
Geospacialization and statistical analysis of the evolution of cases of sporotrichosis: Timbaúba and Grande Recife/PE_Brasil

Geoespacialização e análise estatística da evolução de casos de esporotricose: Timbaúba e Grande Recife/PE_Brasil

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ABSTRACT

With a predominance in countries with tropical and subtropical climates, dermatozoonosis such as sporotrichosis occurs in several nations. Sporotrichosis is caused by species of the genus *Sporothrix*, whose dissemination between animals and humans is due to the traumatic inoculation of the fungus. The objective of the present study was to propose a management model based on geospatialization, with statistical methods applied to preventive and corrective care in order to control the evolution of cases of sporotrichosis in care at animal health establishments in Timbaúba and Grande Recife/PE - Brazil. Computational tools and statistical techniques were used, verifying the emphasis on places of occurrence of the disease by geospatialization with the Kernel density estimation method and descriptive statistical analysis. The research was approved by the CEP (CAAE: 44330921.2.0000.9547) in the period from 2011 to 2020. The results demonstrated the prevalence of the disease in adult felines and, lack of records in the units. It is concluded that the lack of information and knowledge contributes to dispersion and abandonment of treatment. In this sense, a management plan is proposed with the implementation of a computer program.

Keywords: Dermatozoonosis; Feline; Fungus; Notification; *Sporothrix*.

RESUMO

Com preponderância em países de clima tropical e subtropical, dermatozoonoses como a Esporotricose apresenta-se com ocorrência em várias nações. A esporotricose é causada por espécies do gênero *Sporothrix*, cuja disseminação entre animais e humanos é dada pela inoculação traumática do fungo. Objetivou-se propor um modelo de gestão pautado na geoespacialização, com métodos estatísticos aplicados aos cuidados preventivos e corretivos com vistas ao controle da evolução de casos de esporotricose em atendimento em estabelecimentos de saúde animal em Timbaúba e grande Recife/PE - Brasil. Utilizou-se de ferramentas computacionais e técnicas estatísticas, verificando enfatizar locais de ocorrência da doença pela geoespacialização com método estimação de densidade de *Kernel* e análise estatística descritiva. A pesquisa foi aprovada pelo CEP (CAAE: 44330921.2.0000.9547) no período de 2011 a 2020. Os resultados demonstraram prevalência da doença em felinos e, falta de registros nas unidades. Conclui-se que a falta de informações e conhecimento, contribuem para dispers e abandono ao tratamento. Neste sentido, propõe-se um plano gestor com a implantação de um programa computacional.

Palavras-chave: Dermatozoonose; Felino; Fungo; Notificação; *Sporothrix*.

INTRODUÇÃO

In 1986, Benjamin Schenck, in the United States, isolated *Sporothrix schenckii*, in a 36-year-old patient who showed injuries in his right hand and arm. Posteriorly, Hektoen and Perkins, described a second case, whose current name is sporotrichosis (incluir citação).

In Brazil, the first record was in 1907, on rats and in 1956, on cats. *Sporothrix schenckii* is a dimorphic fungus, found in soil in association with plants, water and decomposing organic materials. The fungus can be found in nature, at 25°C, in its saprophytic form with 1 or 2 µm in diameter, on the other hand when developing at 37°C (in vitro), or in a host tissue, it grows in a form of yeast (oval, round), with approximately 2 to 6 µm in diameter.

It should be noted that sporotrichosis affects people regardless of age, or any other classification, being common to notice it on men, given their occupational activity. Whose infection occurs through implantation (cutaneous) due to contact with contaminated material or traumas with these materials.

Sporotrichosis is a zoonosis characterized by a subcutaneous mycosis, a subacute infection that can be shown as a chronic infection, that is, a fungal infection caused by *Sporothrix* complex (Bedrikow & Novais-Mencalha, 2022). There are more than six species whose type most related to infections in humans is *Sporothrix Schenckii* (Silva et al., 2020).

From the perspective of human sporotrichosis, given that it is a zoonosis, there are not many reports in literature. Mycosis is considered rare in Europe (Tóffoli, 2022), with an occurring frequency in Portugal. However, it is still considered as an implantation mycosis, either by biting or scratching. This disease appears in different ways, such as localized or disseminated cutaneous and extracutaneous (Filho, 2020), the most common being the cutaneous-lymphatic.

