

**EPIDEMIOLOGY OF DENGUE IN NORTHWESTERN MUNICIPALITIES OF THE  
STATE OF PARANÁ, BRAZIL**

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## **ABSTRACT**

This study outlines the behavior of dengue in microregions of the northwestern part of Paraná State between 2000 and 2007 based on a survey of dengue records of the National Monitoring and Notification System and Health Surveillance Section. A total of 24,015 cases of dengue confirmed by serological examination were notified during the study period. Individuals older than 30 years were the most affected, corresponding to 54.3% (n=13,035) of the cases notified. With respect to the evolution of dengue, 76.05% (n=18,281) of the cases were cured. Severe forms (dengue with complications, hemorrhagic fever, shock syndrome) of the disease were observed in 22 cases and four of these (0.03%) died of the disease. Most cases (66.3%, n=10,200) were classified as classic dengue. Two cases of dengue hemorrhagic fever were notified in 2002 and five 2007. Viral isolation was only performed in 48 samples. Of these, 28 infections were caused by serotype I, four by serotype II and 16 by serotype III. The large number of autochthonous cases (63.7%) suggests that dengue is not controlled in the region. The house and Breteau indices were above those recommended by the WHO, indicating high infestation of houses and water containers with *Aedes aegypti* larvae.

## **INTRODUCTION**

Dengue viruses (DENV) are the most important arboviral pathogens in tropical and subtropical regions throughout the world. DENV are members of the genus *Flavivirus* in the family Flaviviridae and comprise of 4 antigenically distinct serotypes (serotypes DEN-1, DEN-2, DEN-3 and DEN-4). All DENV cause dengue fever, a self-limited febrile illness lasting 2-10 days. However, some patients progress to develop life threatening syndromes including dengue hemorrhagic fever characterized by thrombocytopenia and hemorrhage, and dengue shock syndrome due to excessive plasma leakage (Weaver et al. 2009).

Dengue is currently one of the main public health problems in the world. The World Health Organization (WHO) estimates that 50 to 100 million people are infected per year. About 550,000 patients require hospitalization and 20,000 will die of dengue. In Brazil, dengue has become an epidemic in numerous municipalities of the State of Paraná (Gubler 2002). In the southern region of Brazil, the State of Paraná has reported cases of dengue since 1995. Non-autochthonous cases have been observed until the end of 2006 in the states of Santa Catarina and Rio Grande do Sul, but in 2007 dengue epidemics were confirmed in the

latter state, as well as non-epidemic cases in Santa Catarina. These new data confirm that dengue infections occur throughout the country (Nogueira et al. 2007).

The sequential introduction of different serotypes of the dengue virus has contributed to the growing incidence of this disease. In 1981, serotypes DEN-1 and DEN-4 were the first to be isolated during a dengue epidemic that occurred in Boa Vista, State of Roraima. After an epidemiological silence, in 1986-1987 serotype DEN-1 invaded the southeastern (Rio de Janeiro) and northeastern (Alagoas, Ceará, Pernambuco, Bahia, Minas Gerais) regions of Brazil and has spread throughout the country since then, with the occurrence of serotype DEN-2 in 1990-1991 and serotype DEN-3 in 2001-2002. At present, these three serotypes circulate simultaneously in 24 states of Brazil (Camara et al. 2007). Molecular data indicate that introduction of the DEN-3 genotype may dislodge other circulating serotypes that were first introduced in an area. However, a more careful evaluation of these data is still necessary (Nogueira et al. 2007).

The progression of dengue depends on ecological and socio-environmental conditions that facilitate the vector dispersion. As long as no effective vaccine is available, the control of transmission of the dengue virus requires the combined effort of society as a whole in the combat against *Aedes aegypti*. This mosquito is adapted to domestic and peridomestic environments, breeding in drinking water containers and disposable containers that accumulate rainwater and are commonly found in the town's garbage (Tauil 2001).

No specific antiviral treatment exists, but patients generally recover with fluid and electrolyte therapy, especially when therapeutic measures are applied early. The early recognition of warning signs of dengue hemorrhagic fever and early treatment are of the utmost importance to reduce the case fatality rate (Brasil 2005a).

The objective of the present study was to outline the behavior of dengue in the microregions Astorga, Floráí and Maringá located in the northwestern part of Paraná State between 2000 and 2007.

