Systematic Review

Journal of Public Health Research

Factors associated with the expansion of leishmaniasis in urban areas: a systematic and bibliometric review (1959–2021)

Journal of Public Health Research
2022, Vol. 11(3), 1–9

DOI: 10.1177/2279903622115775
journals.sagepub.com/home/phj
SAGE

Marília Schutz Borges[1], Luana Budny Niero[2], Laíse Dimer Sant'ana da Rosa[3], Vanilde Citadini-Zanette[4], Guilherme Alves Elias[5] and Patrícia de Aguiar Amaral[6]

Abstract

This work describes a systematic and bibliometric review of the factors that contribute to the expansion of leishmaniasis in urban areas. Three scientific databases were used: *Scientific Electronic Library* (Sci*ELO*), *Scopus* and *Web of Science*, encompassing all original and review articles between 1959 and 2021. Three descriptors were used: "leishmaniasis" AND "urban" AND "rural." Planning, execution, summarization, and selection processes were performed using StArt (*State of the Art through Systematic Review*) software. We obtained a total of 304 articles, 60 of which concerned canine leishmaniasis. The factors associated with the expansion of leishmaniasis in urban areas are interrelated, including socioenvironmental and economic complexity, the type of leishmaniasis, the reservoirs, vectors, deforestation, disorderly occupation of space, poor sanitary conditions, and human migration trends. A lack of diagnosis and underreporting of cases in some regions may reflect the increase of cases seen in urban areas. A majority ($n = 121$) of studies were conducted in Brazil, followed by Iran ($n = 43$). In relation to publications; in general, output has increased over the years, particularly in 2021. The majority of published studies were in the area of epidemiology ($n = 158$).

Keywords

Cutaneous leishmaniasis, dogs, migration, visceral leishmaniasis

Date received: 9 July 2022; accepted: 9 July 2022

Introduction

Leishmaniases are common anthropozoonoses in tropical and subtropical regions of the world and are caused by protozoa of at least 20 species of the genus *Leishmania*.[1] The parasite is transmitted to hosts through infected phlebotomine vectors and has diverse clinical manifestations, varying according to the *Leishmania* species involved.[2]

The transmission cycle of leishmaniasis occurs through a reservoir-parasitic interaction.[3] Reservoirs are vertebrate animals that harbor the parasite in the wild, which become infected upon biting by vectors, thus favoring the propagation of the cycle.[4] About 70 animal species, including humans, were reported as natural hosts of *Leishmania* parasites,[5] however, dogs are reported as the main reservoirs in urban areas.[4,6,7]

There are three main forms of the disease: visceral or kala-azar, cutaneous and mucocutaneous.[1] Visceral leishmaniasis is the most severe form and is almost

[1]Mestra em Ciências Ambientais, Programa de Pós-Graduação em Ciências Ambientais, Universidade do Extremo Sul Catarinense (UNESC), Criciúma, Santa Catarina, Brasil
[2]Farmacêutica e mestranda do Programa de Pós-Graduação em Ciências Ambientais, Universidade do Extremo Sul Catarinense (UNESC), Criciúma, Santa Catarina, Brasil
[3]Acadêmica do curso de farmácia da Universidade do Extremo Sul Catarinense (UNESC), Criciúma, Santa Catarina, Brasil
[4]Doutora em Ecologia e Recursos Naturais, Programa de Pós-Graduação em Ciências Ambientais, Universidade do Extremo Sul Catarinense (UNESC), Criciúma, Santa Catarina, Brasil
[5]Doutor em Ciências Ambientais, Programa de Pós-Graduação em Ciências Ambientais, Universidade do Extremo Sul Catarinense (UNESC), Criciúma, Santa Catarina, Brasil
[6]Doutora em Ciências Farmacêuticas, Programa de Pós-Graduação em Ciências Ambientais, Universidade do Extremo Sul Catarinense (UNESC), Criciúma, Santa Catarina, Brasil

Corresponding author:
Marília Schutz Borges, Programa de Pós-Graduação em Ciências Ambientais, Universidade do Extremo Sul Catarinense (UNESC), Av. Universitária, 1105 - Bairro Universitário CEP: 88806-000 Criciúma, Santa Catarina, Brasil.
Email: msb@unesc.net

always fatal if not treated. Most cases occur in Brazil, East Africa and Southeast Asia. In 2017, more than 95% of new cases occurred in Bangladesh, Brazil, China, Ethiopia, India, Kenya, Nepal, Somalia, South Sudan, and Sudan. The most common form of the disease is cutaneous, which is manifested mainly by ulcers on exposed parts of the body. In 2017, more than 95% of new cases of cutaneous leishmaniasis occurred in Afghanistan, Algeria, Brazil, Colombia, Iran, Iraq and the Syrian Arab Republic. The third main form of the disease (mucocutaneous), leads to partial or total destruction of the mucous membranes of the nose, mouth and throat.[5]

Leishmaniasis is one of those diseases classified as neglected, in which diseases characterized by infectious or parasitic causes are included and are considered endemic in low-income populations. Addressing this group of diseases requires collaborative and intersectoral health system efforts and a multidisciplinary approach that considers the environmental complexities where humans and animals coexist.[8]

According to Souza,[9] leishmaniasis has been a health concern both because of its geographic expansion and because of the trend toward urbanization. According to Bevilacqua et al.[10] the urbanization of diseases usually characterized as rural endemics, such as leishmaniasis, which has always been characterized as a typically rural disease, stems both from the precarious conditions in the peripheries of cities and the articulation of these areas with the rural environment. According to Waitz et al.[11] any environmental change that alters the structure of the landscape inhabited by hosts and vectors can modify diseases that occur in humans, either positively or negatively. Along with climate change, man-made actions in the landscape are occurring simultaneously with population growth, potentially altering the availability of habitats for hosts and vectors.[11]

Faced with this scenario, it becomes necessary to understand the factors that have been changing the ecological space of the disease and consequently expanding its endemic areas. To elucidate this, some questions are raised: What factors contribute to the expansion of leishmaniasis in urban areas? How do anthropic actions interfere with this process? Do migratory movements influence it? Is the disorderly occupation of geographical space a conditioning factor? Is poverty and poor sanitation a reality in regions with registered cases? Are there reservoirs of the disease still little studied?

