Human Visceral Leishmaniasis: epidemiological monitoring and life indicators in municipalities in Bahia, Brazil

Leishmaniose Visceral humana: monitoramento epidemiológico e indicadores de vida nos municípios da Bahia, Brasil

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ABSTRACT

The behavior of life indicators of notified cases of Visceral Leishmaniasis (VL) in Bahia and sociodemographic factors were analyzed. The study analyzes the behavior of life indicators of notified cases of Visceral Leishmaniasis (VL) in Bahia and its correlation with sociodemographic factors. This is an analytical and retrospective study (2010 - 2020) that used the SINAN/DATASUS secondary database between. Were analyzed data on notifications, incidence, transmission, risk stratification and life indicators. During the period there were 3,573 cases of VL, highest incidence of 3.52 cases/100,000 inhabitants and sporadic transmission in most municipalities. The Annual Increment Rate (AIR) in the South and East health macro-regions showed significant values for incidence and lethality in the West, East and Center-North regions. Disability Adjusted Life Years (DALY) showed that the infected Bahian population lost 10 years of life. The analysis of individual aspects of the municipalities made it possible to identify the need to implement effective public policies at this administrative level.

Keywords: Quality of life indicators. Visceral leishmaniasis. Health Policy.

RESUMO

O comportamento dos indicadores de vida dos casos notificados de Leishmaniose Visceral (LV) na Bahia e fatores sociodemográficos foram analisados. Trata-se de um estudo analítico e retrospectivo (2010 a 2020) que utilizou dados secundários do SINAN/DATASUS. Foram analisados dados de notificações, incidência, transmissão, estratificação de risco e indicadores de vida. No período foram registrados 3.573 casos de LV, maior incidência de 3,52 casos/100 mil habitantes e transmissão esporádica na maioria dos municípios. A Taxa de Incremento Anual (TIA) no Núcleo Regional de Saúde Sul e Leste apresentou valores significativos para a incidência e, para a letalidade, na Oeste, Leste e Centro-Norte. O *Disability Adjusted Life Years* (DALY) demonstrou que a população baiana infectada perdeu 10 anos de vida. A análise de aspectos individuais dos municípios permitiu identificar a necessidade de implementação de políticas públicas efetivas nessa esfera administrativa.

Palavras-chave: Indicadores de qualidade de vida; Leishmaniose visceral; Política de Saúde.

INTRODUCTION

Environmental and socioeconomic conditions of a population directly influence health and the occurrence of infectious and parasitic diseases[1]. "Visceral leishmaniasis" is one of these diseases, considered to be a public health problem with an estimated 50,000 to 90,000 cases a year worldwide. In this context, the World Health Organization (WHO) classifies it as one of the main infectious diseases, which can cause outbreaks and mortality[2].

In the Americas, there are three epidemiological scenarios for visceral leishmaniasis (VL), as it is endemic in 12 countries. These scenarios are: countries with sporadic transmission (Costa Rica, Guatemala, Honduras, Nicaragua, Bolivia, Guyana, and Mexico); countries with stable or controlled transmission (Colombia and Venezuela); and countries with expanding transmission (Argentina, Brazil, and Paraguay)[3,4].

In Brazil, VL has a wide geographical distribution with several epidemiological, climatic, and social characteristics according to the region in which it is present, making it difficult to control[5,6]. The spread of the disease to new areas, the climate, deforestation, migrations, and the lack of urban planning are factors that contribute to the appearance and risk of VL infections[7]. The disease is transmitted by vectors *Lutzomyia longipalpis* and *Lutzomyia cruzi*, known in the region as "mosquito straw", "birigui", "tatuquira", or "cangalhinha". Its main urban host are dogs[8,9,10].

In addition to the reported cases, the Ministry of Health advises on protection measures related to the human and canine population and vector control through actions such as the Visceral Leishmaniasis Control Program (PCLV)[8]. For Zuben and Donalisio[11], there are problems in the implementation of the Brazilian VL control policy, both in the effective actions of this program and in containing the dispersion and incidence of the disease.

Throughout Brazil, the registration of cases of the disease has been confirmed. The Northeast region is the one with the highest transmission rate and number of case notifications[12]. It has a high rate of social vulnerability, being a risk area for the establishment of the vector[13].

In the Northeast Region, Bahia is one of the states with a wide distribution of VL, being the third with the highest number of cases in the region between 2007 and 2019, thus presenting an endemic character[12,14]. In order to verify the current state of endemic in the state of Bahia, the study aims to analyze the temporal trend (2010-2020) of notifications of human cases of

VL and the behavior of life indicators. In addition, the sociodemographic aspects were correlated to support the monitoring, control and prevention of the disease.

