Epidemiological profile of leishmaniasis notifications in the Pernambuco state in Brazil from 2015-2019

Perfil epidemiológico das notificações de leishmaniose no estado de Pernambuco no Brasil de 2015-2019

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ABSTRACT

Here, we provide an epidemiological analysis of leishmaniasis in Pernambuco, Brazil, from 2015 to 2019. Our results revealed 1,705 of American cutaneous leishmaniasis-ACL and 859 cases of visceral leishmaniasis-VL. VL and ACL affect children aged 1–4 years (23% and 3.2% of all cases, respectively) and adults aged 20–39 years (26% and 28%, respectively), mainly women. The highest percentage (54.6%) of VL cases was found in urban areas, while ACL occurred mainly in rural areas (63.2%). Individuals with a higher level of education were less affected by leishmaniasis and data on prognosis revealed good chances of clinical cure, but deaths are still recorded. These data show that preventive health actions must be developed to hinder leishmaniasis spread, reduce its impact on public health, and restore the population's life quality. This study can be useful in further elaboration of strategies to minimize leishmaniasis impacts.

Keywords: Epidemiology. Leishmaniasis. American cutaneous leishmaniasis. visceral leishmaniasis. Pernambuco.

RESUMO

Aqui, fornecemos uma análise epidemiológica da leishmaniose em Pernambuco, Brasil, de 2015 a 2019. Nossos resultados revelaram 1.705 casos de leishmaniose tegumentar americana-LTA e 859 casos de leishmaniose visceral-LV. LV e LTA afetam crianças de 1 a 4 anos (23% e 3,2% dos casos, respectivamente) e adultos de 20 a 39 anos (26% e 28%, respectivamente), principalmente mulheres. O maior percentual (54,6%) de casos de LV foi encontrado na área urbana, enquanto LTA ocorreu principalmente na área rural (63,2%). Indivíduos com maior escolaridade foram menos acometidos pela leishmaniose e dados de prognóstico revelaram boas chances de cura clínica, mas óbitos ainda são registrados. Esses dados mostram que ações preventivas de saúde devem ser desenvolvidas para impedir a disseminação da leishmaniose, reduzir seu impacto na saúde pública e restaurar a qualidade de vida da população. Este estudo pode ser útil na elaboração de estratégias para minimizar os impactos da leishmaniose.

Palavras-chave: Epidemiologia. Leishmaniose. Leishmanione tegumentar Americana. Leishmaniose visceral. Pernambuco..

INTRODUCTION

Leishmaniasis is a global public health concern, as it occurs in 98 countries worldwide, with more than 1.3 million cases recorded per year. Brazilian people, which are considered one of the poorest nations, are strongly affected by this disease since 96% of all reports around the world are notified in this country[1]. Leishmaniasis comprises a set of infectious parasitic diseases caused by protozoa of the genus *Leishmania*, which are transmitted through the bite of infected female phlebotomine sandflies. Leishmania infection has a wide range of clinical manifestations, including cutaneous, mucocutaneous, visceral, post-kala-azar dermal, and diffuse cutaneous leishmaniasis, depending on the parasite species and the immune response of hosts[2]. *Leishmaniasis* is now endemic in tropical and subtropical regions, and it is estimated that >20,000 and 3,000 cases of the cutaneous and visceral forms, respectively, are recorded annually[3].

Visceral leishmaniasis (VL), also known as kala-azar, is a neglected tropical disease reported in more than 80 countries, representing the most severe and lethal form of leishmaniasis when diagnosed and treated late[4,5]. VL is mainly caused by *Leishmania infantum* with the most important vector being the sandfly *Lutzomyia longipalpis*[6]. After blood meal, the mosquito receives parasite cells that pass the amastigote stage to the promastigote stage. The incubation time of *L. infantum* in the mosquito midgut is approximately 8–20 days. Next, promastigotes multiply in the insect midgut and migrate to the proboscis. After the bite, promastigotes are phagocytized by host macrophages and transform into amastigotes, which multiply inside these cells[7].