From an epidemiologic point of view, the fungus is dimorphic with very distinct micro and macro aspects (25°C – filamentous and 37°C – yeast-like), either for animal or human inoculation. In this regard, tropical and subtropical climate conditions are favorable scenarios for outbreaks to occur in both rural and urban areas.

As *Sporothrix Schenckii* grows in the environment in vegetations, thorns, soil and, above all, in decomposing organic material, the transmission of sporotrichosis takes place through animal scratches or bites (cats and dogs), commonly on humans who act professionally as gardeners, florists, farmers among other professions that deal with meadow. Pet owners are also exposed to the contamination by having their animals face routine outings and walks as an integrating part of care for their pets.

Thus, the disease sporotrichosis receives the ICD-1 code: B42 in the International Classification of Diseases, informed by the Health Ministry, it reaches the skin, subcutaneous tissue and lymphatic vases, and can also affect internal organs, resulting of the direct inoculation of the fungus in the skin through contaminated materials (Santos et al., 2018).

The knowledge about this disease is necessary due to continuous exposure between owners and their animals, as well as concerning the social environment that congregates passers-by and stray animals (Oliveira-Neto et al., 2018). Also, for

understanding that sporotrichosis is a high impact disease on public health, given its rapid dissemination which occurs in situations of localities and regionalities around tropical regions (Pereira et al., 2021).

Once characterized as a notifiable disease in accordance with the Resolution No. 50/2013 of the Ministry of Agriculture, Livestock and Supply - MAPA, it becomes possible to raise together with social aspirations, public policies in preventive care and service protocols, as well as the supply and free access to medical procedures necessary to the cure of infected animals (Brasil, 2013a, 2013b).

The lack of data aligned with the lack of knowledge about the disease between pet owners, work together to justify this research in its important contribution with statistical data and geospatialization of the disease. Because with the publication of the research results, it will be possible to elaborate proposals to make it a notifiable zoonosis with the service units and bodies linked to public health issues.

The objective of this study was to propose a management model based on geospatialization, with statistical methods applied to preventive and corrective cares with a view to controlling the evolution of sporotrichosis cases in care at animal health establishments in Timbaúba and Grande Recife/PE - Brazil.

MATERIAL AND METHOD

This research was carried out in the municipalities of Timbaúba and Grande Recife, state of Pernambuco, located in northeastern Brazil and composed of 184 municipalities added to the district of Fernando de Noronha, whose territorial extension is 98.146.315 km². The random selection of municipalities was used as a selection criterion and for Grande Recife, opting for Recife, Cabo de Santo Agostinho and Camaragibe, whose common characteristic is the existence of animal health units with a manager responsible for training in Veterinary Medicine and Veterinarians working in the medical clinic.

In the municipality of Timbaúba, data were collected at Centro Veterinário Santa Cândida. In Grande Recife, data were collected at the Veterinary Hospital of the Federal University Pernambuco (Recife), Veterinary Medical Center Clinic (Cabo de Santo Agostinho), Veterinary Medical Center - CEMEVET (Timbi-Camaragibe) and at the Veterinary Clinic NORTVET (Santo Amaro-Recife).

Thus, the information was collected based on a semi-structured questionnaire developed and applied electronically using the email sent, considering several categories, such as: species, breed, age, place of residence, profession, instruction degree and contamination form. Considering a 10-year period, that is, from 2011 to 2020.

Using the QGIS software package, specifically the MMQGIS and the GeoDa software, the geocoding work was performed referring to the animal's address and its owner, contained in the records found in the previous step. However, addresses will be converted to geographic coordinates. To define the geographic coordinates, we will use the Google Maps® algorithm, with the support of the SIRGAS 2000 UTM coordinate systems.

The statistical analysis was processed after data tabbing, on Excel spreadsheets, with a descriptive statistics method. Then proceeded the normality test (Shapiro-Wilk), finally, the correlation test was performed using the coefficient statistics Spearman's Correlation. These statistical analyzes were performed on the Jamovi Software (version 2.3), with R Core Team language (version 4.1), in Software R Studio (4.2.2) and Software GeoDa (version 1.2).