METHODS

The study has a descriptive, retrospective and analytical design. The data collected considered cases of human VL notified in the state of Bahia, from 2010 to 2020. The information was retrieved from the Department of Informatics of the Unified Health System of The Ministry of Health (DATASUS), via The Information System for Notifiable Diseases (SINAN).

To analyze the behavior of VL in Bahia, it was necessary to investigate the rates of mortality, lethality, incidence and transmission, as well as the Triennial Composite index of VL and the annual increment rate (TIA). The incidences of VL cases by municipality of notification were classified based on a stratification, which used the criteria: very intense (65.93-125.27/100 thousand people), intense (33.1-65.92/100 thousand people), high (17.09-33/100 thousand people), medium (7.05-17.08/100 thousand people), and low (0-7.04/100 thousand people)[15]. The areas for surveillance and control of VL were classified according to the type of transmission: no transmission; sporadic (less than 2.4 cases); moderate (between 2.4 and 4.4 cases); and intense (equal to or greater than 4.4 cases)[16]. The risk stratification for disease contagion was also verified, based on the Triennial Composite Index of VL (ICTLV) from 2018 to 2020, according to the Pan American Health Organization/World Health Organization[17,18].

To analyze the annual increment rate (AIT) in the state of Bahia, the following Regional Health Centers (NRS) were considered: South (NRS - Ilhéus), Southwest (NRS - Vitória da Conquista), West (NRS - Barreiras), North (NRS - Juazeiro), Northeast (NRS - Alagoinhas), East (NRS - Salvador), Extreme South (NRS - Teixeira Freitas), Middle-East (NRS - Feira Santana), and Center-North (NRS - Jacobina). In context, the Prais-Winsten regression was used to understand the dynamics of the disease according to each variable over the years. Thus, it was possible to know if the disease showed trends of growth, decrease, or stability during the period. The calculation was based on a study conducted by Antunes[19] and applied by Böhm et al.[20], who calculated the AIT using the regression data: $AIT = [-1 + (10b)] * 100$, in which b is the inclination coefficient of the line in the Prais-Winsten regression. Trends were considered significant when the values of p of the regression presented $\alpha < 0.05$. Otherwise, the

trends were considered stable. This analysis was conducted in the statistical program PAST 4.11.

As for the indicators of life, they were DALY (*Disability Adjusted Life Years*), YLL (*Years of Life Lost* - years of life lost to premature death) and YLD (*Years Lived with Disability*). The DALY is the indicator used in studies of disease burden to simultaneously measure the effects of mortality and morbidity. It is the result of the sum of two-time plots: (1) YLL and (2) YLD. In addition, it incorporates, in the estimation process, a discount rate and age weighing function, as well as the importance of disability. Every 1 DALY represents 1 year of healthy life lost. The calculation was carried out using functions of the Excel program.

A generalized Linear model (GLM) with Poisson distribution was used to understand the Association of the disease with epidemiological factors. For the variables "education", "age", "gender" and "race", the following variables were calculated: odds ratio and the confidence interval (95% CI) with its lower (LL) and upper (UL) limit. The odds ratio (OR) is defined as the ratio of the odds of an event happening in the presence of another event. The odds are the likelihood for this event to occur, divided by the probability of the non-occurrence of the same event. When OR = 1, there is no association, that is, the chance is the same. If OR > 1, the control group has a lower chance than the test group. If OR < 1, the control group is more likely to respond than the test group.

The maps were prepared in QGIS, a free geoprocessing software. The table with the incidence rate data was associated with the spatial representation file (Shapefile), considering the municipal limits of the state of Bahia, provided by IBGE.

As the research used secondary data available in SINAN, it was not necessary to submit it to the Ethics Committee on Research with Human Neings of the Universidade Luterana do Brasil. In this context, the study is in accordance with the CNS resolution nº 466/2012.

RESULTS

In the period from 2010 to 2020, 3.573 cases of human VL cases were notified in the state of Bahia. The year 2014 had the highest prevalence of the disease, with 14.4% (513) of the total cases, while 2020 had the lowest (5.5%; 195).

