyi *post-hoc* test was applied, in which it was possible to observe statistically significant differences between the modality of state-level calls (PPSUS) with the other modalities (state calls and direct contracting – p value = 0.021; state calls and national calls – p value=0.000) (*table 1*).

Regarding the distribution of the number of studies financed by the regions of Brazil, it was verified that institutions based in the Northeast region were responsible for carrying out the largest number of research on dengue (36.21%), however, institutions based in the Southeast region concentrated 77.55% of resources (*table 1*).

A significant difference was observed between, at least, two regions, both in the number of sponsored research and in the distribution of the funded amount (Kruskal-Wallis test – p value <0.05). With the *post-hoc* Nemenyi test, a statistically significant difference was noticed in the number of studies between the South and Northeast regions (p value <0.006). As for the distribution of financed amounts, the

difference was statistically significant between the Northeast and Central-West (p value=0.018), Northeast and North (p value=0.025), Southeast and Central-West (p value= 0.000), Southeast and North (p value=0.000) and Southeast and Northeast (p value=0.003) (*table 1*).

Table 1. Distribution of research on dengue financed by the Department of Science and Technology of the Ministry of Health and partners by research contracting method and Region of Brazil. Brazil, 2004 to 2020

Variables	Number of funded research (%)	Amount financed in millions of reais - R$ (%)	Average amount financed in millions of reais – R$
Research hiring modality	**Kruskal-Wallis test (p> 0.05)**	**Kruskal-Wallis test (p <0.05)[1]**	-
State calls (PPSUS)*	153 (65.95)	35.32 (21.53)	0.23
National calls*	72 (31.03)	68.14 (41.54)	0.95
Direct hiring*	7 (3.02)	60.58 (36.93)	8.65
Brazilian Region	**Kruskal-Wallis test (p <0.05)[1]**	**Kruskal-Wallis test (p <0.05)[1]**	-
Southeast£	79 (34.05)	127.22 (77.55)	1.61
Northeast**£	84 (36.21)	26.93 (16.42)	0.32
North£	32 (13.79)	4.03 (2.46)	0.13
South**	15 (6.47)	3.63 (2.21)	0.24
Central-West£	22 (9.48)	2.23 (1.36)	0.1

Source: Own elaboration, based on data from the Pesquisa Saúde repository[21].

PPSUS – Research Program for the SUS;

[1]The Post-hoc Nemenyi test was applied, as a statistically significant value (p<0.05) was found in the Kruskal-Wallis Test, indicating differences in the distribution of the number of funded research or funded amount; *There was a significant difference (Post-hoc Nemenyi Test - p value <0.05) in the distribution of the financed amount between state calls (PPSUS) and direct contracting and between state calls (PPSUS) and national calls; **There was a significant difference (Post-hoc Nemenyi Test - p value <0.05) in the distribution of the number of studies between South and Northeast; £ There was a significant difference (Post-hoc Nemenyi Test - p value <0.05) in the distribution of the amount financed between the Northeast and the Central-West, between the Northeast and the North, between the Southeast and the Central-West, between the Southeast and the North and between the Southeast and the Northeast.

Distribution of research funding on dengue by region of Brazil and Federated Unit in comparison with disease prevalence and mortality

Regarding the distribution of funding in the FUs of Brazil, institutions located in Minas Gerais and Rio de Janeiro, both FUs in the Southeast region, carried out the highest number of surveys (31 surveys each; 13.36%), with Minas Gerais also receiving a bigger share of the financing (R$ 98.51 million; 60.05%). On the other hand, institutions in Pará and Acre, both in the North region, stood out for carrying out the lowest number of surveys (Pará – one survey; 0.43%) and receiving the lowest funding (Acre – R$ 0.13 million; 0.08%).

When comparing the average prevalence and mortality coefficients in the period from 2004 to 2020, the number of studies contracted and the amount invested in the same period, it was observed that there was a misalignment

between investment in research versus the prevalence or mortality of the disease in some regions and FUs of Brazil (*table 2*).

Regarding the Brazilian regions, it was possible to notice this misalignment in the Central-West and South regions. The Central-West region had the highest prevalence of dengue (843.38/100,000 inhabitants), however, it occupied the penultimate place among the five regions of Brazil in relation to the number of research contracted (22 studies) and last place for the value financed (R$ 2.23 million). The South region had the highest mortality rate (0.89/100,000 inhabitants) among the country's regions, however, only five studies on dengue were carried out in institutions based in the region, with an investment of R$ 3.63 million, occupying, therefore, the last place

in relation to the other regions in number of contracted researches and the penultimate in financed amount.

