

DENGUE: WHO IS DYING IN THE STATE OF PARÁ?

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- **ABSTRACT:** In the last 50 years, the incidence of dengue grew over 30 times, with the development of the geographical expansion for new countries and currently, reaching small towns and rural areas. It is estimated about over than 50 million of infection by dengue occur annually and approximately 2.5 billion people die in countries where the disease is endemic. In the state of Pará, 4042 cases of dengue were confirmed until October 1st, 2015. At the same period in the year of 2014, 2704 occurrences were registered, which represents an increase of almost 50%. Thus, this work's objective is to trace the patient's with dengue profiles in the state of Pará and to verify the relationship between those patients stage of life and the type of dengue with evolution case. For this end, the descriptive analysis technique was utilized, aiming to trace the patient's profiles confirmed with dengue. The correspondence analysis technique was utilized to verify what was (exclude) the relationship between the patients's stage of life and the type of dengue fever with evolution case. As the main results, it was noticed that the majority of the patients are female, residing in urban zones and are adults. It was still perceived that elders, children and individuals that had dengue with complications, shock syndrome and hemorrhagic fever had the highest probabilities of dying. Therefore, it is due noticed that is important to give this disease greater attention, above all to the children and elderly stages of life, because, from the results it was evidenced that the individuals on these stages of life are the most prone to die from the disease.
- **KEYWORDS:** Correspondence analysis; probability; dengue fever cases.

1 Introduction

Dengue is a highly infectious disease, caused by a virus of the family flaviviridae, of great epidemiologic magnitude and demographic amplitude, in which, causes high epidemic crisis over the world, mostly in the tropical regions, reaching millions of people annually (WILDER-SMITH *et al.*, 2009; BARRETO and TEIXEIRA, 2008).

The *Aedes aegypti* is found fully adapted into urban environment. This mosquito finds on the human domestic dwellings, favorable conditions for its development, in which, this evolution occurs most of the time on still water, cumulated on recipients and/or opened objects propitious for the mosquito's proliferation. The climate is another relevant factor

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towards the mosquito's survival, because, for their development, they need a humid environment with temperature between 15°C e 35°C (COSTA, 2001). The dengue is a disease that can suffer effects indirectly by climatic changes, contributing or not towards the proliferation of the mosquito that transmits the disease, interfering on their distribution, proliferation, development, and frequency of bites and the virus's period of incubation, affected by the temperature (MENDONÇA, 2003).

The main form of transmission occurs by the bite of the female hematophagous (feeds off blood) of the *Aedes* genus, infected with the dengue virus, aiming for their eggs maturity. The transmission, in rarer cases, can be made over organ transplant or blood transfusion through infected donors (RAMOS, 2008).

The *Aedes aegypti* mosquito transmits the dengue, which is a viral disease that spreads quickly throughout the world. In the last 50 years, the incidence of dengue grew over 30 times, with the development of the geographical expansion for new countries, and currently, reaching small towns and rural areas. It is estimated about over than 50 million of dengue infections occur annually, and approximately 2.5 billion people die in countries where the disease is endemic. In the Americas, this disease spreads with cyclic surges in every 3-5 years. In Brazil, the transmission occurs continuously since 1986, alternating with the epidemic occurrences, generally associated with the introduction of new serotypes in former unharmed areas or with the alteration of the predominant serotype (MS, 2015a).

Moreover, in Brazil, this disease has the most impact on public health care, and approximately 70% of the cases, concentrates itself on the specific period between January and May (MS, 2015b).

According to the data from the Computing Department of the SUS (DATASUS, 2017), from the periods of 2001 until 2012 there have been registered 5589474 cases of dengue in Brazil, in which the state of Pará is the 12th state with the most notification numbers of the disease. In addition, in the northern region, Pará is the state with the most amount of dengue notification cases. Thus, it is noticed that dengue fever is a serious problem on the public health care of Pará, evidencing the necessity to understand and identify the profiles/factors related with the disease, finally subsidizing combat and control measures towards it.

Regarding the Tenth Epidemiological Report about the dengue fever's situation in the state of Pará, 4042 cases of dengue fever were confirmed until October 1st, 2015. In the same period in the year of 2014, 2704 occurrences were registered, which represents an increase of almost 50%. (SESPA, 2015).