Of the 471 municipalities that make up the state, 229 (55%) had at least one confirmed case of human VL. In the period analyzed, the years 2011 and 2014 stand out with the largest number of municipalities with records of the disease (20.8% and 20.0%, respectively). Detailing

the analysis on the notifications of human VL cases in the municipalities of Bahia, we found that the city of Salvador had the highest prevalence of notified cases (16.2%), followed by Irecê (9.7%), Feira de Santana (7.5%), Juazeiro (5.2%), Guanambi (4.3%), Jequié (4.0%) and Barreiras (3.1%). (Figure 1). These municipalities presented cases in all years and together represent 50.1% of the total.
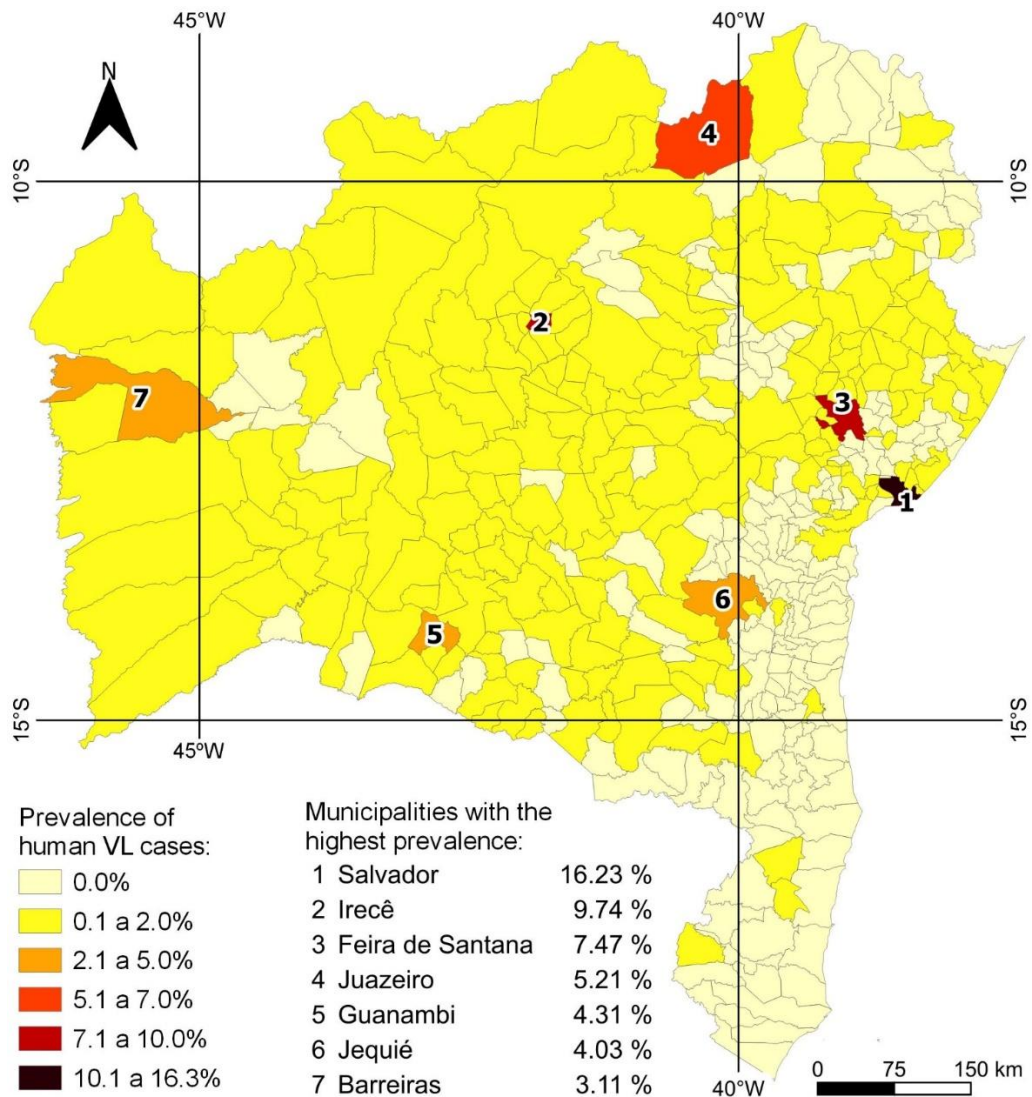

Figure 1. Prevalence of human VL cases, by municipality in Bahia, in the analyzed period.

As for the factors related to the disease, all of them were statistically significant (Table 1). In Bahia, there are 1.7 times more cases of VL in men than in women; more cases in brown people; and 8.5 times more in people with less than 9 years of study. Regarding the chances of having VL according to age group, children aged 1 to 4 years have a 4.4 chance, young adults aged 20 to 39 years have 3.4; and adults between 40 and 59 years have 2.3.

