ORIGINAL ARTICLE

Dengue incidence trend in Brazil, 2002-2012

doi: 10.5123/S1679-49742016000400006

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Abstract

Objective: to analyze dengue incidence trend in Brazil from 2002 to 2012. **Methods**: this was an ecological study with data of the Information System for Notifiable Diseases (Sinan); the incidence rate was calculated by age groups, states and macroregions, through Prais-Winsten regression. **Results**: dengue incidence rates in Brazil, in 2002 and 2012, were of 401.6 and 301.5 per 100,000 inhabitants, respectively; annual increment rates were stable (21.4%; 95%CI -19.8;83.7) in most of the states, except for Alagoas (38.9%; 95%CI 5.1;83.5) and Tocantins (50.4%; 95%CI 12.6;100.7); the North Region was the only region to present increase trend in the incidence of dengue. **Conclusion**: although rates have remained stable in most of the states, they are still high in Brazil; broader public policies focusing on new dengue control strategies are necessary.

Key words: Dengue; Epidemiological Monitoring; Aedes; Ecological Studies; Time Series Studies.

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Introduction

Dengue is an acute febrile infectious disease, which can be mild or severe, classified by the World Health Organization (WHO) as dengue with and without warning signs and severe dengue.[1] Dengue is considered a public health issue worldwide, especially in tropical countries, whose environmental conditions favor the development and proliferation of its main vector, the mosquito *Aedes aegypti*.[2]

In 2002, there was a pandemic of dengue in the Americas. In Brazil, in 2008, dengue incidence achieved approximately 800 cases per 100 thousand inhabitants.[2] There were about 50 thousand hospitalizations due to the disease in 2002 and 2008. In the country, the environmental conditions, in general, provide vector proliferation due to the close geographic location to the Equator. The increase in the number of reported cases has become worrying, since it can lead to an increase in the number of hospitalizations and deaths due to the disease.[2,3]

> *Dengue is a notifiable disease and all suspected or confirmed cases should be reported to the Information System for Notifiable Diseases (Sinan).*

Dengue consequences are beyond the problems caused to the health sector, and it can also affect the economy. For instance, dengue outbreaks lead to expenditures and absenteeism, keeping ill individuals out of labor market.[4] There is no consensus in the literature on the relationship of the disease with socioeconomic determinants. However, a great number of individuals have been affected by the disease, regardless of their social and economic status.[5] Lack of infrastructure and sanitation, as well as poor living conditions are pointed out as contributing factors to the increase of dengue incidence rates.[6,7]

Studies that investigate prevention measures and dengue control in Brazil have not showed positive results. The strategies focus mainly on vector control and have not been very effective, which makes the scenario more alarming.[8] Some authors suggest that low incidence periods are the result of the reduction of the susceptible population to the disease and not of the effectiveness of preventive measures.[9,10]

Although the country still presents inequalities in the access and use of health services, it is important to highlight that dengue is a notifiable disease and all suspected or confirmed cases should be reported to the Information System for Notifiable Diseases (Sinan), in order to make dengue epidemiological surveillance easier. Nevertheless, there are few researches[13,14] that intend to demonstrate how the incidence of dengue has behaved in Brazil over the years, to scale the problem and to identify the most affected areas. The objective of this study was to describe the trend in the incidence of dengue in Brazil, between 2000 and 2012.

Methods

An ecological study with time series analysis regarding the period from 2000 to 2012 was conducted using data from Sinan. This information system incorporates a list of notifiable diseases, with the use of a standardized form, in which individual data, symptoms, information on hospitalization, laboratory tests and final classification of the case are registered. Healthcare professionals fill the recording instrument, which is, then, sent to epidemiological surveillance centers. More information is available on Sinan website.[12]

Dengue incidence rate was calculated using the number of new cases (classic and hemorrhagic) reported to Sinan, divided by the local population and year, multiplied by 100,000 inhabitants. The rates were calculated using the Brazilian macroregions, the states (UF) and age groups (in years: children under 5; 5-9; 10-19; 20-39; 40-59; and 60 or over).

For trend analysis, Prais-Winsten regression was used, considering the serial autocorrelation. Using the annual increment rates (AIR), 95% confidence intervals (95%CI) and p values (5% significance level), the trends were classified as increasing, stationary or decreasing. Not significant p values were classified as stationary trend (accepting the null hypothesis that incidence rates have not changed over the years). The significant p values resulted in increasing trend classification (positive AIR) and decreasing trend (negative AIR). For AIR, the calculation proposed by Antunes was used17 {TIA= [-1+(10β)]*100}, where β is the natural base logarithm resulting from Prais-Winsten regression.