Thus, it is observed that dengue is a disease with highly clinical aspects, in other words, can attack many different human organs, which can lead to death. Its mostly common symptoms are high fever, weakness, nausea, headaches, muscle pain, joint pain and behind the eyes, among others (MS, 2013a).

The main aim of this work is to trace the dengue fever patient's profiles in the state of Pará and verify the relationship between those patients stage of life and the type of dengue with evolution case.

2 Materials and methods

2.1 Data description

The data was obtained through Pará's State Secretary of Public Health Care -Secretaria de Estado de Saúde Pública do Pará (SESPA) and given to the Laboratory of Information Systems and Georeferencing - Laboratório de Sistema de Informação e Georreferenciamento (LASIG), referencing to 76986 confirmed cases of dengue fever in the State of Pará, in the period from January 2007 until July 2013.

To trace the patients profiles, the following variables and categories were utilized: Sex (Male and Female), Race (Brown, White, Black, Yellow and Indigenous), Residence Zone (Urban, Rural and Peri-urban) and Stage of life (Children, Teenager, Adult and Elderly). We identify of the factors related to the patient's evolution cases throughout the application of the correspondence analysis technique. The following variables and categories were utilized: Evolution case (Cure and Decease), Stage of Life (Children, Teenager, Adult and Elderly) Residence Zone (Urban, Rural and Peri-urban) and Types of Dengue (Classic Dengue, Dengue with Complications, Dengue Hemorrhagic Fever and Dengue Shock Syndrome).

The classic dengue is the lighter form of the disease, similar to a common flu. Generally, it lasts 5 to 7 days, whereas the infected shows high fever (39° to 40°C), headaches, weakness, muscular and joint pains, indisposition, nausea, vomit, red rashes on the skin, abdominal pain (mainly on children), amongst other symptoms. The dengue hemorrhagic fever is a grave disease and is characterized by alterations on the blood coagulation of the infected person. Initially is similar in terms with the classic dengue, but, after the third or fourth day of the disease's evolution, hemorrhage appears due to the bleeding of small blood vessels on the skin and internal organs. These hemorrhages can be nasal, gingival, urinary, gastrointestinal or uterine. While the Dengue Shock Syndrome is characterized by manifesting a big loss or absence of blood pressure. The person attacked with this disease shows a nearly imperceptible pulse, pallor and loss of consciousness. In this type of dengue fever, a number of complications can occur, such as neurological alterations, cardiorespiratory problems, hepatic insufficiency, digestive insufficiency and pleural stroke (CD, 2011).

2.2 Correspondence analysis (CA)

To verify the relationship between the patients stage of life and the Type of dengue with the evolution cases, the CA technique was utilized, which is a multivariate technique capable of evaluate the significant relations between the categories of the variables on this work. To apply the CA technique, Moscarola (1991) and Lagarde (1995) initially recommend the realization of the chi-squared distribution test (χ^2) with the intent of verifying the dependency between variables. The test statistic is

$$\chi^2 = \sum_{i=1}^l \sum_{j=1}^c \frac{(O_{ij} - E_{ij})^2}{E_{ij}},$$

where O_{ij} is the observed frequency of the i lines and j columns, E_{ij} is the expected frequency of the i lines and j columns, with $i = 1, \dots, l$ e $j = 1, \dots, c$. Where E_{ij} is given accordingly with the following equation:

$$E_{ij} = \frac{n_i \times n_j}{n},$$

where n_i is the total times of observations on the i line, n_j is the total times of observations on the j column and n is the total observations in analysis, with $i = 1, \dots, l$ e $j = 1, \dots, c$.

Next, it is recommended that the β criteria must be calculated, with the intent of verifying the dependency between variables in study, meaning that the test's significance will be observed if $\beta \geq 3$ to a risk of 5% (MOSCAROLA, 1991; LAGARDE, 1995). Thus, β is calculated from

$$\beta = \frac{\chi^2 - (l - 1)(c - 1)}{\sqrt{(l - 1)(c - 1)}},$$

where χ^2 is the chi-squared statistic, l is the number of the categories of the lines variable and c is the number of categories of the columns variable.