Among the FUs, Acre and Goiás stood out, with the 1st and 2nd highest prevalences among the Brazilian FUs (1,169.47/100,000 inhabitants and 1,069.80/100,000 inhabitants respectively); but in relation to the number of studies contracted, they appeared in 12th and 9th places, and in terms of the amount destined for these studies, in 25th and 13th places respectively. Rio Grande do Sul also stood out, as it had the highest mortality (1.35/100,000 inhabitants) when compared to the other FUs, however, the state occupied the 11th position in the ranking of the number of researches contracted and 18th in the amount financed (*table 2*).

Table 2. Ranking of dengue prevalence and mortality coefficient, number of funded research and funded amount of research on dengue by the Department of Science and Technology of the Ministry of Health by Brazilian Regions and Federated Units. Brazil, 2004-2020

Region of Brazil/Federal Unit	Dengue prevalence coefficient/100,000 inhabitants[1]*	Dengue prevalence ranking[1]*	Dengue mortality rate/100,000 inhabitants[1]**	Dengue mortality ranking[1]**	Number of funded research§	Ranking of the number of funded research§	Amount financed in millions of reais – R$§	Financed amount ranking§
North region	**257.18**	**4**	**0.14**	**4**	**32**	**3**	**4.03**	**3**
Acre	1,169.47	1	0.39	7	2	12	0.13	25
Amapá	264.08	21	0.66	4	5	9	0.24	21
Amazonas	221.04	22	0.17	16	8	7	1.99	8
Pará	119.09	25	0.63	5	1	13	0.22	23
Rondônia	335.58	16	0.12	20	6	8	0.43	17
Roraima	362.90	14	0.56	6	5	9	0.58	14
Tocantins	486.48	9	0.25	12	5	9	0.44	16
Northeast region	**274.52**	**3**	**0.15**	**3**	**84**	**1**	**26.93**	**2**
Alagoas	392.12	12	0.16	17	6	8	0.69	11
Bahia	264.89	19	0.12	20	12	5	8.36	5
Ceará	364.47	13	0.18	15	19	3	5.45	6
Maranhão	97.46	26	0.31	10	6	8	0.58	14
Paraíba	264.76	20	0.24	13	3	11	0.39	18
Pernambuco	265.18	18	0.13	19	27	2	9.89	4

Table 2. Ranking of dengue prevalence and mortality coefficient, number of funded research and funded amount of research on dengue by the Department of Science and Technology of the Ministry of Health by Brazilian Regions and Federated Units. Brazil, 2004-2020

Region of Brazil/Federal Unit	Dengue prevalence coefficient/100,000 inhabitants[1]*	Dengue prevalence ranking[1]*	Dengue mortality rate/100,000 inhabitants[1]**	Dengue mortality ranking[1]**	Number of funded research§	Ranking of the number of funded research§	Amount financed in millions of reais – R$§	Financed amount ranking§
Piauí	184.97	23	0.13	19	5	9	0.23	22
Rio Grande do Norte	519.10	8	0.21	14	2	12	0.86	9
Sergipe	161.78	24	0.15	18	4	10	0.48	15
Central-West region	**843.38**	**1**	**0.24**	**2**	**22**	**4**	**2.23**	**5**
Distrito Federal	395.87	11	0.33	8	2	12	0.26	20
Goiás	1,069.8	2	0.16	17	5	9	0.60	13
Mato Grosso	596.26	7	0.28	11	5	9	0.65	12
Mato Grosso do Sul	1,065.58	3	0.25	12	10	6	0.71	10
Southeast region	**451.11**	**2**	**0.13**	**5**	**79**	**2**	**127.22**	**1**
Espírito Santo	636.58	6	0.32	9	2	12	0.19	24
Minas Gerais	657.27	5	0.02	22	31	1	98.51	1
Rio de Janeiro	398.10	10	0.03	21	31	1	15.38	2
São Paulo	357.49	15	0.84	2	15	4	13.14	3
South region	**135.57**	**5**	**0.89**	**1**	**15**	**5**	**3.63**	**4**
Paraná	332.59	17	0.39	7	10	6	2.86	7
Rio Grande do Sul	8.64	28	1.35	1	3	11	0.39	18
Santa Catarina	22.84	27	0.76	3	2	12	0.38	19

Source: *Notifiable Diseases Information System[10,22,23] (2004-2020 data); **Mortality Information System[24] (2004-2020 data);

§Own elaboration, based on data from the Pesquisa Saúde repository[21], accessed in June 2022.