Based on this assumption, this paper presents a systematic review of studies published between 1959 and 2021, with the objective of understanding the factors that contribute to the expansion of leishmaniasis in urban areas. We also sought to profile the origins of scientific studies, by means of bibliometric indicators. We hope that this work will serve as a resource for future research and reveal research gaps in the subject.

Methods

Initially, a systematic review was performed in three international online databases: *Scientific Electronic Library* (Sci*ELO*), *Scopus* and *Web of Science*, including all original and review articles between 1959 (year of first publication) and December 2021. For this purpose, three descriptors were used in English, combined with Boolean operators: "leishmaniasis" AND "urban" AND "rural" in abstract, title and keywords.

The planning, execution and summarization of this survey, including the filtering and selection of publications, were performed in the StArt (*State of the Art through Systematic Review*) software version 3.4, as shown in Table 1:

For duplicate articles (execution stage), only one was kept for analysis. In some cases, it was necessary to read the articles in their entirety in order to clearly distinguish the importance of the data in the contribution of this work and thus apply the inclusion and exclusion criteria (Table 2).

The publications found in the databases included in this research were also analyzed in order to perform the bibliometric analysis, where it was possible to draw the profile of scientific productions, check their trends and thematic areas over the years 1959 to December 2021.[12,13] All articles were systematically organized, grouped by region, year of publication and study categories.

Results

The results of this survey were systematized through four main steps. In the initial stage of identification, 571 publications were found, and from their analysis, some were eliminated, according to criteria established in Table 2. Thus, we obtained a total of 304 articles related to the theme, as described in Figure 1.

We analyzed the factors related to the dissemination of leishmaniasis and found a number of studies aimed at the reservoir animals of the disease. In total, we found 69 studies specifically conducted in animals, all mammals. Dogs were particularly relevant in research conducted, with a total of 60 studies, followed by cats ($n=2$), bats ($n=2$), rodents ($n=4$) and horse (1). A recent study investigated the presence of DNA and anti-Leishmania spp. antibodies in the serum of 112 healthy horses. These animals can be considered environmental bioindicators of the presence of *Leishmania* spp. in Brazil.[14] In order to understand the epidemiology of canine leishmaniasis, many studies were dedicated to serological investigation, where they found the presence of *Leishmania* antibodies in the analyzed samples.[15–21] Other studies showed the participation of dogs in the process of urbanization[22,23] and resurgence of leishmaniasis,[22] as well as suggesting that the disease is expanding in urban areas, with an exponential increase of positivity within dogs.[24]

Table 1. Stages of the systematic review in the StArt software.

Stages	Description
Planning	- Filling in the research protocol: objective, guiding question, databases investigated, exclusion and inclusion criteria, and the key words in English that represent factors associated with the expansion of leishmaniasis (*deforestation, migration, poverty*, and *sanitation*).
Execution	- Extraction of articles from databases (in BibTeX format) and insertion into the software (identified by title, authors and year of publication). - The publications were classified in a score from zero to 100, where 100 represented the highest occurrence of keywords in the articles, and zero, the lowest. - The articles were classified in reading priority (low, high or very high). - Evaluation using the selection tool, with articles classified as: accepted, rejected or duplicated.
Summarization	- Data visualization, organization by year of publication and transfer to Microsoft Excel program.

Table 2. Criteria adopted for the inclusion and exclusion of articles.

Inclusion criteria	Exclusion criteria
Articles published in English, Portuguese and Spanish.	Articles related to therapeutic alternatives for the treatment and prevention of leishmaniasis.
Articles dealing with leishmaniasis in a specific way.	Studies focusing on insecticides for the control of leishmaniasis transmission vectors.

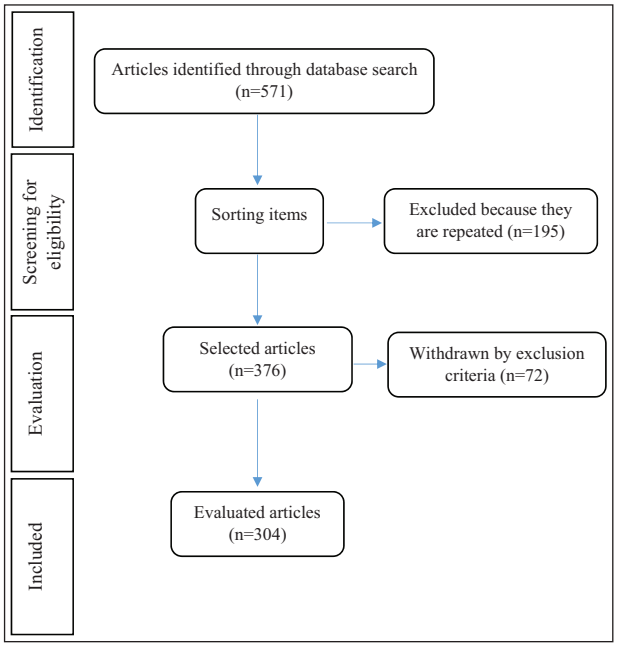

Figure 1. Selection steps in article identification.