Another important assumption to be analyzed is the inertia percentage calculation, which refers to the variation explained by each dimension. According to Ramos *et al.* (2008), when the simple correspondence analysis is utilized, the associations are propagated on a two-dimensional plan, ergo, the sum of the inertia percentage from the dimensions 1 and 2 must be equal or superior to 70% for the results to be valid.

Ramos *et al.* (2008), affirm the necessity to evaluate the proximities between categories, through the residues calculation (Z_{res}), which indicates the standard deviation from the estimated values (waited) in relation to the observed data between the categories of the variables in study. Therefore, the standard residues are calculated performing the subtraction between the observed frequencies and the estimated frequencies. The standard residue is given by

$$Z_{res} = \frac{O_{ij} - E_{ij}}{\sqrt{E_{ij}}}.$$

Next, the confidence coefficient is calculated (γ) to obtain the degree of association between the categories of the variables, which means, they indicate the probability of association between the categories of the variables in study (Ramos *et al.*, 2008), given by

$$\gamma = \begin{cases} 0, & se \ Z_{res} \leq 0 \\ 1 - 2 \times [1 - P(Z < Z_{res})], & se \ 0 < Z_{res} < 3 \\ 1, & se \ Z_{res} \geq 3, \end{cases}$$

where Z is a random variable with normal and standard probability distribution. The associations between the categories of the variables are considered moderately significant when the confidence coefficient value shows probabilities between 50.00% and 69.99%.

When the confidence coefficient shows values higher or equal to 70.00%, this coefficient will indicate highly significant probabilities.

The correspondence analysis was utilized with the aid from the software *Statistica*, version 8.0. In all of the tests, $\alpha = 5\%$ ($p\text{-value} \leq 0.05$) was fixed for the rejection of null hypothesis.

3 Results and discussion

The majority of the patients who had confirmed cases were female (52.98%), brown (73.99%), residing in urban zones (88.34%) and were adults (61.68%) (Table 1). Disagreeing with the results obtained by Moraes, Duarte and Duarte (2013), who asserted that people residing in rural areas have double the risk of dying by severe dengue (with complications, shock syndrome and hemorrhagic fever) when in comparison with urban zone residents. Travassos *et al.* (2002) reports that these results could be from the major concentration of health services and professionals from the urban health centers, but could also be a reflection of the socioeconomic situation, or both.

According to the Brazilian Institute of Geography and Statistics (Instituto Brasileiro de Geografia e Estatística) – IBGE, 76.7% of the paraenses call themselves brown or black, from these, 69.5% are self-declared brown and 7.2%, black (IBGE, 2010), justifying the obtained results.

According to a study made by Scandar *et al.* (2010), where they utilized a spatial analysis technique based off Moran's index for the distribution patterns for spatial analysis, in the city of São José do Rio Preto – SP, in the period from 1990 until 2005, they observed that the age groups between 15-50 years had the most notifications of dengue. These age groups comprise the stages of life between children and adult, whereas the major incidence of the disease attacked females.

Similar results were found by Silva and Camargo Júnior (2015), where they verified with descriptive statistics that women were the most attacked by dengue in the period between 2010 until 2013, with the most cases notified in urban zones. According to the authors, one of the reasons in which the urban zone had the most amount of dengue cases was because of its great populational occupation, in comparison with the rural zone. Johansen and Carmo (2012) utilized the descriptive statistics technique to show that in the city of Altamira – PA, the urban zone has favorable socio-environmental features for the outbreak of dengue epidemics.

Table 1 - Percentage of Patients Confirmed with Dengue in the State of Pará, in the period from January 2007 until August 2013, by Sex, Race, Residence Zone and Stage of Life

Variable	Category	Percentage (%)
Sex	Female	52.98
	Male	47.02
Race	Brown	73.99
	White	18.56
	Black	5.84
	Yellow	1.12
	Indigenous	0.49
Zone	Urban	88.34
	Rural	11.26
	Peri-urban	0.40
Stage of Life	Children	14.94
	Teenager	14.08
	Adult	61.68
	Elderly	9.30

Because the descriptive level values (p -value) are less than the significance level adopted ($\alpha = 0.05$) and the results of the Beta Criteria (β) are greater than 3, the conclusion is that the variable of the evolution case and its categories has a dependency relationship with the variables/categories of stage of life, residence zone and type of dengue (Table 2). Moreover, it can be observed that the sum of the percentage of inertia indicates that over than 70% of the information was given by CA. Therefore, all of the assumptions (dependency between variables/categories of the variables) for the utilization of the Correspondence Analysis technique were met.