## **MATERIAL AND METHODS**

For this study, dengue records of the National Monitoring and Notification System (SINAN) and Health Surveillance Section (SCVGS) obtained from the Sector of Epidemiology of the 15<sup>th</sup> Regional Health District were surveyed. The data comprised the period from 2000 to 2007. The study area included the microregions of Astorga, Floráí and Maringá located in the northwestern part of Paraná State.

The following variables were analyzed: evolution of dengue over the years, classification of the type of dengue, source of infection (autochthonous cases), area of residence where dengue is prevalent (urban and rural zone), and house index (HI- percentage of houses positive for larvae of vector) and Breteau index (BI- number of positive containers for vector per 100 houses) according to municipality. Since the data evaluated were census data, the variables selected were analyzed descriptively. The results are presented in tables and figures to permit a critical analysis of the true situation of dengue in the 15<sup>th</sup> Regional Health District of the State of Paraná between 2000 and 2007.

## RESULTS

Thirty-eight (9.5%) of the 399 municipalities of the State of Paraná represent a priority in the National Dengue Control Program: Alto Paraná, Apucarana, Arapongas, Assis Chateaubriand, Cambé, Campo Mourão, Cascavel, Cianorte, Diamante do Norte, Floresta, Foz do Iguaçu, Guaíra, Ibiporã, Iguaçu, Itaipulândia, Jataizinho, Londrina, Mandaguaçu, Mandaguari, Marialva, Marechal Cândido Rondon, Maringá, Metalândia, Medianeira, Missal, Nova Esperança, Nova Londrina, Paiçandu, Paranaguá, Paranavaí, Rolândia, Santa Fé, Santa Helena, Santa Terezinha de Itaipú, São Miguel do Iguaçu, Sarandi, Toledo, and Umuarama. The municipalities that belong to the 15<sup>th</sup> Regional Health District of Maringá concentrate 27.8% of the population of the state (Brasil 2006).

According to the Dengue Information Bulletin No. 01/2008 published by the State Secretary Office of Health (SESA), in 2007, among the 22 regional health districts, the 15<sup>th</sup> Regional Health District of Maringá, with a population of 716,273 inhabitants, presented the highest concentration of confirmed dengue cases (n=10,346), including five cases of hemorrhagic fever, two with shock syndrome and thirteen with complications, corresponding to an incidence of 1,444.42 cases per 100,000 inhabitants. The city of Maringá, with a population of 339,800 inhabitants, presented 5,790 cases of dengue, corresponding to an incidence of 1,704 cases per 100,000 inhabitants.

A total of 24,015 cases of dengue confirmed by serological examination were notified between 2000 and 2007 in the 30 municipalities that comprise the 15<sup>th</sup> Regional Health District of Maringá. Their distribution is shown in Table 1. The largest number of notified cases (n=15,349, 63.9%) was observed in 2007, followed by 1,444 cases (6%) in 2001, 3,995 (16.5%) in 2002, and 1,460 (6%) in 2003, also representing important epidemics in the region studied. The municipalities with the largest number of cases were Maringá with 50.0% of cases (n=12,037), Sarandi with 13.1% (n=3,141), Paiçandu with 8.9% (n=2,154), Colorado

with 4.3% (n=1,091), Doutor Camargo with 3.4% (n=817), and Nova Esperança with 3.3% (n=803). These municipalities accounted for 83% of all cases notified.

**Table 1.** Number of dengue cases notified in the 15<sup>th</sup> Regional Health District of Paraná (Maringá) between 2000 and 2007 according to year.

Year	Number of cases notified	
	n	%
2000	236	1.0
2001	1,444	6.0
2002	3,955	16.5
2003	1,460	6.0
2004	267	1.0
2005	759	3.2
2006	545	2.3
2007	15,349	64.0
<b>Total</b>	<b>24,015</b>	<b>100.0</b>

Patients older than 30 years were the most affected age group, corresponding to 54.3% (n=13,035) of the cases notified (Table 2).

**Table 2.** Number of dengue cases notified in the 15<sup>th</sup> Regional Health District of Paraná (Maringá) between 2000 and 2007 according to age group.