In addition, according to López et al.[25] besides the characteristics and behaviors of dogs, their relationship with environmental conditions and disorderly occupations are relevant to the high prevalence of leishmaniasis. In fact, a study conducted in Argentina observed that poverty is a social determinant of risk, resulting in increased probability of contact between humans and infected animals.[25]

Vector insects that transmit *Leishmania* species, because they are important in entomological surveillance studies, have also been the focus of investigations.[19,26] Moreover, the geographical distribution of infected phlebotomine vectors has been analyzed in some studies.[19,27,28] This makes it possible to detect the areas in which they are concentrated, providing important information for health surveillance actions.

Studies note that factors related to the expansion of leishmaniasis involve the presence of several animal species, both vectors and reservoirs. However, the issue cannot be addressed in isolation, as it involves multifactorial complexity, which according to Conti et al.[29] are interrelated variables. Similarly, a review on urban parasitology in Brazil verified the main factors associated with disease expansion, listing three main causes: the large population of urban canine reservoirs, the presence of vectors and human migration.[7]

Among other variables, it is possible to highlight the importance of socioeconomic issues, observed by Gutierrez et al.,[30] Lima et al.,[31] and El Omari et al.[32] Furthermore, an epidemiological study conducted with residents of urban areas found a strong association of the disease with socioeconomic conditions, highlighting that the poorest are more exposed to risk.[33] The study by Gutierrez et al.[30] even associated the occurrence of leishmaniasis with environmental determinants, a factor also observed by other studies.[16,34]

Socio-environmental analysis in a city of more than 37,000 inhabitants revealed that the large number of animals, organic material from trees and deficiencies in environmental sanitation possibly contribute to the continuation of the transmission cycle.[35] The absence of toilets and sanitation was also highlighted by Ribeiro et al.[36] as an epidemiological indicator in urban areas. Similar findings on poor sanitation were pointed out in other studies.[37,38]

Table 3. Grouping of publications according to study categories.

Study class	Description	Number of studies
Methodological comparison	Comparison of methods for vector sampling, comparison of serological detection methods.	2
Geographical distribution, epidemiology and socio-environmental analysis	Identification of areas of infection, ecological approaches, land use, environmental risks, sanitation conditions of endemic areas.	21
Geographical distribution, epidemiology and entomology	Spatio-temporal analysis of the presence of insects in sites with recorded cases of leishmaniasis. Identification of vector species.	38
Entomology	Capture, identification of vector species in endemic areas, analysis of the presence of parasites in insects.	47
Interviews	Implementation of questionnaires with the population and veterinarians.	7
Epidemiology	Case studies, clinical aspects, histopathology, prevalence analysis and seroprevalence in humans, dogs, cats, horses, bats and rodents.	158
Immunology	Eosinophil analysis in blood samples from infected patients.	2
Reports, bulletins, reviews	Characterization of obstacles faced in disease control, prevention, urbanization, disease status, ecoepidemiology.	28
Taxonomy	Identification of *Leishmania* spp. species.	1
Total		**304**

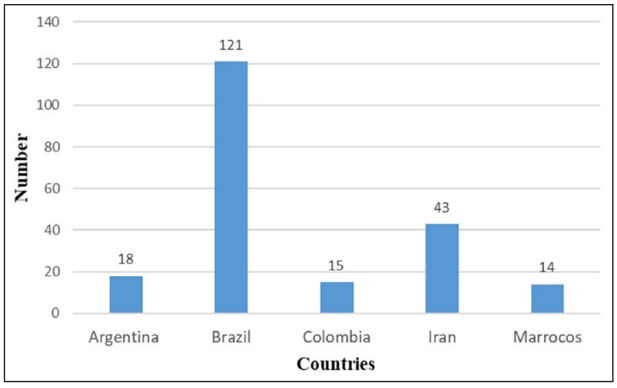

Figure 2. Country of origin of published studies on leishmaniasis.

Vilela et al.[34] points out that deforestation can facilitate the spread of leishmaniasis. This aspect was also observed in the study by Ramos et al.[39] which highlights the main causes of this phenomenon, including the construction of hydroelectric plants, roads and railroads, selective logging, agriculture, cattle raising, and especially the establishment of new settlements.

According to Ghatee et al.,[40] environmental variables such as land cover, including in urban areas, climate and temperature factors, influence the distribution of leishmaniasis. However, this same study pointed out the proximity of the investigated area to nomadic travel routes, which represented the most important factor in the distribution of the disease.[40]

The influence of migration patterns has also been discussed by other authors.[7,29,34,41] A study by Mott et al.[42] on the development of urban parasitologies, including leishmaniasis, explores this, addressing the relationship between human migration, endemic areas, the ordering of urbanization and the presence of vectors.

Therefore, reaffirming the above, the factors associated with the expansion of leishmaniasis are interrelated, involving social, environmental, economic, ecological and public health complexity. Above all, it is necessary to know the social and geographic scenario where the disease is established in order to develop intervention actions aimed at promoting the health of the population in the main endemic regions.

In this sense, from the 304 articles of the systematic review, for bibliometric analysis purposes, it was possible to verify the geographical location of the published studies, which allowed us to identify and quantify the countries where research on leishmaniasis was carried out. We highlighted those countries with more than 10 studies, and we noted that Brazil represents the origin of most published research, as shown in Figure 2.

After the analysis of origin, articles were organized by study areas, where they were separated by categories and identified by nine different classes, as shown in Table 3.

In relation to the analysis of research output over the years, in general, we have noticed a growth, especially in 2021, as seen in Figure 3.