Table 1. Epidemiological characteristics of patients with VL in Bahia, between 2010 and 2020

Characteristics		Estimate	p	OR1	2.5%	97.5%
Race	Brown		Reference			
	White	-1.90777	**< 0.001**	0.148	0.133	0.166
	Indigenous	-5.98813	**< 0.001**	0.003	0.001	0.006
	Yellow	-4.64439	**< 0.001**	0.01	0.006	0.014
	Black	-1.43953	**< 0.001**	0.237	0.216	0.26
Educational level	Illiterate		Reference			
	< 9 years	2.15075	**< 0.001**	8.591	7.083	10.421
	>9 years	0.69315	**< 0.001**	2	1.599	2.502
Gender	Female		Reference			
	Male	0.52699	**< 0.001**	1.694	1.585	1.811
Age group (years)	< 1 year		Reference			
	1 to 4	1.47717	**< 0.001**	4.381	3.791	5.061
	5 to 9	0.70196	**< 0.001**	2.018	1.72	2.366
	10 to 14	0.13629	0.134	1.146	0.959	1.37
	15 to 19	0.11285	0.218	1.119	0.936	1.339
	20 to 39	1.23233	**< 0.001**	3.429	2.957	3.977
	40 to 59	0.84477	**< 0.001**	2.327	1.991	2.72
	60 to 69	-0.60025	**< 0.001**	0.549	0.441	0.683
	70 to 79	-1.20103	**< 0.001**	0.301	0.229	0.395
	More than 80	-2.08833	**< 0.001**	0.124	0.084	0.183

The higher incidence of the disease in Bahia followed the behavior of the registration of notifications. The highest rate was 3.52 cases/100 thousand people in 2014, and the lowest was 1.31 cases / 100 thousand people in 2020.

The incidence stratification in Bahia from 2010 to 2020, allowed the identification of seven municipalities with the classification of "very intense" (Cafarnaum, Salinas da Margarida, Boa Vista do Tupim, Marcionílio Souza, Nova Redenção, Andaraí, and Irecê). In addition, 21 municipalities were stratified as having an intense incidence (Irecê, Iraquara, Uibaí, Cabaceiras do Paraguaçu, Antônio Cardoso, América Dourada, Canarana, Ituaçu, Ibirataia, Barro Alto, Cafarnaum, Nova Redenção, Marcionílio Souza, Presidente Dutra, Barra do Mendes, Lajedinho, São Félix do Coribe, Sento Sé, Salinas da Margarida, São Gabriel, Maetinga) (Figure 2). In 2019, there was no record of the "intense" classification in the state of Bahia for human VL. The municipality of Irecê was stratified as having a very intense incidence (2014 and 2015) and intense (2010, 2012, 2013, 2016, 2017 and 2018). In 2011 and 2019, it was high; and, in 2020, medium, being the municipality with the highest frequency of records of the condition. Its incidence over the studied period ranged from 16.32 to 84.97/100 thousand people. Camaçari (0.35-0.79 cases/100 thousand people) and Itabuna (0.48 cases/100 thousand people) were among the stratified municipalities with low incidence.
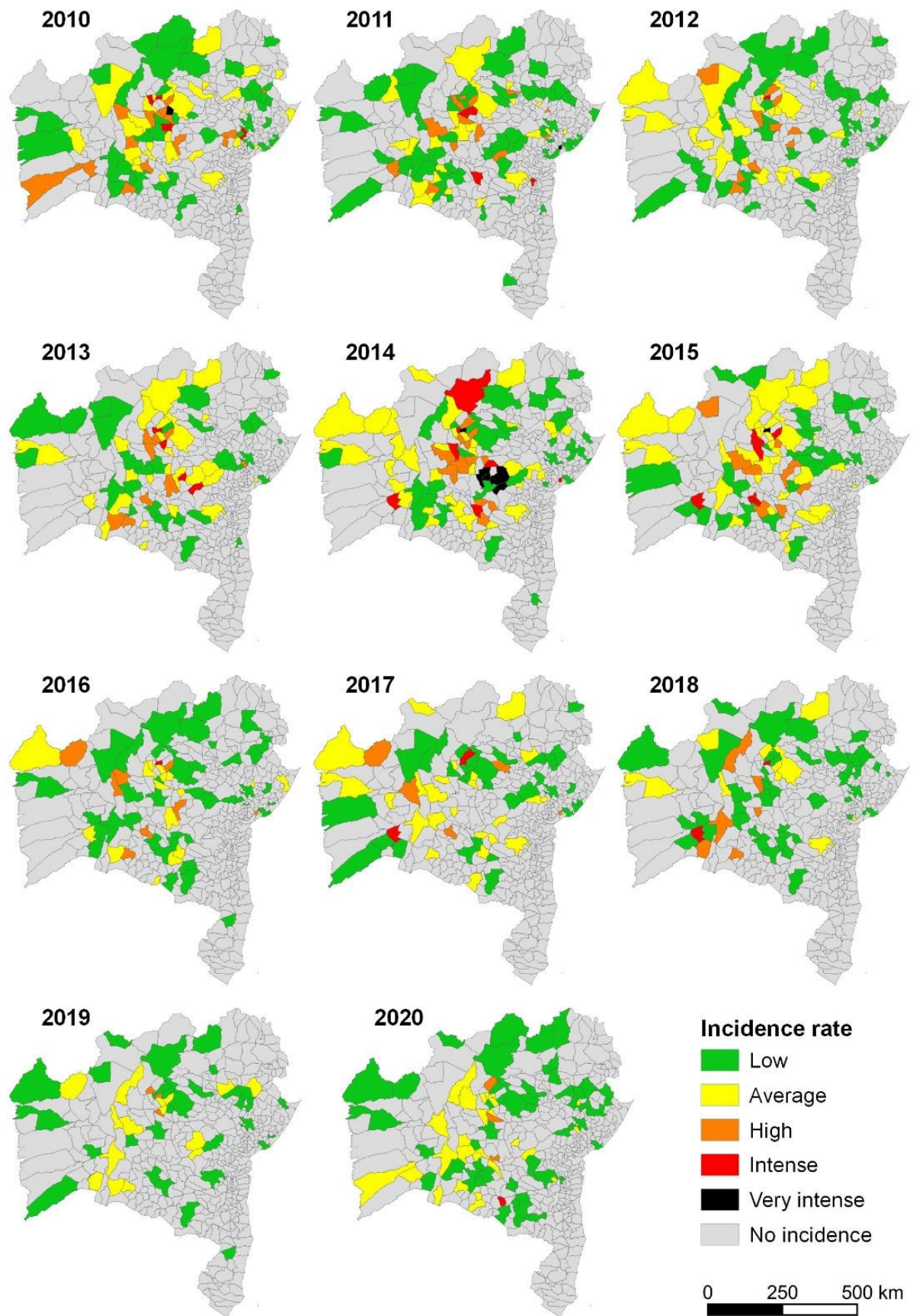
Figure 2. Stratification of Bahia municipalities according to incidence rate per year.