The clinical manifestations of VL range from asymptomatic infection to severe systemic cases associated with high fever, loss of weight, asthenia, anemia, splenomegaly, and hepatomegaly[8]. The treatment currently recommended by the World Health Organization[3] involves the administration of pentavalent antimonials, mainly N-methyl glucamine or amphotericin B, in special cases. In addition, some symptomatic treatments are also adopted through the use of antipyretics, antibiotics, hemotherapy, nutritional support, and hydration[9]. The diagnosis of VL is initiated by the measurement of clinical manifestations, followed by laboratory assays that include parasitological, immunological, and molecular tests. Parasitological tests investigate the presence of parasites in tissue aspirates from the spleen, bone marrow, lymph nodes, and peripheral blood using optical microscopy[10].

American cutaneous leishmaniasis (ACL) is an infectious and non-contagious anthropozoonosis that affects the skin and mucous membranes of humans and wild, synanthropic, and domestic animals, such as canids, felids, and equines, which act as reservoirs of parasites[11]. In South America, *Leishmania brasiliensis* is the parasite which is most frequently associated with disease outbreaks; however, *Leishmania amazonensis* and *Leishmania guyanensis* are also etiological agents. The taxonomic identification of leishmania-causing species allows us to draw an epidemiological profile because each species induces different evolution of the disease clinical manifestations[12,13].

The main vector of ACL described in South America is the sandfly *Lutzomyia* which transmits *L. brasiliensis* after a blood meal in non-human animals with no person-to-person transmission[14]. In Brazil, the diversity of leishmaniasis vectors contributes to the high risk of contamination; *L. flaviscutellata*, *L. whitmani*, *L. umbratilis*, *L. intermedia*, *L. wellcome* and *L. migonei* have been reported as vectors of different *Leishmania* species in Brazil[15,16]. The incubation period in human hosts averages 2 to 3 months, and the diagnosis can be made through histopathological analysis and detection

of *Leishmania* DNA by polymerase chain reaction (PCR) or skin smear[11,17]. It is recommended to use more than one diagnostic method and consider the epidemiological context of the region[18,19].

Both the clinical forms of leishmaniasis were recorded in all Brazilian states by the *Departamento de Informática do Sistema Único de Saúde* (DATASUS), through the *Sistema de Informação de Agravos de Notificação* (SINAN). Epidemiological surveillance is responsible for analyzing any notified suspected or confirmed cases of SINAN to identify disease expansion in amplitude and number of cases. By monitoring the occurrence of leishmaniasis, it is possible to develop health prevention strategies to reduce the spread of the disease and its impact on public health, as well as to restore the population's quality of life.

The WHO has recommended the search for new strategies to treat leishmaniasis because of the high cost of currently available drugs and the severe side effects caused by them, as well as the emergence of resistant parasite strains. In this sense, the immunotherapy, which uses parts of human body, such as biological substances or molecules, to modulate immune responses, has been pointed as a more effective and safe therapeutic strategy to treat leishmaniasis[3,20]. It has been reported that associations between immunomodulators and chemotherapeutic agents (chemoimmunotherapy), may show synergistic effect, activating the immune response and exerting direct toxicity on parasite cells[20,21].

The impacts of human activity on the environment and the migrations to urban areas have directly influenced the epidemiological profile of leishmaniasis in northeastern Brazil, resulting in the persistence of the disease, despite the various social improvements achieved in this region in terms of education, housing conditions and nutrition, as well as the implementation of public policies that included the National Surveillance Program for Cutaneous Leishmaniasis, instituted to reduce morbidity, mortality and deformities due to this disease[22,11].

This work was stimulated by the need to bether know leishmaniasis epidemiology in an endemic area and awaken he scientific community and the public at large to develop better structured monitoring strategies, which may allow measuring the magnitude, distribution and behavior of the disease. In this sense, an epidemiological analysis of leishmaniasis in the State of Pernambuco, in the Northeast region of Brazil, from 2015 to 2019, is provided.