Discussion

The participation of dogs in the disseminations of leishmaniasis in urban areas is a consolidated theme and is discussed in many studies.[43–49] According to Menn et al.,[50] canine leishmaniasis is an emerging disease in many parts of the world due to the increasing number of dogs being transported by their owners to different regions, including

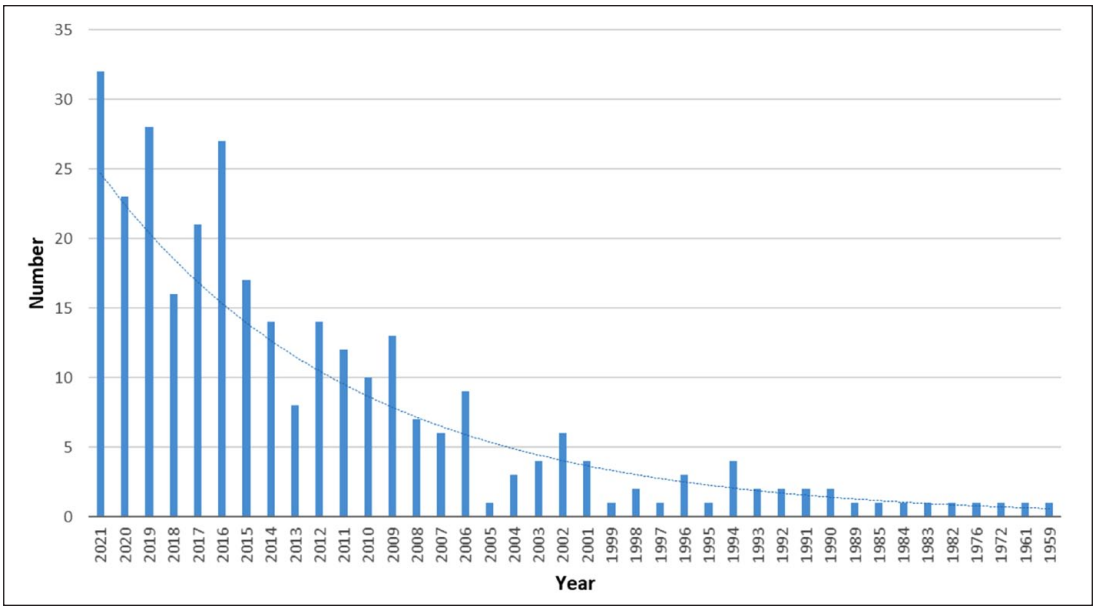

Figure 3. Scientific output from 1959 onward.

non-endemic areas. Also, Deane's study[51] on visceral leishmaniasis conducted in Brazil claims that outbreaks among dogs apparently precede human epidemics, reinforcing the importance of the dog in leishmaniasis transmission.

According to Gontijo and Melo,[52] there is difficulty in diagnosing canine leishmaniasis, as many tests do not have 100% reliability and specificity. Associated with the broad spectrum of clinical signs, the diagnosis is a challenge for the veterinarian. According to this study, in canine leishmaniasis there are cases of animals that remain asymptomatic for long periods of time and there are also animals that go through oligosymptomatic stages, even those that present with severe illness.[52]

The contribution of other animals as possible reservoirs of the disease, such as cats, rodents and bats, although noted, is little studied. It's important to highlight the participation of bats in the process of dissemination of leishmaniasis, as there is evidence of *Leishmania* infections in blood samples of these mammals, as observed by Gómez-Hernández et al.[53] which is of epidemiological importance due to the absence of cases in the region studied. Although the importance of bats as a reservoir is considered uncertain,[53] it is relevant to note that some vector species can live in places also inhabited by bats, for example, in caves, crevices, houses and abandoned buildings, where in these environments bats can be a food source to insects and vice versa. In addition, another factor to be discussed is the high dispersion capacity and longevity of bats, which if infected, can have an important impact on the spread of *Leishmania* parasites.[54]

Regarding vectors, Ramos et al.[39] states that some species of phlebotomines tend to synanthropize, due an increase in food availability and places for rest and oviposition. In settled regions, the presence of domestic and savage animals provides a food source for vectors, thus favoring their adaptation to new environments. Such vector adaptation was also observed by De Melo Ximenes et al.[55] who verified the distribution of insects in peridomiciliary areas in northeastern Brazil.

A study of cutaneous leishmaniasis by Oliveira et al.[56] reports that the presence of potential transmitter phlebotomines of *Leishmania* and their adaptation to human homes is worrying, as it puts thousands of people at risk. The author also noted that the disease was previously considered rural, but in recent years has presented at the urban-rural interface, emerging as an important public health problem.[56] According to Werneck et al.[57] this fact is associated with the characteristics of urban areas, where social networks, population density and housing relationships with the natural environment are more varied and complex compared to rural settings.

Although there is favorable evidence for the geographic and epidemiological transitions of leishmaniasis to urban areas, other authors show opposing results. A study of visceral leishmaniasis urbanization in Morrocco observed that in spite of the disease is established in urban areas, the geographic distribution of cases has been predominantly in rural areas.[58] This was also observed in a study conducted in Iran regarding visceral leishmaniasis, where the author noted a higher risk of infection in rural areas.[59] Confirming this, Almeida et al.[37] noted that dogs in rural areas had an approximately twofold higher risk of infection than those in urban environments.

Considering these studies, it is necessary to reflect on disparities of diagnosis and underreporting in various

regions. According to Gontijo and Melo[52] although leishmaniasis is a notifiable disease, available data are based on passive case detection. The number of people exposed to infection or asymptomatic is in some areas much greater than the number of cases detected.

It is important to highlight that the local environment and risk factors can vary from one region to another, highlighting that the way of life of animals is one of the determinants for acquiring infection.[60] Besides this, others factors may present particularities in various regions, such as poor maintenance of houses, low socioeconomic conditions, the presence of trees and others vegetation, including in urban areas.[16]

Regarding vegetation, areas containing *Adhatoda schimperiana* and *Acacia* spp. are associated with cutaneous leishmaniasis, as they can be important species for the shelter of vectors during the day,[61] and a source of nutrition to these insects.[62]

Many environmental influences are involved in the dynamics of fauna in anthropized areas. The disordered human occupation of space, the use of landscapes,[63] precarious housing, poor sanitation conditions,[64] climate change, environmental degradation,[65] deforestation,[66] reduced investments in health and education, discontinuity of health control actions, and migration of large population to urban centers[52] are all determinants that shape the epidemiology of parasitic diseases such as leishmaniasis.