In another analysis, the UF were categorized according to the criteria of the National Program for Dengue

Control[18]: low incidence (up to 100 cases per 100,000 inhabitants); medium incidence (101-299 cases per 100,000 inhabitants); and high incidence (300 cases or more per 100,000 inhabitants). Finally, UF frequencies were presented for each category, in the period from 2002 to 2012.

The downloads of the databases were performed in .csv files for Microsoft® Office Excel® 2010 and subsequently tabulated and analyzed using the Stata 12.1 software (College Station, Texas, USA) .

The Research Ethics Committee exempted the study from evaluation, once it exclusively used public access data.

Results

In Brazil, dengue incidence rates were 401.6 per 100 thousand inhabitants in 2002 and 301.5 per 100 thousand inhabitants in 2012. The annual increment rate in the period was 21.4% (95%CI -19.8;83.7), presenting stationary incidence rates (Table 1).

Stability of dengue incidence rates was observed in most UF and macroregions. Only Alagoas and Tocantins presented increasing trend, with annual increment rates of 38.9% (95%CI 5.1;83.5) and 50.4% (95%CI 12.6;100.7), respectively. The only macroregion that presented increasing trends was the North (34.6%; 95%CI 10.9;63.3) (Table 1).

The states with higher incidences *per* 100,000 inhab. in 2002 were Rio de Janeiro (1,691.6), Pernambuco (1,235.3), Espírito Santo (796.0) and Rio Grande do Norte (764.8). In 2012, Rio de Janeiro (1,100.7) and Rio Grande do Norte (822.1) remained among the states with the highest incidence rates, followed by Mato Grosso (1,069.1), Alagoas (856.8) and Tocantins (826.6) (Table 1).

The regions with the highest dengue incidence rates in 2002 were the Northeast (548.2) and Southeast (480.7). In 2012, the highest incidence rates were recorded in the Northeast (403.3) and Midwest (483.4) (Table 1).

Stationary trends were also observed in dengue incidence rates for all age groups studied. The highest increase in dengue incidence has occurred among children under five years old, however this increase was not significant (38.4; 95%CI -16.3;128.6) (Table 2).

In 2002, there was a lower proportion of states classified as high incidence (11/27), compared to the end of the period: 16/27 in 2010; and 14/27 in 2012 (Figure 1). In 2002 and 2012, the states of the South region remained with low incidence. Most states in the North region of the country remained with medium incidence, with changes observed only in Acre (medium incidence in 2002 and high incidence in 2012) and Amazonas (low incidence in 2002 and medium incidence in 2012). The states in the Midwest region remained with high incidence, except for the Federal District, which passed from medium to low incidence rate. Most of the states in the Northeast region remained with high incidence, although there have been changes, for example, in Ceará (medium incidence in 2002 and high incidence in 2012). The states of the Southeast region remained among medium and high incidence; except for the state of São Paulo, which passed from medium to low incidence (Figure 2).

Discussion

This study revealed that, although dengue incidence rate has presented stability in Brazil in the period from 2002 to 2012, there was an increasing trend in the North, as well as in the states of Alagoas and Tocantins. The incidence rates also remained stable for all age groups. Although not being statistically significant, a higher increment among children under five years old was observed.

Even though dengue trend in the country has been stable over the 11 years observed, it is important to highlight that, added to its high incidence, the burden of the disease leads to great challenges for health systems.[19]

All the countries of the Americas, except for Canada, are infested by *Aedes aegypti* and 60% of the cases reported to WHO are from Latin America.[20] In this region, the process of recurrent dengue epidemics has been explained, basically, by urbanization. Besides, according to estimates, epidemics can spread in middle and low income countries, where the urban population can double in size by 2050.[20] In Brazil, a literature review indicated peak of dengue epidemic in 2002, 2008 and 2010[21], which corroborates with the findings of this research.