METHODOLOGY

The epidemiological analysis performed in this work used a descriptive and quantitative approach, carried out through a situational survey of leishmaniasis as a public health problem in the State of Pernambuco (7°15'45″–9°28'18″ S; 34°48'35″–41°19'54″ W), in the Northeast region of Brazil, from 2015 to 2019. Pernambuco has 9,674,793 inhabitants distributed in 185 municipalities, according to the latest census of the *Instituto Brasileiro de Geografia e Estatística* (IBGE)[23]. Most of the Pernambuco territory is in a semi-arid zone with diverse climatic conditions. The pluviometric index varies from 400 to 600 mm per year, with March to July being the period of the year when the rainfall events ofter occur. The temperatures were high and could exceed 40 °C. In the coastal and forest zones, the climate is humid tropical, and the pluviometric indexes exceed 1,500–2,000 mm per year, while in the agreement (transition area between the coast and backwood), it varies from 500 to 900 mm per year[24].

This research was carried out in 2022 through a systematic search of studies, contemplating the object of the proposed study with relevance for the analysis in the following databases: PubMed, Google Scholar,

ScienceDirect, and Scielo, using the following descriptors: visceral leishmaniasis, American cutaneous leishmaniasis, epidemiology, northeast, and Pernambuco. The review of the selected reports was presented in the "Introduction" to provide a brief review of the state of the art on the research topic, and in discussion of the data presented in the "Results" section.

The DATASUS program was used with different filters in the database to collect information on the annual frequency of VL and cutaneous leishmaniasis in Pernambuco. The main sociodemographic variables obtained for epidemiological information were the number of cases, sex, age group, schooling, and area of residence. The main variables obtained for clinical information were the confirmation criteria, case evolution, number of deaths, and the clinical form of TL (mucosal or cutaneous). The calculations of epidemiological ACL and VL indicators for the 5-year period under study were carried out to verify morbidity: incidence coefficient (number of new cases disease $\times$ 10^n/local population of the same period) and mortality: fatality rate (number of deaths $\times$ 100/total number of cases). After data collection, graphs and statistical analyses were performed using IBM® SPSS Statistics® and OriginPro 2019b.

RESULTS

The analysis of data from 2015 to 2019 revealed 859 confirmed cases of VL in Pernambuco, and this occurrence was lower than that presented for ACL, which included 1,705 cases. Although ACL is the most common form in northeast Brazil, the collected data showed that a significant reduction in notifications has occurred since 2010.

The incidence of VL and ACL in Pernambuco from 2015 to 2019 is shown in Figure 1. Despite the higher incidence coefficient values per 100,000 inhabitants for ACL over the entire period compared with VL, the pattern of disease distribution over the years was similar for both. In addition, it was possible to perceive a drop in the number of cases after 2015, followed by a peak in 2017, which remained stable until 2019. It was considered a total number of inhabitants in 2019 of 9,557,071, according IBGE.
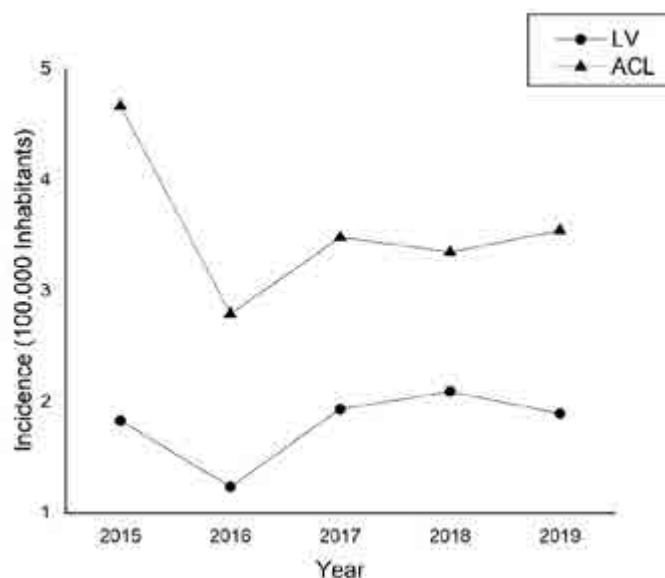