Of particular note is the migration of socioeconomic phenomena, such as the search for new employment opportunities in urban environments.[42] Costa et al.[67] suggested that migration movements have triggered the visceral leishmaniasis epidemic in Piauí, Brazil where it was observed that the geographic distribution of the epidemic process occurred concomitantly with a long drought, accompanied by widespread migration of people and domestic animals from endemic regions.

The contribution of migration, as well as other factors already mentioned, are characteristics that provide a favorable environment for the transmission of infectious and parasitic diseases in developing countries[64] such as Brazil, a tropical country with a hot and humid climate.[68] In addition, Brazil is among those countries with more than 95% of new cases of visceral and cutaneous leishmaniasis registered by WHO in 2017.[69] This fact possibly justifies the high quantity of studies conducted in the area of leishmaniasis in Brazil, as shown in the results of this research.

Iran was the second country in terms of numbers of studies, and is one of the seven countries listed by the WHO with new cases of cutaneous leishmaniasis registered in 2017.[69] Alongside other countries of the Middle East and North Africa (Algeria, Libya, Morocco, Syria, Egypt and Yemen), Iran has high rates of neglected tropical diseases,[70] which arouses the interest of scientists to dedicate themselves to research in this area.

Regarding the study categories, it is clear that epidemiological research is necessary to describe, analyze and understand epidemic processes in quantitative form. In addition, it allows the investigation of factors related to the identification of etiological agents, vectors and reservoirs, so that extent of the problem is known, thus allowing the proposition of effective control measures.[71] However, isolated numbers can be limiting to the researcher who seeks to infer more comprehensive explanations of health events, and who seeks to overcome a potential reductionist or fragmented understanding, characteristic of risk analysis.[66]

Therefore, relevant studies in epidemiological areas are necessary to afford a wider understanding, coupled with interdisciplinary approaches, as well as amassing knowledge about social, anthropological and cultural determinants.[72]

The quantification of scientific output on leishmaniasis has shown, in general terms, a growth over the years. Such increase in knowledge can contribute to the planning of control measures, as the incidence of visceral leishmaniasis has decreased substantially since 2012 in some regions. In 2015, the incidence of new cases decreased about 67% in Bangladesh, 61% in India and 46% in Nepal.[73] In Nepal, medications with anti-leishmanial activity, diagnostic tests with easy handling, and effective vector control methods were primary drivers in reducing the incidence to a historically low level.[74]

In the Americas, a total of 940,396 new cases of cutaneous and mucocutaneous leishmaniasis were reported by 17 of the 18 endemic countries in the period of 2001–2017.[75] The 17 years historical series showed that in 2015 was registered the lowest number of new cases (46,074); however, as of 2016 there was an increase.[75] This fact may be related with enhanced reporting of leishmaniasis in 2016. However, in the years 2019 and 2021, there was a growing scientific contribution in the area of leishmaniasis, with emphasis on the publications in the year 2021, which contributes to the improvement of actions, management and control of the disease.

Strengths of this research include the use of systematic review in three databases, associated with a bibliometric analysis. In addition, no restrictions were made regarding the year of the publication, thus including the totality of evidence in the databases. A limitation of this study is the absence of meta-analysis, although this was not the object of the study.

Conclusion

In this systematic review, 304 studies were analyzed, in which it was possible to explore how factors associated with the expansion of leishmaniasis in urban areas are interrelated. Particularities of each region should be analyzed as a whole, considering the socio-environment and economic complexity, the type of leishmaniasis, reservoirs, vectors, deforestation, the disordered occupation of space,

sanitary conditions and human migratory tendencies. A lack of diagnosis and underreporting of cases in some regions may contribute to the findings of this research.

The participation of mammalian species such as dogs in the dissemination of the disease in urban areas is well consolidated, however more studies should be undertaken exploring other species as potential reservoirs as horses and bats.

The analysis of scientific output showed that most studies on the subject were conducted in Brazil, followed by Iran, which represent endemic areas of leishmaniasis. The number of publications, in general, has grown over the years, particularly 2021. Most of the studies were directed to the epidemiological area, and many were also dedicated to investigations in the entomology area and space-temporal distribution.

Contributors

MSB, conceptualized this article, drafted and composed the introduction, results, discussion, conclusion, and references, sections; LBN, participated in the editing and contributed to the methodology and results section; LDSR; contributed to the methodology and references section; VCZ participated in the discussion and contributed to the final reading of the manuscript; GAE, contributed to the methodology and provided mentorship and guidance; PAA, provided mentorship and contributed to the critical review of the content and final proof of the version to be published.

Declaration of conflicting interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The author(s) disclosed receipt of the following financial support for the research, authorship, and/or publication of this article: University Scholarship Program of Santa Catarina - UNIEDU, maintained by the Support Fund for the Maintenance and Development of Higher Education - FUMDES, for a scholarship granted to the first author. Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (CAPES) and Programa Institucional de Bolsas de Iniciação Científica (PIBIC/UNESC).

Patient consent for publication

Not applicable.

Informed consent

The manuscript does not contain any individual person's data in any form.

Significance for public health

Leishmaniasis is one of those diseases classified as neglected. The disease has been a health public concern both because of its geographic expansion and because of the trend toward urbanization. Addressing this group of diseases requires collaborative and intersectoral health system efforts and a multidisciplinary approach that considers the environmental complexities. Studies note that factors related to the expansion of leishmaniasis are interrelated, involving social, economic, ecological and public health complexity. It is necessary to know the social and geographic scenario where the disease is established in order to develop intervention actions aimed at promoting the health of the population in the main endemic regions.