Studies performed in Brazil and Latin America, between 2000 and 2012, pointed that the transmission of the disease has been cyclical, varying between high

Table 1 – Dengue incidence trend (*per* 100 thousand inhabitants) and annual change, Brazil, macroregions and states (UF), 2002-2012

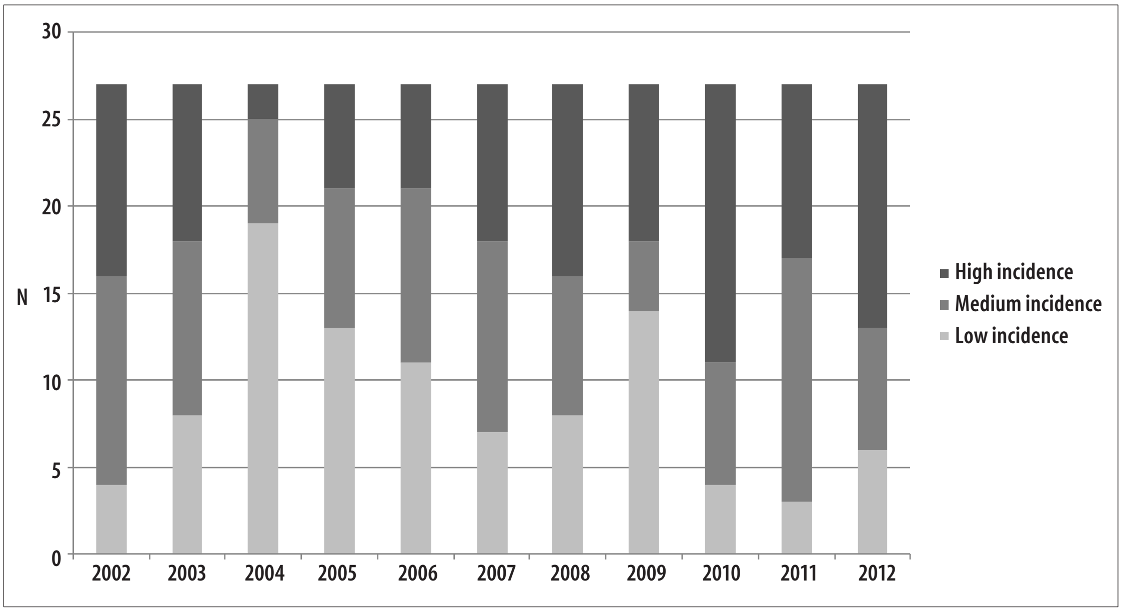
Macroregions and UF	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	Annual increment rate % (95%CI)	p-value [a]	Situation
North	150.0	207.7	135.7	175.4	136.8	246.5	306.2	350.4	619.0	699.3	257.8	34.6 (10.9;63.3)	0.007	Increasing
Acre	152.0	161.5	727.7	345.5	39.6	74.9	312.8	2,655.2	4,745.1	2,427.2	306.1	54.8 (-36.1;274.7)	0.293	Stationary
Amapá	166.1	755.4	458.0	430.6	300.3	562.2	194.6	255.7	491.4	392.8	223.2	-6.6 (-22.1;11.9)	0.414	Stationary
Amazonas	75.8	1,32.4	29.0	31.5	19.3	61.4	222.9	48.9	229.7	1740.7	149.5	61.9 (-8.0;184.7)	0.086	Stationary
Pará	178.3	148.3	84.6	118.3	92.5	199.5	207.5	94.7	199.4	216.5	205.5	50.0 (-32.4;232.8)	0.279	Stationary
Rondônia	109.4	206.7	224.9	387.5	272.3	212.6	365.8	1,211.2	1,321.9	182.2	205.0	23.1 (-20.4;90.4)	0.309	Stationary
Roraima	351.1	1,390.1	153.2	602.8	251.9	212.2	1207.7	715.1	1,632.5	282.9	390.4	7.5 (-22.3;48.7)	0.627	Stationary
Tocantins	163.9	153.2	120.3	257.2	445.8	949.4	778.2	304.3	649.0	666.7	826.6	50.4 (12.6;100.7)	0.011	Increasing
Northeast	548.2	305.2	44.6	148.9	135.3	241.4	338.7	220.9	320.3	326.4	403.3	12.7 (-22.4;63.7)	0.490	Stationary
Alagoas	259.0	209.0	150.8	88.7	103.9	344.4	418.5	115.3	1,443.8	246.6	856.8	38.9 (5.1;83.5)	0.026	Increasing
Bahia	582.3	315.3	34.1	129.4	49.0	68.3	235.5	647.3	313.0	257.4	338.5	11.7 (-38.9;104.2)	0.687	Stationary
Ceará	257.0	429.6	50.1	335.9	346.3	414.2	576.5	84.8	253.9	705.6	635.7	20.9 (-14.5;70.8)	0.246	Stationary
Maranhão	146.5	99.8	27.0	108.3	83.6	213.6	88.0	33.6	87.2	153.3	79.0	0.1 (-24.9;34.7)	0.967	Stationary
Paraíba	536.3	362.0	38.3	166.4	85.2	296.8	208.2	23.8	165.4	286.3	225.0	-7.3 (-41.5;47.1)	0.719	Stationary