Figure 1. Incidence coefficient of visceral leishmaniasis and American cutaneous leishmaniasis in the state of Pernambuco, Brazil, from 2015 to 2019. ACL, American cutaneous leishmaniasis; VL, visceral leishmaniasis.

Table 1 shows the distribution of VL and ACL according to sociodemographic indicators in Pernambuco, Brazil, from 2015 to 2019. Both leishmaniasis forms affect individuals of all age groups (0 to >60 years). The analysis of leishmaniasis distribution according to age group (Figures 2A and 2B) showed that children aged 1–4 years represented 194 (23%) and 54 (3.2 %) cases of VL and ACL, respectively. In contrast, adults aged 20–39 years also participated in a relevant way of VL and ACL

epidemiology with 227 (26%) and 479 (28%) cases, respectively. It was also recorded that in the group of adult aged 20–39 years, men were more frequently affected than women, representing 60.6% and 68.3% of ACL and VL cases, respectively.
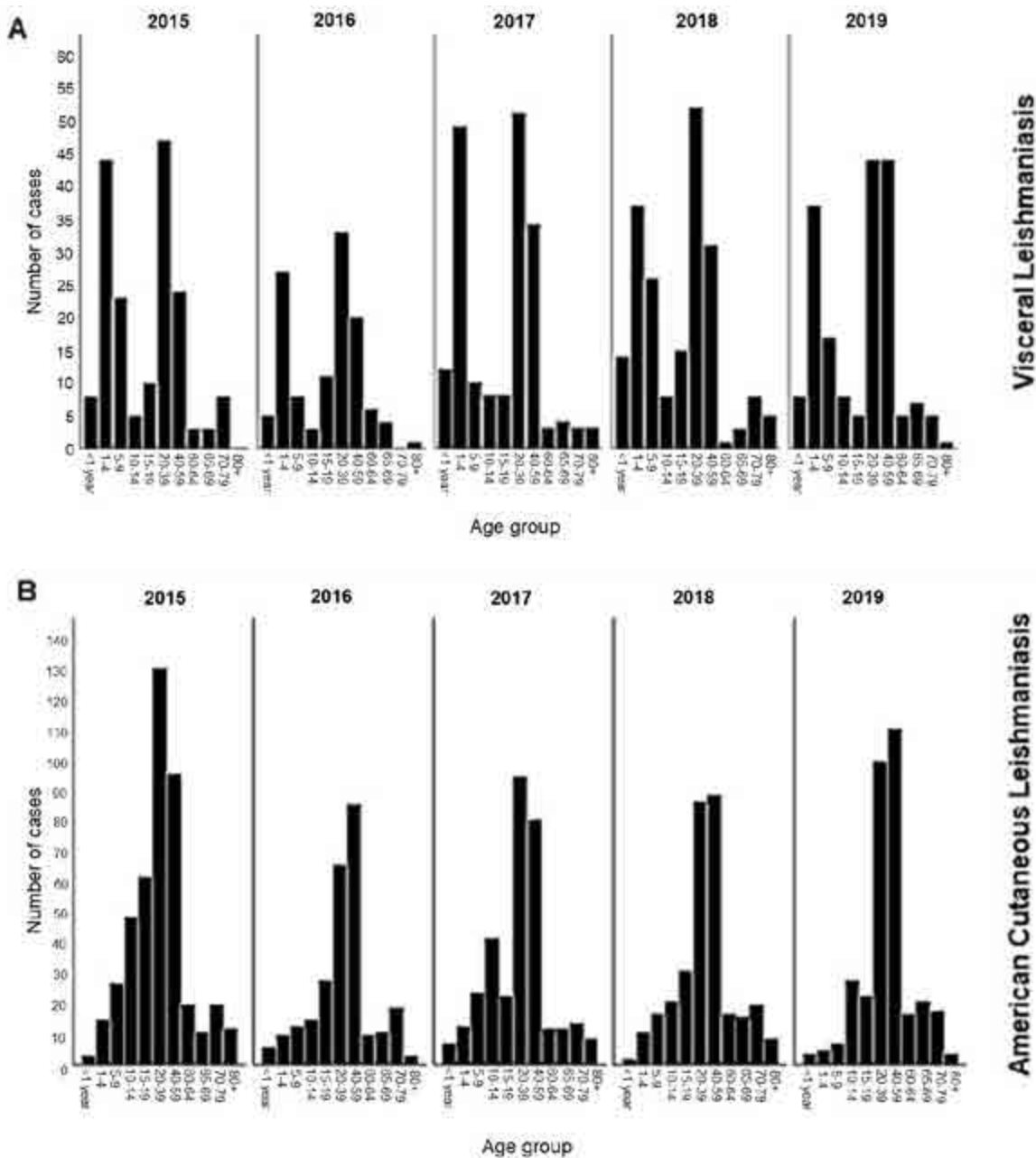