Availability of data and materials

The data used to support the findings of this study are available from the corresponding author upon request.

References

1. World Health Organization. Leishmaniasis. https://www.who.int/news-room/fact-sheets/detail/leishmaniasis (2022, accessed 07 August 2022).
2. World Health Organization. *Global leishmaniasis update, 2006–2015: a turning point in leishmaniasis surveillance*. Geneva: WHO 2017; 38: pp. 557–572.
3. Brasil. Manual De Vigilância Da Leishmaniose Tegumentar, Brasília: Ministério da Saúde, 2017; p. 189.
4. Organización Paranmericana De La Salud. *Manual de procedimientos para la vigilancia y control de las leishmaniasis en las Américas*, Washington, DC: OPS; 2019; p.166.
5. World Health Organization. *Leishmaniasis*. https://www.who.int/en/news-room/fact-sheets/detail/leishmaniasis (2020, accessed 29 January 2020).
6. Brasil. *Manual de Vigilância e Controle da Leishmaniose Visceral*, 1st ed., Brasília: Ministério da saúde, 2006; p. 120.
7. Harhay MO, Olliaro PL, Costa DL, et al. Urban parasitology: visceral leishmaniasis in Brazil. *Trends Parasitol* 2011; 27: 403–409.
8. World Health Organization. *Neglected zoonotic tropical diseases*. hhttps://https://www.who.int/news-room/facts-in-pictures/detail/neglected-zoonotic-tropical-diseases (2015, accessed 07 August 2022).
9. Souza WDE. *Doenças negligenciadas*. Rio de Janeiro: Academia Brasileira de Ciências, 2010. pp.56.
10. Bevilacqua PD, Paixão HH, Modena CM, et al. Urbanização da leishmaniose visceral em Belo Horizonte. *Arq Bras Med Vet Zootec* 2001; 53: 1–8.
11. Waitz Y, Paz S, Meir D, et al. Effects of land use type, spatial patterns and host presence on *Leishmania* tropica vectors activity. *Parasit Vectors* 2019; 12: 320–411.
12. Elias GA, Corrêa FP, Citadini-Zanette V, et al. Arecaceae: Análise Bibliométrica das Espécies Nativas do Estado De Santa Catarina. *Rev Cienc Exatas Nat* 2015; 37: 85–92.
13. Guedes VLS and Borschiver S. Bibliometria: Uma ferramenta estatística para a gestão da informação e do conhecimento, em sistemas de informação, de comunicação e de Avaliação Científica e Tecnológica. *CINFORM - Encontro Nacional de Ciência da Informação* 2005; 6: 1–18.
14. Lopes KFC, Delai RM, Fazoli KGZ, et al. Urban horses as environmental bioindicators for Leishmaniasis. *Vector Borne Zoonotic Dis* 2021; 21(7): 534–538.
15. de Araújo VE, Pinheiro LC, Almeida MC, et al. Relative risk of visceral leishmaniasis in Brazil: A spatial analysis in Urban Area. *PLoS Negl Trop Dis* 2013; 7: e2540.