Pernambuco	1,235.3	186.1	28.0	66.3	103.3	262.2	210.9	30.2	375.4	185.2	341.7	0.7 (-44.5;82.8)	0.979	Stationary
Piauí	304.9	325.1	29.4	150.7	158.4	315.3	74.8	121.2	225.3	308.6	384.2	13.5 (-21.7;64.4)	0.460	Stationary
Rio Grande do Norte	764.8	718.9	90.8	160.5	275.4	432.3	916.6	72.9	222.6	651.0	822.1	52.0 (-18.9;184.9)	0.166	Stationary
Sergipe	286.7	255.0	22.5	34.2	57.5	73.9	1,065.2	47.5	28.5	117.5	212.9	38.8 (-28.2;168.2)	0.290	Stationary
Southeast	480.7	87.4	27.9	27.9	161.5	257.9	354.0	131.5	572.1	412.2	307.1	33.4 (-24.8;136.6)	0.287	Stationary
Espírito Santo	796.0	899.9	104.2	81.0	292.2	194.7	753.2	960.5	666.3	922.8	330.0	7.2 (-28.1;112.6)	0.792	Stationary
Minas Gerais	209.8	77.2	72.3	58.8	154.3	143.9	247.7	268.7	1,072.5	172.5	158.0	30.9 (-9.9;90.1)	0.137	Stationary
Rio de Janeiro	1,691.6	37.3	8.2	9.1	171.1	367.1	1,242.4	44.8	169.0	981.7	1,100.7	4.8 (-35.9;71.4)	0.834	Stationary
São Paulo	117.5	43.3	7.9	15.8	150.2	276.0	28.0	28.8	482.6	261.8	68.4	-0.7 (-47.2;86.6)	0.980	Stationary
South	30.9	42.8	0.74	4.26	5.1	100.5	7.45	5.8	152.2	105.8	18.1	47.9 (-32.2;223.6)	0.238	Stationary
Paraná	73.8	111.4	1.6	10.3	12.0	258.7	17.2	14.1	363.1	273.1	45.1	11.9 (-4.8;31.4)	0.149	Stationary
Rio Grande do Sul	4.2	0.5	0.2	0.4	0.6	3.8	1.2	0.5	33.6	3.0	1.5	60.0 (-43.7;354.8)	0.335	Stationary
Santa Catarina	5.3	1.1	0.3	0.8	1.0	2.5	1.6	0.8	2.7	2.2	1.4	5.7 (-31.3;62.6)	0.778	Stationary
Midwest	385.1	170.8	69.3	205.4	355.5	753.8	320.6	797.3	1,505.1	251.4	483.4	34.9 (-8.2;98.2)	0.113	Stationary
Distrito Federal	147.5	40.6	11.5	16.6	21.8	46.9	45.4	32.4	581.9	55.5	56.0	23.6 (-28.1;112.6)	0.399	Stationary
Goiás	421.6	161.5	106.1	335.4	424.5	257.6	605.9	738.8	1,653.1	380.0	405.8	31.7 (-5.1;82.8)	0,090	Stationary
Mato Grosso	356.6	357.0	87.2	245.0	348.6	564.7	222.6	1,719.2	1,160.2	164.0	1,069.1	33.4 (-4.8;87.0)	0.085	Stationary
Mato Grosso do Sul	568.9	97.6	15.5	28.5	538.6	2,971.4	32.2	616.9	2,538.5	250.6	397.8	57.3 (-30.6;256.2)	0.242	Stationary
Brazil	401.6	156.9	40.0	82.3	143.2	264.9	293.2	204.2	514.4	356.6	301.5	21.4 (-19.8;83.7)	0.318	Stationary