Age (years)	Year								Total
	2000	2001	2002	2003	2004	2005	2006	2007	
< 1	1	5	22	23	5	5	8	142	211
1-4	5	34	91	40	13	14	6	218	421
5-9	10	63	210	84	11	28	23	553	982
10-14	16	91	344	123	12	46	53	1,196	1,881
15-19	14	140	415	154	27	69	55	1,655	2,529
20-29	50	317	814	296	49	164	119	3,147	4,956
30 or +	140	794	2,059	740	150	433	281	8,438	13,035
<b>Total/year</b>	<b>236</b>	<b>1,444</b>	<b>3,955</b>	<b>1,460</b>	<b>267</b>	<b>759</b>	<b>545</b>	<b>15,349</b>	<b>24,015</b>

With respect to the evolution of dengue between 2000 and 2007, 75.9% (n=18,281) of the cases were cured and outcome was unknown in 23.9% (n=5,760). Severe forms of the disease were reported in 22 cases and four of these (18.2%) died of the disease. Four of the 29 deaths notified were confirmed to be due to the disease. These deaths occurred in the following municipalities: Doutor Camargo (n=1) and Maringá (n=3) (Table 3).

**Table 3.** Distribution of dengue cases notified in the 15<sup>th</sup> Regional Health District of Paraná (Maringá) between 2000 and 2007 according to the type of evolution.

Evolution	Year								Total
	2000	2001	2002	2003	2004	2005	2006	2007	
Unknown	9	1	2	18	16	120	241	5,353	5,760
Cure/discharge	226	1,443	3,948	1,436	248	636	302	10,042	18,281
Death	1	-	5	6	3	3	2	-	20
Death due to the disease	-	-	-	-	-	-	-	4	4
Death due to other causes	-	-	-	-	-	-	-	5	5
<b>Total</b>	<b>236</b>	<b>1,444</b>	<b>3,955</b>	<b>1,460</b>	<b>267</b>	<b>759</b>	<b>545</b>	<b>15,404</b>	<b>24,070</b>

Regarding the type of dengue, 66.3% (n=10,200) of the cases were classified as classic dengue. Two (0.01%) cases of dengue hemorrhagic fever were notified in 2002 and five (0.02%) in 2007 (Table 4).

During the period studied, viral isolation was only performed in 48 samples. Of these, 28 (58.3%) infections were caused by serotype DEN-1, four (8.3%) by DEN-2 and 16 (33.3%) by DEN-3. No data regarding viral isolation were available for 2007 (Table 5).

According to the data of the Health Surveillance Section (SCVGS), the HI and BI referring to 2007 were higher than those recommended by the WHO, indicating high infestation of houses and deposits with *Aedes aegypti* larvae. The records showed a decline in the HI and BI after the visit of community health agents, and some municipalities had indices of less than 1%, a rate recommended by the WHO. However, there are still municipalities presenting an HI higher than 1%, a finding demonstrating the constant need for information about the disease and routes of transmission. In some municipalities, the HI and BI again increased after the visit of the community health agents, a finding that might be explained by the high resistance of the eggs of the vector to dry climate. *Aedes aegypti* eggs can remain

dormant for approximately 450 days. During rainy periods, the eggs initiate embryonic development, which lasts about 12 to 24 h, thus again increasing the number of vectors (Souza 2008).

**Table 4.** Distribution of dengue cases notified in the 15<sup>th</sup> Regional Health District of Paraná (Maringá) between 2000 and 2007 according to type of dengue classification.

Type of classification	Year								Total
	2000	2001	2002	2003	2004	2005	2006	2007	
Unknown	8	-	-	9	-	16	8	46	87
Classic dengue	127	797	2,235	759	46	240	124	10,200	14,528
Dengue with complications	-	-	-	-	-	-	-	13	13
Hemorrhagic fever	-	-	2	-	-	-	-	5	7
Shock syndrome	-	-	-	-	-	-	-	2	2
Discarded	101	647	1,718	690	221	503	413	4,762	9,055
Inconclusive	-	-	-	-	-	-	-	368	368
<b>Total</b>	<b>236</b>	<b>1,444</b>	<b>3,955</b>	<b>1,458</b>	<b>267</b>	<b>759</b>	<b>545</b>	<b>15,395</b>	<b>24,059</b>

**Table 5.** Distribution of dengue serotypes of the cases notified in the 15<sup>th</sup> Regional Health District of Paraná (Maringá) between 2000 and 2007.