Table 2 – Resulting Statistics by the application of the Correspondence Analysis technique. The variables: Evolution Case; Stage of Life; Residence Zone and Type of Dengue, from the confirmed cases of dengue in the State of Pará, in the period from January 2007 until August 2013

Variables	χ^2	L	C	β	% Inertia	p -value
Evolution Case vs. Stage of Life	28.26	4	2	26.52	100.00	0.000
Evolution Case vs. Residence Zone	6.21	3	2	4.80	100.00	0.044
Evolution Case vs. Type of Dengue	11660.80	4	2	11659.07	100.00	0.000

Note: χ^2 - Chi-squared value; L - Number of categories on the line variable (Stage of Life; Residence Zone; Type of Dengue); C - Number of categories on the column variable (Evolution Case); p -value - Descriptive level and β - Value of the Beta criteria.

By the means of CA, it is noticed that children and elderly have significantly high probabilities to decrease by dengue (Table 3). There were not any statistically significant associations between the categories of evolution case variable and the categories teenager and adult (Stage of Life).

It is a fact that elders are vulnerable to suffer more with dengue, because the advanced age decreases the human's body resistance. Therefore, if the proper care is not given, the situation can be harmful. Accordingly, with the health ministry (MS, 2013b), children and elderly are the most vulnerable to dengue, because the organism resistance is lower on these two groups if in comparison with the other ones.

According to the Health Ministry (2013c), individuals with age above 60 years have 12 time more risk of dying by dengue than the other age groups. In the first three months of 2013, 132 (42%) elders died from dengue in Brazil.

In children, the dengue diagnosis is particularly difficult on its initial phase, because the clinical manifestations overlap the innumerable other diseases of this age group (JAIN and CHATURVEDI, 2010). In a research made by Santos and Ferrari (2013) in an endemic county in the state of Mato Grosso, it was found that the majority of dengue notifications were from the age groups between 19 to 40 years, reinforcing that the disease afflicted newborns, children, teenagers, adults and elders too.

With children, the cutaneous condition can be atypical, characterized, for example, by macular lesions with tendency to confluence, vesicular lesions, and even tendency to return under precipitant determined factors, like stress. In immunosuppressed people, it is possible the occurrence of conditions with severe visceral complications, prolonged or fatal, as it happens with others viral infections on this population segment (ZANLUKA *et al.*, 2015).

Table 3 – Residuals and confidence levels (between parenthesis) resultant with the application of the Correspondence Analysis technique. The variables: Evolution Case; Stage of Life; Residence Zone and Type of Dengue, from the confirmed cases of dengue in the state of Pará, in the period between January 2007 until August 2013

Variables	Categories	Evolution Case	
		Cure	Decease
Stage of Life	Children	-0.07(0.00)	2.00(95.41)*
	Teenager	0.08(6.04)	-2.07(0.00)
	Adult	0.06(4.73)	-1.62(0.00)
	Elder	-0.15(0.00)	4.16(100.00)*
Residence Zone	Urban	-0.03(0.00)	0.90(63.23)**
	Rural	0.08(6.54)	-2.23(0.00)
	Peri-Urban	0.02(1.94)	-0.66(0.00)
Type of Dengue	Classic	0.40(31.36)	-9.75(0.00)
	With Complications	-0.98(0.00)	23.67(100.00)*
	Shock Syndrome	-4.00(0.00)	96.74(100.00)*
	Hemorrhagic Fever	-1.67(0.00)	40.33(100.00)*

Note: *Highly significant probabilities; **Moderately significant probabilities.