The area classification according to the criteria "with transmission" and "without transmission" has been used to assess the risk of occurrence of the disease, in order to contribute to the surveillance and control of human VL. In this context, the state of Bahia has 9 municipalities classified as having intense transmission; 8 with moderate; 150, sporadic; and 62 municipalities without transmission (Figure 3). The municipalities classified as having intense transmission are: Salvador, Irecê, Feira de Santana, Juazeiro, Guanambi, Barreiras, Bom Jesus da Lapa, Jequié, and Vitória da Conquista.
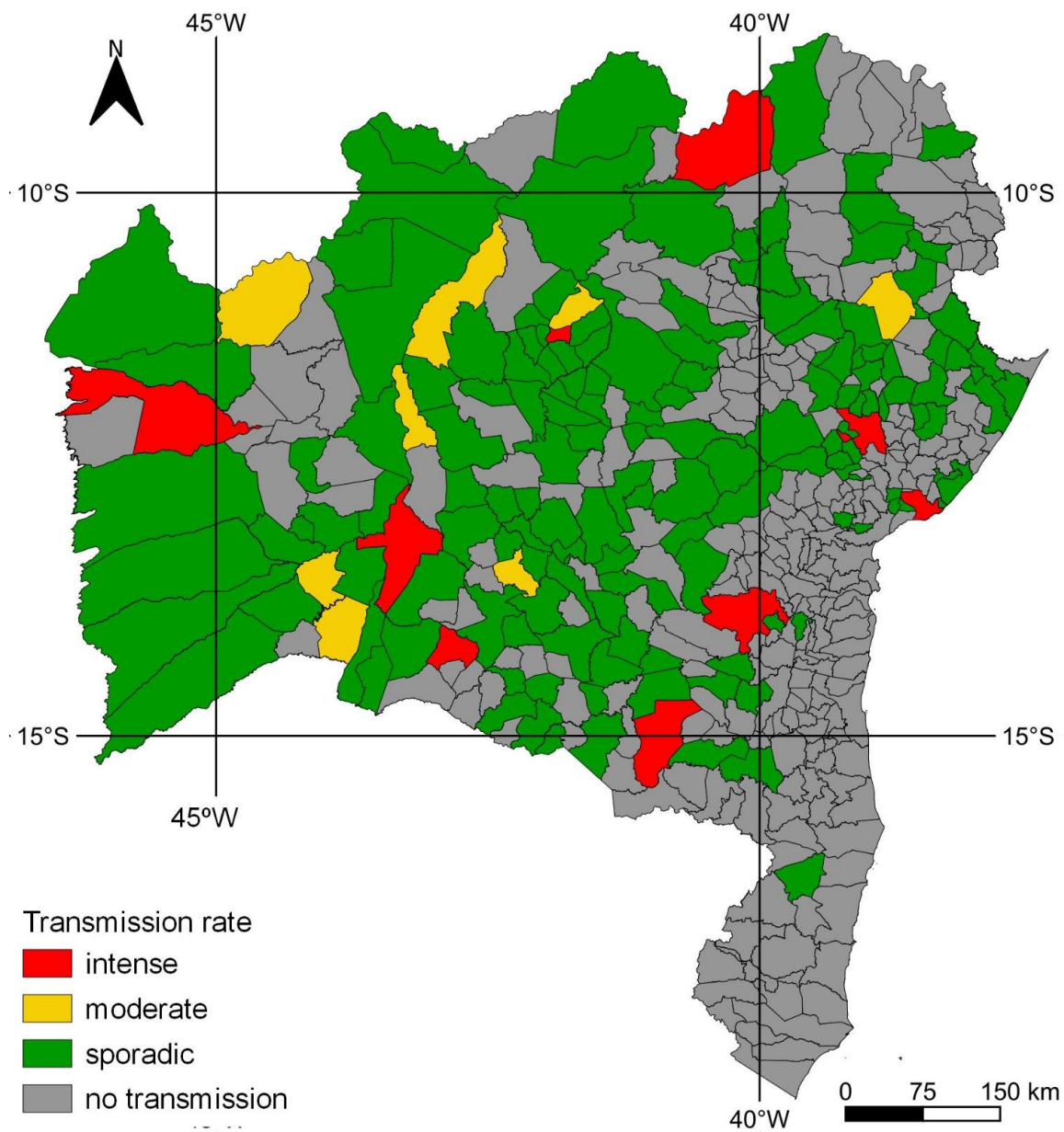