a) Prais-Winsten regression ($p<0.05$)

Table 2 – Trends of dengue incidence rates (*per* 100 thousand inhab.) according to age groups. Brazil, 2002-2012

Age groups (in years)	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	Annual increment rate % (95%CI)	p-value [a]	Situation
<5	153.9	57.3	14.1	33.2	51.0	127.3	241.6	147.5	290.0	275.0	175.4	38.4 (-16.3;128.6)	0.178	Stationary
5-9	214.2	75.8	19.9	49.0	74.3	169.6	324.6	167.8	379.6	330.9	199.3	35.4 (-15.5;117.0)	0.180	Stationary
10-19	350.7	140.1	36.5	75.8	137.2	270.6	347.0	230.8	557.8	418.1	344.1	29.4 (-15.9;98.9)	0.209	Stationary
20-39	526.5	204.6	53.0	104.2	176.9	313.0	314.2	238.3	598.6	394.5	364.5	17.6 (-21.4;75.9)	0.387	Stationary
40-59	478.7	185.5	46.8	93.7	171.2	298.5	272.7	198.1	530.8	337.7	301.3	16.0 (-22.3;73.1)	0.424	Stationary
≥60	323.4	136.6	31.2	64.5	124.9	224.4	182.6	133.0	387.0	244.0	191.2	15.6 (-23.0;73.8)	0.440	Stationary

a) p-value results from Prais-Winsten regression ($p<0.05$)



a) ICD-10: International Statistical Classification of Diseases and Related Health Problems 10th Revision

Figure 1 – Frequencies of the states classified as low, medium and high dengue incidence (confirmed cases according to ICD-10[a]: A90 e A91). Brazil, 2002-2012

and low incidences.[20,21] The peaks of epidemics coincide with the rainy seasons, and an important risk factor observed is to live or walk around areas where there is incidence of the disease.[22,23] Besides the aspects related to infrastructure, which may contribute to vector proliferation, the climate is strongly related to the spread of the mosquito, since it needs ideal conditions for its reproduction.[24]

Coelho[3] also highlights the importance of epidemiological and demographic aspects. In recent decades, especially after 1960, a fast population growth has occurred in Brazil, and most of the population migrated to urban areas.[2] Urban agglomeration has influence upon other issues, such as water supply and inadequate garbage disposal, which are characteristics that favor vector proliferation and consequent emerging of the disease.[2]

During the studied period, all the states of the South region showed the lowest incidence rates of the disease in comparison to the others. This finding corroborates the study of Câmara et al.,[19] who identified fewer reported cases in the South, accounting for only 1.2% of the total of the five macroregions. One of the possible explanations for this difference is the climate: the South presents well defined seasons, with lower temperatures compared to the other regions of the

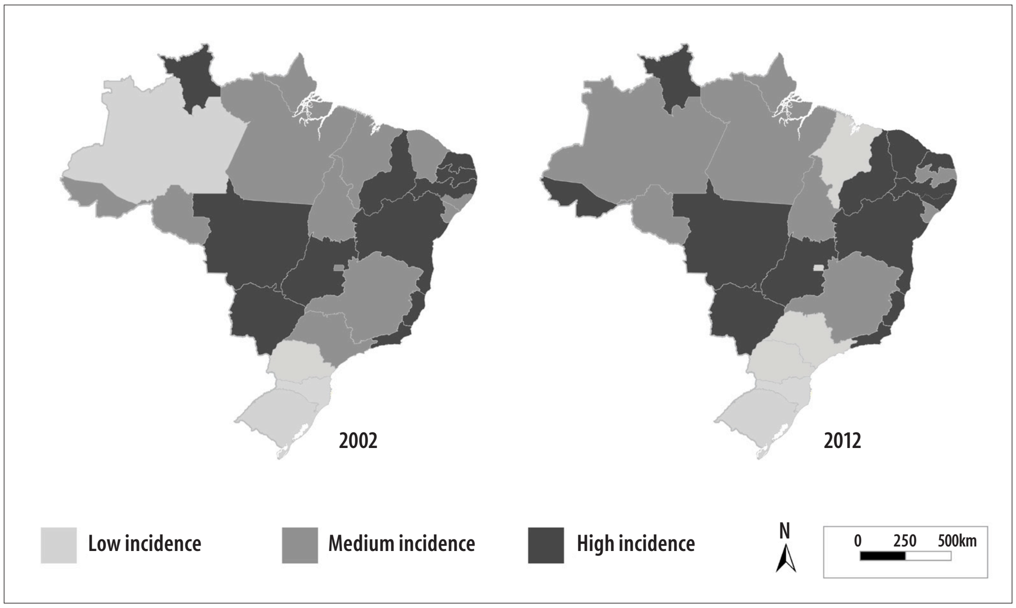


Figure 2 – States classified with low, medium and high dengue incidence. Brazil, 2002-2012

country. These conditions, although not preventing it, disfavor the proliferation of the mosquito.[25]