It was still noted that patients residing in urban zones and had dengue, had moderate probabilities of dying, however, the patients residing in another areas (rural zone and peri-urban) did not show statistically significant relations with the disease's decease or cure. The *Aedes aegypti* mosquito, vector of the disease, is highly domicile and is present in great amounts of urban residences (FORATTINI *et al.*, 1987; FORATTINI *et al.*, 2000; SILVA

et al., 2001; MEDRONHO, 2006), which has been propitiating the dengue's urbanization as much as in Brazil and as in Colombia. It is worth mentioning that both have favorable environmental and social requirements for the mosquito's proliferation, besides the fact that the state of Amazonas has borders with Colombia (MEDRONHO, 2006; CASSAB *et al.*, 2011).

Patients who have shown cases of dengue with complications, shock syndrome and hemorrhagic fever have substantially significant probabilities of dying (Table 3). There was not statistically significant association between the Evolution Case and the Classic Dengue category.

The symptoms of classic dengue, in the majority of the cases, are incapable of leading to death. Its common symptoms are high and intermittent fever, headaches, joint pain, muscle pain (localized or not), retro orbital pain, nausea and vomit. Although having a low index of lethality, the classic dengue, being the most common, causes serious individual and social disorders, which gain an even bigger dimension with each new epidemic. The harder forms of the disease are the Dengue's Hemorrhagic Fever (DHF) and the Dengue's Shock Syndrome (DSS), comprising a high fever, which initiates equal to classic dengue, but evolves into worse overall health status, heart attack, low arterial pressure, decrease of blood circulation on the peripheral tissues and hemorrhagic manifestations. The external signs that indicate the worsening of classic dengue into hemorrhagic includes the appearance of red rashes on the skin, bleeding (nose, gums) intense and continuous pain on the abdomen and persistent vomit (BRASIL, 2011).

Conclusion

From the descriptive analysis, it is noticed that the majority of the patients confirmed with Dengue are female, brown, residing in urban zones and are adults. The CA technique emphasized that the elder and children individuals showed high probabilities of deceasing by dengue. It was still perceived that individuals that had confirmed dengue cases and are urban zone residents have moderate probability of dying, and the types of dengue with complications, shock syndrome and hemorrhagic fever had the highest probabilities of leading to death. Therefore, it is due noticed that is important to give this disease greater attention, above all to the children and elderly stages of life, because, from the results, it was evidenced that the individuals in these stages of life are the most prone to die from the disease.

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- **RESUMO:** Nos últimos 50 anos, a incidência da dengue aumentou 30 vezes, com ampliação da expansão geográfica para novos países e, atualmente, para pequenas cidades e áreas rurais. Estima-se que cerca de 50 milhões de infecções por dengue ocorram anualmente e que aproximadamente 2,5 bilhões de pessoas morrem em países onde a dengue é endêmica. No estado do Pará, foram confirmados 4.042 casos de dengue até o dia 01 de outubro de 2015. No mesmo período do ano de 2014, foram registradas 2.704 ocorrências, o que representa um aumento de quase 50%. Diante disto, o trabalho objetivou-se em traçar o perfil dos pacientes com dengue no estado do Pará e verificar a relação entre a fase da vida desses pacientes e o tipo de dengue com a evolução do caso. Para isso, utilizou-se a técnica análise descritiva com o intuito de traçar o perfil dos pacientes confirmados por dengue. Já a técnica análise de correspondência foi utilizada para verificar qual (excluir) a relação da fase da vida dos pacientes e o tipo de dengue com a evolução do caso. Como principais resultados, percebeu-se que a maioria dos pacientes é do sexo feminino, residem em zona urbana e são adultos. Observou-se ainda que os indivíduos que estão na fase da vida criança e idoso, e pacientes que apresentaram quadro de dengue com complicações, síndrome do choque e febre hemorrágica, tiveram maiores probabilidades de evoluir a óbito pela doença. Portanto, conclui-se que é importante maiores atenções a esta doença, principalmente, quando acometem idosos e crianças, pois, a partir dos resultados evidenciou-se maior propensão destes evoluírem a óbito.
- **PALAVRAS-CHAVE:** Análise de correspondência; probabilidade; casos de dengue.

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