Figure 3. Transmission rate of human VL in the state of Bahia, from 2016 to 2020.

The annual increment rate (AIT) in the Regional Health Centers of notification of Bahia (Table 2) was analyzed considering the incidence rate, mortality and lethality. The incidence of the disease showed significant (negative) values only for the Southern (p = 0.0018) and Eastern (p = 0.0019) NRS, with a tendency to decrease. The other regions showed stability. Mortality from the disease did not show significant values of AIT, and all regions showed a stable situation. The lethality of the disease showed significant (positive) AIT values for the West (p = 0.0229), East (p = 0.007) and Center-North (p = 0.0486) NRS, with a tendency to grow. The other regions showed stability.

The composite index of the triennium of VL (ICTLV), represented by the average number of cases and incidence/100.000 people for the triennium 2018 to 2020, indicated the risk stratification of the population for becoming ill[18]. The Western NRS (NRS-Barreiras) presents a higher risk for the population to acquire VL (Table 2).

Table 2. Annual increment rate (AIT) of VL in the regional notification Health Centers of Bahia, from 2010 to 2020

Regional Notification Health Center	Incidence			Mortality			Lethality			Composite Index**
	AIT	p*	Sit	AIT	p*	Sit	AIT	p*	Sit	ICTLV
South (NRS – Ilhéus)	-0.26	**0.0018**	D	-0.17	0.2779	E	-0.56	0.5689	E	-1.402
Southwest (NRS-Vitória da Conquista)	-0.16	0.123	E	0.03	0.9524	E	1.53	0.4604	E	-0.882
West (NRS-Barreiras)	0.41	0.8571	E	3.93	0.5225	E	4.89	**0.0229**	C	1.098
North (NRS-Juazeiro)	-0.24	0.2092	E	-0.01	0.8352	E	0.10	0.6361	E	-1.228
Northeast (NRS-Alagoinhas)	-0.32	0.5938	E	-0.23	0.0821	E	-0.96	0.2301	E	-1.504
East (NRS – Salvador)	-0.28	**0.0019**	D	-0.05	0.1765	E	1.52	**0.007**	C	-0.582
Far South (NRS-Teixeira de Freitas)	2.25	0.3238	E	-0.02	0.9101	E	-0.89	0.9084	E	-1.543
Middle-East (NRS - Feira Santana)	-0.27	0.2797	E	-0.13	0.5155	E	0.58	0.7326	E	-0.317
Center-North (NRS-Jacobina)	0.23	0.1115	E	-0.99	0.2983	E	3.05	**0.0486**	C	-0.569