16. Guimarães A, Raimundo JM, Santos HD, et al. Serosurvey for canine visceral leishmaniasis in rural and urban areas of the Brazilian Legal Amazon. *Braz J Infect Dis* 2017; 21: 207–208.
17. Lugo DA, Ortega-moreno ME, Rodríguez V, et al. Seroprevalence of canine visceral leishmaniasis by rK39-ELISA in endemic foci in Venezuela. *Rev Fac Cs Vets* 2015; 56: 42–51.
18. Melo ALT, et al. Área rural do pantanal Brasileiro associada à ocorrência de anticorpos anti-*leishmania spp*. em cães. *Braz J Vet Res An Sci* 2017; 54: 375–382.
19. Oliveira TN, Guedes PE, Souza GB, et al. Diagnosis and epidemiology of canine leishmaniasis in southeastern Bahia, Brazil. *Genet Mol Res* 2016; 15: 1–10.
20. Perez TD, Figueiredo FB, Junior AAMV, et al. Prevalence of American Trypanosomiasis and leishmaniases in domestic dogs in a rural area of the municipality of São João do Piauí, Piauí State, Brazil. *Rev Inst Med Trop Sao Paulo* 2016; 58: 79.
21. Pimentel DDS, Ramos RAN, Santana MDA, et al. Prevalence of zoonotic visceral leishmaniasis in dogs in an endemic area of Brazil. *Rev Soc Bras Med Trop* 2015; 48: 491–493.
22. Leal GGA, Carneiro M, Pinheiro ADC, et al. Risk profile for Leishmania infection in dogs coming from an area of visceral leishmaniasis reemergence. *Prev Vet Med* 2018; 150: 1–7.
23. Silva RBS, Franco-Silva LF, Lima DA, et al. Differentials in the epidemiological profile of canine visceral leishmaniasis in the semi-arid region of Paraíba, Brazil. *Pesq Vet Bras* 2021; 41: e06773.
24. Campos R, Santos M, Tunon G, et al. Epidemiological aspects and spatial distribution of human and canine visceral leishmaniasis in an endemic area in northeastern Brazil. *Geospat Health* 2017; 12: 503.
25. López K, Tartaglino LC, Steinhorst II, et al. Factores de riesgo en escenarios emergentes de leishmaniasis visceral urbana, misiones, Argentina. *Biomedica* 2016; 36: 51–63.
26. Barrios SPG, Pereira LE, Nazário Monaco NZ, et al. Synanthropy and diversity of Phlebotominae in an area of intense transmission of visceral leishmaniasis in the South Pantanal floodplain, Midwest Brazil. *PLoS One* 2019; 14: e0215741.
27. Kone AK, Diarra AZ, Coulibaly M, et al. Distribution spatio-temporelle de la faune de phlébotomes en zones urbaine et périurbaine de Bamako, Mali. *Ann Soc entomol Fr* 2016; 52: 95–101.
28. Falcão de Oliveira E, Casaril AE, Fernandes WS, et al. Monthly distribution of phlebotomine sand flies, and biotic and abiotic factors related to their abundance, in an urban area to which visceral leishmaniasis is endemic in Corumbá, Brazil. *PLoS One* 2016; 11: e0165155.
29. Conti RV, Moura Lane VF, Montebello L, et al. Visceral leishmaniasis epidemiologic evolution in timeframes, based on demographic changes and scientific achievements in Brazil. *J Vector Borne Dis* 2016; 53: 99–104.
30. Gutierrez JD, Martínez-Vega R, Ramoni-Perazzi J, et al. Environmental and socio-economic determinants associated with the occurrence of cutaneous leishmaniasis in the northeast of Colombia. *Trans R Soc Trop Med Hyg* 2017; 111: 564–571.
31. Lima ÁLM, de Lima ID, Coutinho JFV, et al. Changing epidemiology of visceral leishmaniasis in northeastern Brazil: a 25-year follow-up of an urban outbreak. *Trans R Soc Trop Med Hyg* 2017; 111: 440–447.
32. El Omari H, Chahlaoui A, Talbi F, et al. Impact of urbanization and socioeconomic factors on the distribution of cutaneous leishmaniasis in the center of Morocco. *Interdiscip Perspect Infect Dis* 2020; 2020: 1–7.
33. Uranw S, Hasker E, Roy L, et al. An outbreak investigation of visceral leishmaniasis among residents of Dharan town, eastern Nepal, evidence for urban transmission of *Leishmania donovani. BMC Infect Dis* 2013; 13(1): 21.
34. Vilela ML, Azevedo CG, Carvalho BM, et al. Phlebotomine fauna (diptera: Psychodidae) and putative vectors of leishmaniases in impacted area by hydroelectric plant, state of Tocantins, Brazil. *PLoS One* 2011; 6: e27721–e27727.
35. Ursine RL, Dias JVL, Morais HA, et al. Human and canine visceral leishmaniasis in an emerging focus in Araçuaí, Minas Gerais: spatial distribution and socio-environmental factors. *Mem Inst Oswaldo Cruz* 2016; 111: 505–511.
36. Ribeiro MD, Ferraudo AS, Zaia JE, et al. Sanitation conditions as an epidemiologic indicator for American cutaneous leishmaniasis in the Brazilian southwestern Amazonia. *Inst Oswaldo Cruz* 2017; 5: 64–71.
37. Almeida ADBPFD, Sousa VRF, Cruz FACSD, et al. Canine visceral leishmaniasis: seroprevalence and risk factors in Cuiabá, mato Grosso, Brazil. *Rev Vras Parasitol* 2012; 21: 359–365.
38. Temponi AOD, Brito MGD, Ferraz ML, et al. Ocorrência de casos de leishmaniose tegumentar americana: uma análise multivariada dos circuitos espaciais de produção, Minas Gerais, Brasil, 2007 a 2011. *Cad Saude Publica* 2018; 34: 1–14.
39. Ramos WR, Medeiros JF, Julião GR, et al. Anthropic effects on sand fly (Diptera: Psychodidae) abundance and diversity in an Amazonian rural settlement, Brazil. *Acta Trop* 2014; 139: 44–52.
40. Ghatee MA, SharifI I, Haghdoost AA, et al. Spatial correlations of population and ecological factors with distribution of visceral leishmaniasis cases in southwestern Iran. *J Vector Brone Dis* 2013; 50: 179–187.
41. Khademvatan S, Salmanzadeh S, Foroutan-Rad M, et al. Spatial distribution and epidemiological features of cutaneous leishmaniasis in southwest of Iran. *Alex J Med* 2017; 53: 93–98.
42. Mott KE, Desjeux P, Moncayo A, et al. Parasitic diseases and urban development. *Bull World Health Organ* 1990; 68: 691–698.
43. Fernández J, Bello F, López MC, et al. Seroprevalencia de leishmaniosis visceral canina en la comuna 8 de neiva y en cuatro municipios de Huila, Colombia. *Biomedica* 2006; 26: 121–130.
44. Zambrano Hernández CP, Ayala Sotelo MS, Fuya Oviedo OP, et al. Cartagena: nuevo foco de leishmaniasis visceral urbana en Colombia. *Cien em Desarro* 2016; 7: 83–91.
45. Le Rutte EA, van Straten R and Overgaauw PAM. Awareness and control of canine leishmaniosis: a survey among Spanish and French veterinarians. *Vet Parasitol* 2018; 253: 87–93.
46. Naveda LA, Moreira EC, Machado JG, et al. Aspectos epidemiológicos da leishmaniose visceral canina no município