Serotype	Year							Total
	2000	2001	2002	2003	2004	2005	2006	
DEN-1	-	25	3	-	-	-	-	28
DEN-2	-	-	2	1	-	-	1	4
DEN-3	1	5	10	-	-	-	-	16
<b>Total</b>	<b>1</b>	<b>30</b>	<b>15</b>	<b>1</b>	<b>0</b>	<b>0</b>	<b>1</b>	<b>48</b>

Among the dengue cases recorded between 2000 and 2007, 63.7% were autochthonous, 37.7% were of unknown origin and only 0.6% were imported (Table 6). The large number of autochthonous cases suggests that dengue is not controlled in the region.

**Table 6.** Distribution by origin of dengue cases notified in the 15<sup>th</sup> Regional Health District of Paraná (Maringá) between 2000 and 2007.

Origin	Year								Total	
	2000	2001	2002	2003	2004	2005	2006	2007	(2000/2007)	%
Autochthonous	39	1,078	2,156	680	61	287	51	10,944	15,296	63.7
Imported	3	26	40	24	2	11	7	32	145	0.60
Unknown	194	340	1,759	756	204	461	487	4,373	8,574	37.7
<b>Total</b>	<b>236</b>	<b>1,444</b>	<b>3,955</b>	<b>1,460</b>	<b>267</b>	<b>759</b>	<b>545</b>	<b>15,349</b>	<b>24,015</b>	<b>100.0</b>

Until 2006, the area of residence was not stated in the epidemiological form adopted for compulsory dengue notification, with this information only becoming available from 2007 on. In 2007, 97.8% (n=15,010) of the cases notified occurred in the urban zone (Table 7).

**Table 7.** Distribution of the incidence of dengue in the 15<sup>th</sup> Regional Health District in 2007 according to region of residence.

Region of residence	2007
Unknown	158
Urban	15,010
Rural	177
Periurban	4
<b>Total</b>	<b>15,349</b>

## DISCUSSION

The survey of the SINAN dengue records obtained from the Sector of Epidemiology of the 15<sup>th</sup> Regional Health District showed a large number of vector breeding sites and a high incidence of dengue in northwestern microregions of the State of Paraná over the last years, characterizing an area of high risk for new epidemics. The high incidence of dengue in 2007 emphasizes the severity of the current epidemiological situation.

An increase in the number of children with dengue, including severe and fatal cases, has been observed over the last years (Nogueira et al. 2007). Dengue affects all age groups, but children are at a higher risk of contracting the severe forms of the disease than adults, as

demonstrated in reports from Thailand and other countries in Southeastern Asia (Halstead 1970). In this respect, children require greater and differentiated care, which is obviously difficult to provide during an epidemic.

Dengue hemorrhagic fever and dengue shock syndrome are the main causes of pediatric hospitalization in Southeastern Asia and have become endemic in many Latin American countries over the last 25 years (Regato et al. 2008). In 2001, more than 600,000 cases of dengue infection were notified in the Americas, including 15,000 cases of dengue hemorrhagic fever/dengue shock syndrome (Regato et al. 2008). Clinical manifestations rapidly aggravate, with signs of circulatory insufficiency and shock that can lead to the death of the patient within 24 hours. According to statistical data of the Brazilian Ministry of Health, about 5% of patients with hemorrhagic dengue die (Jarbas & Fabiano 2008).

According to the WHO, the classification of dengue is retrospective and depends on clinical and laboratory criteria that are not always immediately available, especially in cases of classic dengue with complications. These criteria do not permit the identification of potentially severe forms for which the early institution of treatment is crucial (Brasil 2005b).

The laboratory diagnosis of dengue is important since other diseases may present similar clinical signs and symptoms. Dengue is a disease for which notification is compulsory, a procedure that contributes to reduce infection by intensification of vector control measures in the region and a better understanding of the epidemiology of the disease and its clinical presentations. Viral isolation is a reliable and definitive method for the confirmation of suspected cases of dengue. However, since this method depends on the infrastructure for cell culture, it is limited to research and referral laboratories (Jarbas & Fabiano 2008).