[1]Average coefficient of dengue prevalence and mortality during the period 2004-2020.

Distribution of funding by beneficiary institution in Brazil

In total, 80 institutions were granted financing for research on dengue in Brazil, 22 in the Southeast region, 21 in the Northeast, 14 in the North, 13 in the Central-West and ten in the South.

Among the five institutions that received the most financial resources during the period from 2004 to 2020, the Oswaldo Cruz Foundation (Fiocruz) stood out for concentrating more than 60% of the resources (R$ 100.59 million), with 51 studies, distributed among 8 FU with representation of the institution (17 in Rio de Janeiro, 13 in Pernambuco, 7 in Minas Gerais, 5 in Amazonas, 4 in Bahia, 3 in Rondônia, 1 in Ceará and 1 in Mato Grosso do Sul) (*graph 2*). Fiocruz Minas (institution responsible for carrying out research on Wolbachia) received 80.61% (R$ 81.09 million) of the total funding allocated to all the institution's representations, which corresponds to 49.43% of the total resources invested in dengue research.

Graph 2. Five institutions that received the most funding to develop research on dengue financed by the Department of Science and Technology of the Ministry of Health and partners. Brazil, 2004 to 2020
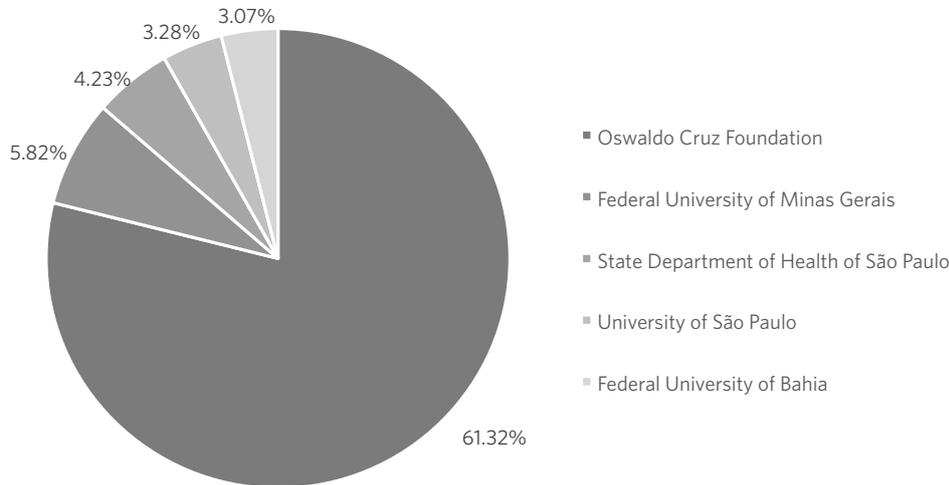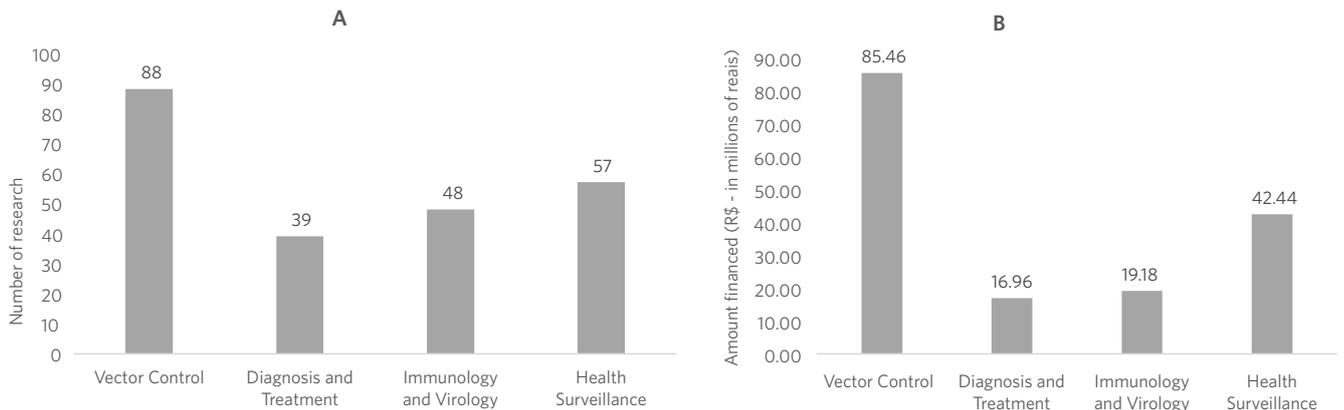

Source: Own elaboration, based on data from the Pesquisa Saúde repository[21].