* Values in bold show α < 0.05; * * triennium from 2018 to 2020.
Table subtitle: Sit. - Situation; C-Increasing; D-Decreasing; E-Stable

Based on DALY analysis, it was found that 2014 and 2018 had the highest values; the period between 2012 and 2015 presented values above the average. The DALY calculation (Table 3) showed that the state of Bahia lost 1,483.2 DALY in 10 years.

Table 3. DALY calculation for the historical series in the state of Bahia

Year	YLL	YLD	DALY
2010	1,354.0	2.20	1,356.2
2011	1,086.4	2.20	1,088.6
2012	1,430.1	1.49	1,431.6
2013	1,710.0	1.68	1,711.7

2014	2,195.2	2.30	2,197.5
2015	1,651.2	1.71	1,652.9
2016	966.0	0.90	966.9
2017	1,522.4	1.51	1,523.9
2018	2,082.0	1.50	2,083.5
2019	974.4	0.87	975.3
2020	1,326.2	0.73	1,326.9

Considering the annual increment rate calculated for YLL (years of life lost), YLD (years lived with disability) and DALY, only YLD showed a significant downward tendency (AIT= 0.25; p=0.0051). The other indicators, YLL (AIT= 0.99; p=0.9608) and DALY (AIT = 0.99, p= 0.958), remained stable.

DISCUSSION

The Northeast region stands out for having the highest number of VL cases (53.9%) in the period from 2017 to 2019, when compared to other regions[21]. The states with the highest number of municipalities with LV records were: Bahia (54 municipalities), followed by Ceará (48 municipalities), and Maranhão (45 municipalities) [22]. According to Cezar et al.[14], Bahia is the third state with the highest number of reported cases. It should be noted that, in this study, it was found that more than half of the municipalities in Bahia had at least one confirmed case of human VL between 2010 and 2020. In the Northeast, Bahia's prominent position can be explained by some of its environmental and social characteristics that are favorable to the vector. One of them is the climate, considered to be hot (average >18 ℃ in all months), since the mosquito develops in high temperatures, of about 20 ℃ and humidity above 90%[23,10]. Other important factors are the state's poverty rate (43.5%) and lack of sanitation (42.4%)[24].

Regarding the epidemiological profile, the predominance of males was also recorded by other authors[25,26,27,28,14,29]. The higher occurrence in men is possibly related to exposure to the vector when performing their work activities[30]. According to Lima et al.[31], the disease has mainly affected children in the age group of 1 to 4 years. In the state of Bahia, this predominance was registered, and similar results were found in other states, such as Minas Gerais[32], Maranhão[33,] Piauí[34], Sergipe [35] and Tocantins[28]. In the first years of life, the formation of antibodies is not as efficient due to immature immune systems, a fact that gets worse when it comes to children with nutritional deficiencies[8]. Brown individuals were predominant, corroborating other studies[25,26,27,14,29]. This occurrence is probably due to the predominance of this skin color in the Northeast. In Bahia, the brown color corresponds to 59% of the population[36]. The educational level "elementary school" was predominant among the notified

patients, which may be related to low socioeconomic levels and less access to information and preventive actions[27,37,33]. The urban area housed a greater number of cases, as in other studies [25,27,33]. In Bahia, the migration process (72%) resulted in precarious living conditions[36]. This process may have led to the growth of the urban area, allowing the expansion of VL there. Regarding the evolution of the disease, most patients were cured, as observed in other studies[27,28,29]. The predominance of cured patients can be the result of two actions: individuals who seek treatment early and those who undergo complete treatment.

Most municipalities in Bahia showed medium-to-low incidence of VL, especially in the last years of the historical series. They border silent municipalities, which can be an aggravating factor for the permanence and growth of VL in the state. Contributing to this, there are low socioeconomic and sanitary conditions, which favor the multiplication of the vector[38]. When relating VL to social inequality, it has been identified that municipalities with greater socioeconomic and infrastructure vulnerability had a greater number of cases of the disease[22]. In this context, when comparing the basic sanitation of the municipalities of Bahia, Irecê is the city that presents 70% of households without adequate basic sanitation, differing from Camaçari (35.5%) and Itabuna (19.3%), which may justify the difference in the incidence of the disease in these municipalities[39].