de Pedro Leopoldo, Minas Gerais, 2003. *Arq Bras Med Vet Zootec* 2006; 58: 988–993.
47. Rajasekariah GH, Cardoso L, Dogcio DA, et al. A novel exo-antigen-based ELISA for the detection of canine leishmaniasis. *Am J Trop Med Hyg* 2008; 78: 616–623.
48. Varjão BM, Pinho FAD, Solcà MDS, et al. Spatial distribution of canine Leishmania infantum infection in a municipality with endemic human leishmaniasis in eastern Bahia, Brazil. *Rev Bras Parasitol Vet* 2021; 30(2): e022620.
49. Batista-Santos F, Dória DA, Sincurá YR, et al. Eco-epidemiological aspects of visceral leishmaniasis in the municipality of Diamantina, Jequitinhonha valley (Minas Gerais state, Brazil). *Yale J Biol Med* 2021; 94(2): 209–215.
50. Menn B, Lorentz S and Naucke TJ. Imported and travelling dogs as carriers of canine vector-borne pathogens in Germany. *Parasit Vectors* 2010; 3: 34–37.
51. Deane LM. *Leishmaniose visceral no brasil: estudos sobre reservatorios e transmissores realizados no estado do ceara*. Rio de Janeiro: Serviço Nacional de Educação Sanitária, 1956.
52. Gontijo CMF and Melo MN. Leishmaniose Visceral no Brasil: quadro atual, desafios e perspectivas Visceral Leishmaniasis in Brazil. *Rev bras epidemiol* 2004; 7: 338–349.
53. Gómez-Hernández C, Bento EC, Rezende-Oliveira K, et al. *Leishmania* infection in bats from a non-endemic region of Leishmaniasis in Brazil. *Parasitology* 2017; 144: 1980–1986.
54. Shaw J. The importance of understanding enzootic cycles in the epidemiology of zoonotic diseases with special reference to the American leishmaniases. *Trans R Soc Trop Med Hyg* 2019; 113: 108–109.
55. De Melo Ximenes MDFF, Castellón EG, de Souza MDF, et al. Distribution of phlebotomine sand flies (Diptera: Psychodidae) in the State of Rio Grande do Norte, Brazil. *J Med Entomol* 2000; 37: 162–169.
56. Oliveira CC, Lacerda HG, Martins DR, et al. Changing epidemiology of American cutaneous leishmaniasis (ACL) in Brazil: a disease of the urban-rural interface.. *Acta Trop* 2004; 90: 155–162.
57. Werneck GL, Rodrigues L, Santos MV, et al. The burden of *Leishmania chagasi* infection during an urban outbreak of visceral leishmaniasis in Brazil. *Acta Trop* 2002; 83: 13–18.
58. Kahime K, Boussaa S, Nhammi H, et al. Urbanization of human visceral leishmaniasis in Morocco. *Parasite Epidemiol Control* 2017; 2: 1–6.
59. Rakhshanpour A, Mohebali M, Akhondi B, et al. Serological survey and associated risk factors of visceral leish-maniasis in Qom Province, central Iran.. *Iran J Public Health* 2014; 43: 50–55.
60. Santos JM, Dantas-Torres F, Mattos MR, et al. [Prevalence of anti-Leishmania *spp* antibodies in dogs from garanhuns, in the middle scrub zone (Agreste) of Pernambuco]. *Rev Soc Bras Med Trop* 2010; 43: 41–45.
61. Negera E, Gadisa E, Yamuah L, et al. Outbreak of cutaneous leishmaniasis in silti woreda, Ethiopia: risk factor assessment and causative agent identification. *Trans R Soc Trop Med Hyg* 2008; 102: 883–890.
62. Costa CHN. Characterization and speculations on the urbanization of visceral leishmaniasis in Brazil. *Cad Saude Publica* 2008; 24: 2959–2963.
63. Rosário IN, de Andrade AJ, Ligeiro R, et al. Evaluating the adaptation process of sandfly fauna to anthropized environments in a leishmaniasis transmission area in the Brazilian Amazon. *J Med Entomol* 2017; 54: 450–459.
64. Desjeux P. The increase in risk factors for leishmaniasis worldwide. *Trans R Soc Trop Med Hyg* 2001; 95: 239–243.
65. Morrone A, Pitidis A, Pajno MC, et al. Epidemiological and geographical aspects of leishmaniasis in Tigray, northern Ethiopia: a retrospective analysis of medical records, 2005-2008. *Trans R Soc Trop Med Hyg* 2011; 105: 273–280.
66. Bevilacqua PD, Paixão HH, Castro MCPS, et al. Leishmaniose visceral: história jornalística de uma epidemia em Belo Horizonte, Brasil. *Interface (Botucatu)* 2000; 4: 83–102.
67. Costa CHN, Pereira HF and Araújo MV. Epidemia de leishmaniose visceral no estado do Piauí, Brasil, 1980-1986. *Rev Saúde Pública* 1990; 24: 361–372.
68. Camargo EP. Doenças tropicais. *Estud av* 2008; 22: 95–110.
69. World Health Organization. Global leishmaniasis update, 2006–2015: a turning point in leishmaniasis surveillance. *WHO* 2017; 38: 557–572.
70. Hotez PJ, Savioli L and Fenwick A. Neglected Tropical Diseases of the Middle East and North Africa: review of their prevalence, distribution, and opportunities for control. *PLoS Negl Trop Dis* 2012; 6: e1475.
71. World Health Organization. *La lutte contre les leishmanioses organisation mondiale de Santé Santé*. Genève: WHO, 2010. pp.228.
72. Graeff-Teixeira C. Interdisciplinaridade e o desafio da leishmaniose visceral. *Sci Med* 2013; 23: 3–4.
73. World Health Organization. *Visceral leishmaniasis: WHO publishes validation document as countries approach elimination*. https://www.who.int/news/item/11-11-2016-visceral-leishmaniasis-who-publishes-validation-document-as-countries-approach-elimination (2016, accessed 07 August 2022).
74. World Health Organization. *Visceral leishmaniasis elimination: intensifying surveillance to overcome last-mile challenges in Nepal*. https://www.who.int/news/item/29-05-2019-VL-Nepal-intensifying-surveillance-overcome-last-mile-challenges (2019, accessed 07 August 2022).
75. Organização Pan-Americana da Saúde. *Informe Epidemiológico das Américas*. http://iris.paho.org/xmlui/bitstream/handle/123456789/50505/2019-cde-leish-informe-epi-das-americas.pdf?ua=1 (2020, accessed 14 February 2020).