Research themes

Regarding the topics studied, vector control concentrated the largest number of research (37.93% – *graph 3A*) and resources (52.10% – *graph 3B*), followed by health surveillance with 24.57% of the studies (*graph 3A*) and 25.87% of resources (*graph 3B*).

Graph 3. Distribution of research on dengue financed by the Department of Science and Technology of the Ministry of Health and partners by research topic. A: Number of funded research on dengue by research topic. B: Amount invested in research on dengue by research topic. Brazil, 2004 to 2020.

Source: Own elaboration, based on data from the Pesquisa Saúde repository, accessed in June 2022[21].

Discussion

Between 2004 and 2020, the DECIT of the Ministry of Health and its partners financed 232 dengue research, totaling an investment of R$ 164.03 million. Over these years, the trend in the number of surveys contracted and the funding allocated to these surveys was stationary, that is, there was no increase or decrease. State calls (PPSUS) were the contracting method that most financed research (65.95%), however, most of the resources were allocated to research contracted by national calls (41.54%). Institutions headquartered in the Southeast region were responsible for executing 77.55% of the budget. Statistically significant differences were observed in the distribution of funding between the Regions of Brazil and between the research contracting modalities. In addition, there was no alignment between research funding and the prevalence or mortality of dengue in the Central-West and South regions and in the FU Acre, Goiás and Rio Grande do Sul. The main topic of the studies was vector control (37.93%).

Although Brazil has an intense scientific production on dengue[12-14], funding for research on the subject by DECIT of the Ministry of Health showed a stationary trend over the years studied. Worldwide, investments in R&D and the need to seek new solutions to fight dengue have grown over the years, as a result of its rapid geographic expansion and increase in the number of cases[12-14]. The stagnation of funding for dengue research in Brazil is a cause for concern, as this disease continues to have negative impacts on the country's health and socioeconomic situation.

Furthermore, it is important to pay attention to the R&D scenario in Brazil, which is in crisis and may, in a few years' time, disfavor investments in dengue research. Since 2013, but more intensely since 2016, investments in the R&D sector have been reduced in Brazil, as a result of the contingency measures of Constitutional Amendment nº 95/2016. Budget cuts drastically affected the payment of grants and the development of research in the country[25,26].

With regard to the research contracting modalities, despite the fact that the resources allocated by the state calls are smaller, the PPSUS can be an important ally in carrying out research on dengue in Brazil, since it proposes the decentralization of resources in order to minimize inequalities of access to funding, boosting research groups and encouraging the resolution of problems at the state level, by prioritizing topics guided by managers, health professionals and researchers from the Brazilian states[27].

On the other hand, national calls that provide more valuable resources can facilitate the performance of network and multicenter research, in addition to the integration of research groups from several states, promoting the exchange of knowledge and the strengthening of scientific skills.

On the other hand, the direct contracting modality, even financing the smallest number of studies, can be positive for the resolution of dengue problems in Brazil, since its resources are directed to researchers with recognized competence in the subject, as evidenced by the results of this study, which demonstrated the funding of research for the implementation of the Wolbachia method for controlling the main vector of arboviruses – *Aedes aegypti*. These studies have been successful in reducing the transmission not only of dengue, but also of other arboviruses, such as chikungunya and zika[28].

Thus, finding a balance in research funding between all types of contracting is essential to qualify the health research system implemented by DECIT of the Ministry of Health, aiming, above all, to evaluate the cost-benefit and the possibility of using and incorporating the results at SUS. The implementation of a funding policy for R&D on the subject through state and national public calls or direct

contracting that ensure the transparency of the selection process and make the access of researchers from all over the country more equitable, including emerging groups, is important to assist in policies to combat dengue and to ensure the continuity of research.