Figure 2. Distribution of visceral (A) and American cutaneous (B) leishmaniasis according the age in the state of Pernambuco, Brazil, from 2015 to 2019.

Table 1. Distribution of visceral and American cutaneous leishmaniasis according to sociodemographic indicators in Pernambuco, Brazil, from 2015 to 2019.

Sociodemographic indicators	Number of cases (%)*	
	VL	ACL
Age groups		
Children (1-4 years)	23	54
Adults (20-39 years)	26	28
Gender		
Male	68.3	60.6
Female	31.7	39.4
Education level		
Illiterate up to complete elementary school	79.93 ± 5.09[a]	82.56 ± 3.78[A]
Incomplete high school education up to complete higher education	20.07 ± 5.09[b]	17.44 ± 3.78[B]

* The number of cases presented for males and females takes as 100% the number of cases in the adult population; For the analysis of data gathered on the education level criterion, the sum of the total number of individuals with VL (388) and ACL (1054) corresponded to a total of 1442 cases, and this value was considered 100%. ACL, American cutaneous leishmaniasis; VL, visceral leishmaniasis. Different letters represent significant differences between VL (lowercase letters) and LTA (uppercase letters) carrier groups.

The highest percentage of VL (54.6%) cases was found in urban areas, followed by 42.5% of cases being recorded in rural areas, while cases in peri-urban areas did not even reach 1%. Interestingly, ACL showed a higher distribution in rural areas (63.2% of cases) than in urban areas (33% of cases). In peri-urban locations, ACL cases accounted for 1% of all cases.

The number of individuals with a higher level of education (incomplete high school to complete higher education) infected by VL or ACL was lower (Table 1) than that of individuals with low levels of education (illiterate to complete elementary school). As expected, 80% of VL cases in Pernambuco from 2015 to 2019 were confirmed by laboratory tests, whereas only 20% were based on clinical-epidemiological criteria. Conversely, the diagnosis of 31.3% of ACL cases was based on laboratory confirmation, whereas 68.7% corresponded to the clinical-epidemiological criteria.

The prevalence of cutaneous leishmaniasis in Pernambuco was 97%, whereas that in the mucosa was approximately 3%. Data on VL and ACL prognosis revealed good chances of clinical cure, since among the 859 cases of VL

reported from 2015 to 2019, 614 (71.5%) had good treatment results and 1,284 (75.3%) out of 1,705 cases of ACL progressed to cure. It was calculated a percentage of treatment abandonment of 0.2% and 1% for VL and ACL, respectively.