Identification of the dengue virus serotype infecting the patient is important since the virulence potential of dengue virus has been associated with the circulating genotype. Molecular epidemiological studies have investigated the possibility of establishing an association between dengue virus serotypes and particular clinical forms of the disease (Ricco-Hesse 2003, Messer et al. 2003). In Paraná, there is a lack of techniques that permit the identification of the viral serotype, a fact impairing the monitoring of epidemiological evolution and increasing the risk of clinically more severe cases when changes in the circulating serotype occur. Serotypes 1, 2 and 3 circulate in Brazil. Virus 3 has been present since December 2000 and was isolated in January 2001 in Rio de Janeiro (CETESB 2008).

Control of the vectors is the only option to reduce the incidence of dengue and the development of entomological indicators is essential for the success of field actions (Glasser

& Donalísio 2002). According to the literature, no transmission of dengue occurs in the case of an HI less than 1% and a BI less than 5%. In this respect, low rates of infestation with *Aedes aegypti* reduce the risk of dengue transmission but do not eliminate it, a fact indicating the need for permanent entomological surveillance and control to keep these indices low (Tauil 2001).

The report of the State Dengue Control Program released by the State Secretary Office of Health of Paraná (Paraná 2008) confirmed the occurrence of autochthonous cases of the disease, with a risk of an epidemic, in 147 municipalities. The main reason is the increased number of breeding sites. According to SESA, the risk has increased in household dwellings due to the behavior of the population. Almost 99% of infestation foci are found in human dwellings. Many individuals still fail to combat foci such as uncovered water containers.

The Brazilian Ministry of Health alerts that persistence of the disease and epidemic outbreaks are the result of factors such as the high breeding rates of *Aedes* and the long period of viability of its eggs, climatic changes, urbanization, and inadequate disposal of tires, plastic bottles and other recyclable material (Brasil 2002).

In view of the uncontrolled dissemination of the vector, surveillance actions were urgently needed in Brazil. These actions were organized by the Brazilian Ministry of Health, SESA and municipalities in affected regions in a heterogenous and intermittent manner. After 1997, with the implementation of the *Aedes aegypti* Eradication Program (PEAa) in Brazil, followed by the Program for the Intensification of Dengue Control Actions, the Ministry of Health increased the redistribution of resources to Brazilian municipalities to decentralize and (re)organize measures of vector elimination and health education (Brasil 1996). However, little is known about the true impact of these measures on the dissemination of this viral infection in the country. Thus, further investigation of the epidemiology of dengue and its vectors by already established research groups becomes relevant. In addition, operational research should be encouraged to rapidly respond to specific questions arising within the control programs and to evaluate the impact of these actions (Glasser & Donalísio 2002).

Knowledge about factors that influence mosquito density are fundamental for the understanding of epidemics and for the guidance of control actions. These factors include urban sanitation infrastructure and socioeconomic and cultural aspects of human communities, since the latter are responsible for the storage of water, type of recipient used, type of garbage disposal, housing characteristics, and transportation of goods, among others (Glasser & Donalísio 2002).

The large number of autochthonous cases suggests that dengue is not controlled in the region. Notification of the first autochthonous cases of dengue in Paraná state dates back to 1993, and important epidemics have been reported since then. Among the dengue cases notified in Paraná, 90% are autochthonous and only 6.8% are imported. New cases are observed every year in Paraná State (Fernandes de Oliveira et al. 2004).

Most dengue cases occurred in urban areas, a finding suggesting the presence of *Aedes aegypti* breeding sites in the dwellings. The precarious conditions of housing, water supply and garbage collection in urban areas result in the creation of new breeding sites for the mosquito. Although dengue is an urban disease that is mainly observed in overpopulated areas, outbreaks in less populated rural areas have been reported frequently (Bos 1992, Erenkranz 1971, Mehendale et al. 1991).

Nogueira et al. (2007) emphasized that constant improvement of medical services for the rapid and correct evaluation of dengue cases is currently crucial in Brazil in order to reduce the impact of the disease and the number of fatal cases.

Despite alarming data and constant concern in preventing the propagation of dengue, the notification of cases is still precarious, not taking into account the relevance of these data for epidemiological studies. In this respect, continued training of healthcare workers to adequately fill out the notification forms is necessary.

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