In this study, it was observed that institutions located in the Southeast region, mainly in Rio de Janeiro and Minas Gerais, carried out the largest number of studies and received the most funding, which suggests that research groups in this region are able to raise more financial resources and, consequently, become more structured. Data from the CNPq Directory of Research Groups in Brazil indicate that, in 2016, of the 37,640 registered research groups, 42% were located in the Southeast region[29]. In 2017, most masters and doctoral degrees (47%) were granted by postgraduate programs from institutions also in this region[30].

Also noteworthy was the mismatch when comparing the prevalence or mortality from dengue with the number of research financed and the amount invested in these between some regions and FU of Brazil, demonstrating that attention is needed on this scenario, because, even though dengue affects the whole country, the impacts caused by the disease are not the same in all places[31,32].

From another perspective, it is noteworthy that studies carried out by research groups, most often linked to teaching and research institutions with tradition and expertise in the subject, located in large centers, such as the Southeast region, produce results that can be applied nationally and internationally.

In view of this, the implementation of strategies that qualify and democratize access to financial resources for research according to the needs of the regions and FUs of Brazil, and that encourage the formation of research networks for dengue in order to promote the exchange of experiences between beginners and expert researchers from different areas, would boost the realization of new projects and expand the ability to access available funding.

Additionally, it is necessary to reflect on the implementation of the governance of a health research system that incorporates the monitoring and evaluation of the quality of research, as well as the use of its results for decision-making, formulation and implementation of health policies, aiming at the efficient use of resources and improvement of the SUS' performance[33-35].

Another outstanding result found was the theme of vector control as the main subject of research. Without a fully effective vaccine, vector control is one of the main strategies for preventing dengue, however, the methods currently used are becoming unsatisfactory, mainly due to the increased resistance of the Aedes aegypti mosquito to the products used in its control[36]. Fitzpatrick et al.[37] suggest that, even with the introduction of a mildly effective dengue vaccine, vector control remains cost-effective.

Therefore, the importance of funding research that develops or evaluates methods for controlling the dengue vector is recognized, but it is also necessary to understand that other topics are essential to overcome the gaps in knowledge about the disease. At ANPPS[19], there are 12 topics related to dengue, including vaccine development, rapid tests, economic impact assessment, evaluation of national and state combat strategies. Ensuring the financing of research on dengue, prioritizing the topics to be studied and taking into account the regional specificities of Brazil, will lead to studies with relevant results for the planning and decision-making on actions to face the disease.

This study was limited to analyzing the financing of research done by DECIT and partners, within the scope of the Ministry of Health, that is, research financed by other departments of the agency that did not have a budget from DECIT were not included. In addition, secondary data from the Pesquisa Saúde repository may contain errors or lack of research records.

Final considerations

Ensuring sustainable and long-term R&D resources for dengue is a key element in seeking solutions to fight the disease and its vector. The results of this study showed that there was no increase or decrease in funding for research on dengue over the years and that there was a difference in the distribution of funding between research contracting modalities and between regions of Brazil. The lack of coordination between funding for dengue research and its prevalence or mortality in some Brazilian regions and UFs was highlighted. These findings show the importance of monitoring research funding to improve the CTIS policy and actions to combat dengue.

The publication of state and national public calls periodically, the promotion of strategic studies for the SUS through direct contracting, linked to the monitoring and evaluation of contracted research, are strategies that will contribute to promoting and democratizing access to funding, to reduce disparities in the distribution of financial resources for research in Brazil, to develop studies aligned with health needs and to the possibility of incorporating the results into the SUS.

Thus, public funding for research on dengue through the DECIT of the Ministry of Health can be an important ally for strengthening CTIS, for consolidating public policies informed by evidence and for qualifying health care and surveillance on the subject, since the objective of the department is to strengthen structures and research groups to meet the health needs of the Brazilian population and the SUS[15].

Collaborators

Melo GBT (0000-0002-6758-0834)* contributed to the conception and design of the study, collection, analysis and interpretation of data, elaboration and final revision of the manuscript. Angulo-Tuesta A (0000-0002-3231-5918)* contributed to the conception and design of the study, analysis and interpretation of data, critical review and approval of the final version of the manuscript. Silva EN (0000-0002-3115-3996)* contributed to the critical review and approval of the final version of the manuscript. Obara MT (0000-0001-6872-0096)* contributed to the conception and design of the study, critical review and approval of the final version of the manuscript. ∎

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