In the study period, 65 deaths of individuals with VL were recorded, and two deaths occurred in the ACL. The lethality of leishmaniasis (case fatality ratio), which estimates the proportion of deaths among confirmed cases, was 7.57% for VL and 0.12% for ACL.

DISCUSSION

This work was motivated by the high occurrence of leishmaniasis in Brazil, mainly in the Northeast region, where the highest number of cases are recorded due to the precariousness of the sanitary conditions that favor the spread of the disease[25]. Furthermore, the research selected the state of Pernambuco because of is one of the Brazilian states with the highest number of confirmed cases and due to its increasing spreading rate.

A possible reason for the reduction of

cases of the most common form of leishmaniasis in Pernambuco (ACL) since 2010 is the existence of the leishmaniasis surveillance programs of *Sistema Único de Saúde* (SUS), which are based on the diagnosis and treatment of the disease[25]. In addition to its higher occurrence, the importance of ACL for public health is due to its serious dermatological injuries with deformities that damage the psychological state of affected individuals, resulting in their social and economic relationships[11].

The highest prevalence of VL regarding to ATL among children aged 1-4 years reported here corroborate those of some studies described in the literature. Barbosa and Costa[26] reported the occurrence of VL in children <5 years of age in the state of Rio Grande do Norte, Brazil, from 2007 to 2011. A study carried out by Batista et al.[27] also showed a higher number of VL cases compared with ACL in children aged 1–4 years in the state of Piauí, Brazil, from 2007 to 2011. Childrens susceptibility to leishmaniasis may be linked to the relative cellular immunological immaturity in the first life-years, which is exacerbated by malnutrition that occurs in areas where leishmaniasis is endemic, especially in developing countries. In addition, children do not develop lifelong immunity to VL[9,28,29].

The high number of leishmaniasis records in the group of adults aged 20–39 years that we observed herein may be because it corresponds to >33.5% of the Pernambuco population, according to the IBGE census (2010), estimated until 2060. Although the census was carried out by the agency every 10 years, in 2020, data collection was not performed because of the restrictions imposed by the Covid-19 pandemic.

The high occurrence of leishmaniasis among working-age adults may be associated with occupational meetings and routine work activities, especially when they occur in forest areas where there is greater exposure to the disease vectors[28,29]. Accord-ing to Guerra et al.[30] and Ximenes et al.[31], the higher frequency of VL

and ACL among men may be associated with the performance of their work activities in agricultural locations where they are exposed to the vector, whereas women, in general, occupy intra- and peri-domiciliary environments.

Our analysis indicated that VL has a higher occurrence in urban areas of Pernambuco, while ACL predominates in rural areas. This data suggest an association between the occurrence of VL, anthropic pressure and the disorderly occupation of spaces due to the urbanization process. In addition, the remarkable domiciliation hability of *L. longipalpis*, which is currently found in virtually all of Pernambuco, corroborates this idea. Conversely, even with the lower occurrence in rural areas, it is important to plan VL control strategies since it remains a neglected disease, affecting mainly children, especially those who are malnourished[32,33].

In fact, in Brazil, ACL presents epidemiological patterns that are linked to the rural environment, with the sylvatic pattern being characteristic of wild animals, but which eventually affect humans, while the occupational pattern is associated with the disorderly exploitation and cutting down of forests for the human activity[34]. The high ACL occurrence in rural areas may be associated with the habits of the populations, where men frequent the atlantic forest fragments to work in agriculture, get food through hunting, or for plant extraction. In addition, women also frequent forest, accompanied by their children, for activities such as washing clothes in rivers. The little access to information, the perpetuation of risky practices and the negligence of the public authorities probably promote the higher occurrence of ACL in rural areas[35,36].

In northeast Pernambuco, rural workers are constantly exposed to endemic locations and risk factors, resulting in a high number of ACL-confirmed cases[15]. Negrão and Ferreira[38] also considered that economically active people living in rural areas show an increased risk of acquiring ACL, mainly because of their proximity to areas

with vegetation. Based on these data, it can be concluded that the predatory process of human occupation of forests favored epidemic outbreaks of the disease.