Tocantins and Alagoas, located in the North and Northeast regions, respectively, showed an increasing trend of dengue incidence rates. Câmara et al.[19] pointed that the Northeast region concentrated a high number of notifications in Brazil between 2001 and 2003. The North is the largest geographic area in the country, much of it is constituted of native forests; however, its urban areas have high population density, besides other factors related to dengue vector proliferation, such as lack of infrastructure, and disorderly and accelerated urbanization.[24] These conditions, together with particularities of each municipality, may contribute to increase the disease rates in each region.

In most states, dengue is still an important public health issue. Although the increasing trend has been observed only in two states, in the others there was stability of dengue incidence rate and in none of them we found decreasing trend, notwithstanding the campaigns to combat the vector.[2] Although stationary, in many states the rates were high, indicating the need for new strategies of prevention and control, and strengthening of the existing actions to combat new cases of the disease.

By observing dengue incidence trend according to age group, we can notice that the incidence remained stable in both 2002 and 2012, although they were higher in the group between 20 and 39 years old and lower in the group under five years old. Individual factors, such as age, possibly have little influence on dengue incidence. Contextual factors, such as climate, population density, among others, are well established in the literature as factors associated with the incidence of the disease.[19,24,25]

Regarding the lowest incidence rates in children under the age of five, Rodrigues et al.[26] raised a number of issues related to the diagnosis of dengue, such as the differences in the definition criteria or the difficulty to distinguish dengue from other febrile diseases common in childhood. The same authors point out that dengue fever in childhood can be, most of times, asymptomatic. Therefore, it is possible that the number of dengue cases among children is still underreported, notwithstanding the improvement of diagnosis in this age group.[26]

One of the possible explanations for this study not finding a decreasing or increasing trend in dengue incidence rates in most of the states and in the five macroregions is the high variability observed:[1] relatively large changes, from year to year, although, most of times, these changes have different meanings, sometimes increasing, sometimes decreasing the incidence.[2] This eventually resulted in very wide confidence intervals and, consequently, lack of precision in measurements – a fact that does not necessarily constitute a limitation, but expresses the real annual variation of each state and macroregion over the studied period.

Because it is based on secondary data, there are some inherent limitations to the present study. First, the existing underdiagnose and underreporting, and the rates presented possibly underestimate the real incidence of the disease. Second, the coverage and quality of the information on the notification form may vary from one region to another, representing one more obstacle to compare the incidence rates between different geographical regions. Likewise, these rates may vary over time, affecting the presented trends.

Assuming that the coverage and quality of Sinan have improved over time, these improvements could explain, at least partially, the observed increment trends. However, other factors could influence the results presented here, such as climate, seasonality, vector behavior and socio-cultural and immunological aspects of the population.[27,28] It is important to highlight that this study did not explore analysis with climatic, territorial, and rainfall variables, nor the building infestation index, factors that revealed to be useful as indicators of dengue transmission.[29]

The findings of this study contribute to the understanding of the dynamics of dengue in Brazil and its states. The fact that the found trends are stationary or increasing, suggests the need for more effective actions to control the disease, including restructuring of epidemiological surveillance, policies review, inclusion of regional realities, environmental management and integration of Health actions with other sectors of the government and society.

Efforts and actions that aim to reduce dengue cases are necessary, with the main focus on the states with high incidence. Although there is a vaccine approved in Brazil and others being developed, studies show that strategies such as incorporation of the "Vector Control Agents" in primary health care, educational activities at schools, media approaches and the implementation of activities with the community participation can help in the awareness of the population and consequent vector control.[30] More comprehensive public policies showed to be necessary, such as measures aimed to reducing urban agglomeration, improving sanitation and preventing floods, and enhancing water drain in rainy periods. Studies with more robust designs should be performed to investigate individual and environmental factors that could influence the substantial increase in the number of dengue cases in some regions.

Authors' Contributions

Böhm AW, Costa CS, Neves RG, Flores TR e Nunes BP contributed to the design of the study, analysis and interpretation of the data, drafting and critical review of the manuscript's intellectual content. All the authors approved the manuscript's final version and declared to be responsible for all aspect of the work, ensuring its accuracy and integrity.

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Received on 17/01/2016
Approved on 30/05/2016