In the state of Bahia, it was found that there are more municipalities classified with sporadic transmission rate, that is, less than 2.4 cases/100 thousand inhabitants of VL in the five-year interval (2016-2020). This scenario contributes to Brazil being classified by PAHO / WHO[3] as a country expanding the transmission of VL. In this context, it is necessary to analyze the limits of these municipalities, because if they are bordering municipalities classified with moderate or intense transmission, there is a possibility that the classification will worsen due to spatial proximity and vector circulation.

AIT related to the incidence and lethality rate showed stability in most Regional Health Centers in the state of Bahia, which can be explained by a possible change in the epidemiological character of the disease. Considering that the composite index of the VL triennium (ICTLV), there is a risk of the population falling ill due the disease. It was found that the NRS West (NRS-Barreiras) has the highest index, therefore, being more susceptible. There are no studies in the literature on this index regarding the Regional Health notification centers of Bahia. In the Americas, the ICTLV by municipalities of infection allowed identifying that the most at risk are Colombia and Brazil, with Bahia being one of the states of prominence for the disease[40].

In Brazil, Bezerra et al. performed the first assessment of the burden of VL and cutaneous and mucocutaneous leishmaniasis in 27 federal units, using the life indicators YLL, YLD, and DALY[41]. These metrics combine data on mortality and morbidity and allow estimating the impact of the disease on the health status of the population. They should be used as key tools for health policies aimed at reducing the burden of disease[42]. When using the DALY global metric, Brazil is among the countries with the highest lethality rates by VL, reaching 7.4% in 2016[6,3]. The ranking of southern countries-that same year showed Brazil as the second country on DALY for VL. This position signals to the country the severity of the disease[43]. The growth in the DALY rate in recent years was due to LV, which showed an increase in all study metrics[41]. The YLL indicator is the main contributor to the DALY of VL, as it shows high mortality rates for this disease. Bezerra et al.[41] observed disparities between the five regions, which led them to suggest the need for subnational analyses. The authors recorded higher YLL values in the Northeast and Southeast and suggested that this is due to the urbanization process, corroborating the results found for the state of Bahia. In this research, the highest values of YLL and DALY were observed between 2013 and 2018, coinciding with the highest incidences of the disease in the region, except for 2016, when the values of YLL and DALY decreased. This same scenario was evidenced by Bezerra et al[41]. In 2016, the authors recorded an improvement in YLL (26.3), changing Bahia's position in the national ranking. In relation to the Federative units of the Northeast Region, Maranhão is the worst state (2nd place), and Bahia improved from the 8th position to the 10th, improving its scenario.

CONCLUSION

Visceral leishmaniasis in the state of Bahia is an important public health problem. This study indicates the endemic occurrence of the disease in the state, since it presents a high percentage of notifications in relation to the northeast region of the country. This study identified the epidemiological profile of VL in Bahia, with higher incidence in males, children, brown-skinned people, those with elementary school education, and urban area residents.

The rate of transmission and incidence of human VL, according to the year and municipalities in Bahia, is distributed in more than half of the municipalities, covering almost the entire state of Bahia. The municipality of Irecê must be highlighted, as it was stratified as very intense and intense in almost the entire period studied. Regarding transmission, the municipalities that presented the highest risk of illness in the population were Salvador, Irecê,

Feira de Santana, Juazeiro, Guanambi, Barreiras, Bom Jesus da Lapa, Jequié, and Vitória da Conquista.

The behavior of human VL can be observed by its transmission rate and incidence. These indicators are alternatives that can be used even in the smallest administrative and geographical units, for decision-making and monitoring of outbreaks. Risk stratification is also a valuable tool to direct, improve, and prioritize actions as well as surveillance and disease control. In addition, the analysis of the behavior of YLL and DALY are essential, as they are metrics that indicate the health status of the population. These indicators should be adopted as health policies and applied to the health management process in the country.

This research identified the relationship between socioeconomic variables and individual aspects of each municipality for the implementation of effective public policies. The analysis of the variables showed how important it is to provide complete information when a case is notified. These are necessary and contribute to more efficient epidemiological surveillance and to the reduction of disease levels. Educational actions are essential so that the population can understand the relationship between the vector and the host, as well as the environment.

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