To support approximately 184 municipalities from Pernambuco in combating various endemic diseases, including leishmaniasis, the *Secretaria Estadual de Saúde* of Pernambuco was divided into 12 administrative units called *Gerências Regionais de Saúde* (Geres I-XII). In 2014, the highest number of cases in Geres I (Recife and the Metropolitan region) and Geres III (Palmares and surrounding municipalities) were reported in coastal municipalities[37].

Studies have revealed changes in the epidemiological behavior of ACL in Brazil, which was previously restricted to forest locations, where humans were bitten by vectors that had performed a blood meal on wild infected animals, which acted as a reservoir of *Leishmania*. Nowadays, an increasing number of ACL cases have been recorded in urban centers, indicating the adaptation of parasites and vectors to the conditions of these areas, with domestic animals serving as new reservoirs[15,39,40]. Additionally, the main factors responsible for the growing number of leishmaniasis cases in urban areas include migratory processes, precariousness in basic sanitation, low socioeconomic status, rapid deforestation, and the growth of agriculture, which invades and destroys the habitat of the sandfly vector of leishmaniasis[41].

The number of individuals with a higher level of education infected by VL or ACL was lower than that of individuals with low levels of education and this finding is certainly associated with lower health education and less chances for epidemiological control owing to poor access to information on preventive measures and treatment[42].

The *Ministério da Saúde* of Brazil recommends that the most reliable strategies for clinical confirmation of leishmaniasis are laboratory tests that identify the presence of

the parasite and assess changes in cellular metabolism[43]. Because of this, the greater number of VL cases in Pernambuco are confirmed by laboratory tests, in comparison with clinical-epidemiological criteria. Nevertheless, the *Manual de Vigilância da Leishmaniose Tegumentar Americana* states that ACL can be diagnosed based on epidemiological, clinical, or laboratory criteria[43]. Thus, we found that most ACL cases were confirmed by clinical-epidemiological criteria, and this datum corroborate those from Vicência (Pernambuco), which showed that the diagnosis of ACL was mainly confirmed through clinical and epidemiological methods (207 cases; 95.4%), with a few notifications (10 cases; 4.6%) based on appropriate laboratory tests[44].

There are three clinical forms of ACL: I. inapparent infection with no clinical signs, II. cutaneous leishmaniasis causing lesions on the skin starting at the vector bite site, but having the ability to spread to the rest of the body, III. mucosal or mucocutaneous leishmaniasis with lesions in the mucosa of the upper airways. Our results showed that the prevalence of cutaneous leishmaniasis in Pernambuco was much higher than that of mucosal leishmaniasis, which can appear several years after the cutaneous lesion or even occur while the primary skin lesion remains active. Mucosal leishmaniasis can occur as an extension of the adjacent skin lesion or it begins in the exposed semimucosa, such as the lip; treatment is difficult, and there are no prognostic studies[13,45].

In the present study, we found that leishmaniasis in Pernambuco has good chances of clinical cure with low rates of treatment abandonment. To consider an individual cured of VL, the patient should be monitored for 12 months after treatment for clinical criteria, such as reduction of hypertrophied organs (spleen and liver), absence of fever, regulation of hematological indices, gradual weight gain, and presence of eusinophilia[37]. According to the *Ministério da Saúde*, ACL cure criteria are

evidence of epithelialization in ulcerated and non-ulcerated forms, resulting in an atrophic or hypertrophic scar that does not show activity. The cure of the mucosal form is defined as the complete regression of all inflammatory signs, which can be confirmed by an otorhinolaryngological investigation performed up to six months after the conclusion of the treatment. Patients must return for medical evaluation three consecutive months after completing the therapeutic scheme. After the clinical cure is attested, the patient should be evaluated every two months within the 12-month period to avoid disease recurrence. If there is no clinical cure but the patient shows evidence of progressive healing, it is possible to extend the clinical follow-up for up to six months without the need to reintroduce treatment. In cases of failure after a new treatment, a second-choice drug, such as amphotericin B or pentamidine, should be introduced[46]. Individuals who did not complete the treatment or who did not appear for clinical evaluation should be notified and followed up by the health service to monitor their severity[11].

In recent years, VL lethality has been gradually increasing, from 7.1% in 2012 to 9% in 2019. Since the Ministério da Saúde recommends that the lethality rate for leishmaniasis be less than 5%, we can infer that, in Pernambuco, the disease is highly lethal[47]. In this sense, the data reported here indicate that measures to control VL are urgently required. To reduce the lethality of this infection, every VL death must have its causes monitored through notifications in SINAN and the *Sistema de Informação sobre Mortalidade* of the *Ministério da Saúde*. After data collection, health professionals examined all cases to identify any treatment failures.

Our analysis demonstrates that even with a broad disease control program that develops actions focused on the detection, diagnosis, and treatment of reported cases, VL remains a public health problem, and actions at different levels of prevention can significantly reduce the occurrence and spread of this disease.

The SUS offers free diagnosis and treatment of VL and ACL in the Brazilian population. Since 2014, the *Ministério da Saúde* has adopted the intralesional treatment developed by the *Instituto Nacional de Infectologia Evandro Chagas*, where subcutaneous injections of lower doses of meglumine antimoniate are administered directly into the wounds[47]. In addition, the *Secretaria de Vigilância em Saúde* of the *Ministério da Saúde* (SVS/MS) offers health professionals the training course "Leishmaniasis in Brazil: diagnosis and treatment" at a distance and free of charge to develop technical skills for the diagnosis and treatment of VL and ACL, and to improve the care for the population affected by these diseases[16].

The *Ministério da Saúde* will distribute more than 1 million collars impregnated with the insecticide "deltamethrin 4%". In Brazil, these collars have been used as individuals' devices to control VL in dogs since 2007. In contact with the skin, it promotes a slow release of deltamethrin 4%, repelling the vector and interrupting the cycle of the parasite, consequently reducing the risk of infection in other animals or humans. The action will be developed for 133 priority municipalities from 16 Brazilian states classified as high, intense, and very intense transmission. This action has already been performed in the municipality of Betânia, Pernambuco[15]. In addition, Law No. 12.604/2012 establishes the week that includes August 10 as an annual milestone to encourage educational and preventive actions, promote debates and events on public policies for surveillance and control of leishmaniasis. In addition, it aims to support activities of prevention and combat to disease organized and developed by civil society, and disseminate technical-scientific advances related to leishmaniasis prevention.

CONCLUSION

This paper provided the epidemiological profile of the population affected by VL and ACL

in Pernambuco, which has a lower incidence of the diseases when compared to other states in Northeast Brazil, including Ceará, Bahia and Piauí. Nevertheless, Pernambuco contributes to the occurrence of the disease in Brazil, the most affected country in the world, according to WHO, where more than 20,000 cases of ACL and 3,000 cases of VL are annually recorded. In this sense, it is important to understand leishmaniasis as a public health concern that deserves the attention of health professionals and government authorities. Therefore, the importance of this study, in addition to helping to better understand the epidemiolog of leishmaniasis, is to emphasize its high incidence, which highlights failures in the control strategies adopted by the Brazilian government. Our discussion indicates that it is necessary to redouble the attention to diagnosis and early treatment as well as to define efficient planning to improve prophylaxis. In this sense, new strategies for population control of vectors and potential reservoirs, alongside alternatives for prevention, diagnosis, monitoring, treatment, and care of the population, as well as public health policies, are urgently needed to decrease the number of leishmaniasis cases in Brazil.

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CONFLICT OF INTEREST

The authors declare no conflicts of interest

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