As for the exclusion criteria, the existence of a Public Institution of Animal Health and veterinary clinics that do not have methodological and laboratory resources for the diagnosis and treatment of sporotrichosis in domestic animals (dogs and cats) was considered. The sample being characterized by spontaneous demand in clinical cases, in each aforementioned unit as an integral part of the research population. The inclusion criterion refers to the survey of cases clinically diagnosed as sporotrichosis typical cases, excluding other clinical cases according to records in medical records.

Data collection proceeded under the authorization of the Research Ethics Committee – CEP. In compliance with Resolution nº 466/2012 of the National Health Council – CNS for involving human beings through the application of semi-structured questionnaires (Brasil, 2012). The research was submitted to CEP, via Plataforma Brasil, and approved with the opinion consubstantiation under registration CAAE: 44330921.2.0000.9547.

A 10-year period was considered for data collecting, that is, from 2011 to 2020. The application of the questionnaire covered three Grande Recife municipalities, and the municipality of Timbauba, considering, at least, one clinic or animal care unit, and an animal health public institution located in Recife.

Geocoding was carried out, which constitutes a relevant stage for this research, since the physiographic aspects based on geographic location characterize significant points in the context of area limits and properties with the most diverse peculiarities such as vegetation and sanitary conditions (Silva Torres et al., 2022).

Using the QGIS software package, specifically the MMQGIS, geocoding was performed referring to the address of the animal and its owner contained in the records found in the previous step. However, addresses will be converted to geographic coordinates. To define the geographic coordinates, we will use the Google Maps® algorithm, with the support of the SIRGAS 2000 UTM coordinate systems. As well as the GeoDa software (version 1.2) was used.

In this sense, the non-parametric interpolation technique of the Kernel density estimator was used, given the distribution of points resulting from the transformation of points on a density surface, allowing the observation of a given occurrence regarding the concentration of a given event (Han et al., 2019). In this way, we seek to estimate the intensity and density of an event per unit area (cluster analysis or hot spots – hotspot).

The parameters, radius of influence (t), are considered, making it possible to define the neighboring circular area, around a sampling point. And an estimation function $k(\cdot)$, seeking the smoothing of the studied phenomenon. Therefore, this estimator uses the functions: Quadratic (biweighted), Triangular, Uniform, Gaussian or Normal and Epanechnikov (Costa et al., 2022).

Thus, the interpolation function (k) is made up of a distance function (h), consisting of the relationship between the location point and the observed event. This function is by the equation:

$$K_{(h)} = 3/\pi (1 - h^2) \quad (1)$$

Then, with the k data obtained, the Kernel density can be estimated where τ is the radius of the function given by:

$$\lambda t(x) = \sum_{hi \leq \tau} 3 / \pi \tau^2 (1 - hi^2/\tau^2)^2 \quad (2)$$

The normality test of the collected data was performed with the statistics of the Shapiro-Wilk test, given by the equation,

$$W = \frac{(\sum_{i=1}^N a_i x_{(i)})^2}{\sum_{i=1}^N x_i - \bar{x}}^2 \quad (3)$$

Where,

- $x_{(i)}$ (with parentheses surrounding the subscript index i ; not to be confused with the x_i is the i th order statistic, i.e., the i th smallest sample number;
- $\bar{x} = (x_1 + \dots + x_n)/n$ is the sample mean.

The coefficients (a_i) are given by,

$$(a_1 + \dots + a_n) = \frac{m^T V^{-1}}{c} \quad (4)$$

Where C is a vector norm:

$$C = \|V^{-1}m\| = (m^T V^{-1} V^{-1} m)^{1/2} \quad (5)$$

and the vector m is given by,

$$m = (m_1 + \dots + m_n)^T \quad (6)$$

which is realized by the expected values of the order statistics of independent random variables, and identically distributed, demonstrated from the standard normal distribution.

After analysis of the normality test, the correlation test was realized using Spearman's correlation coefficient statistics, looking forward to assessing the intensity with which the relationship between the ranks of the variables Municipal Human Development Index – MHDI and cases of sporotrichosis occurs. That is, evaluating monotonous relationships (linear or not).

In order to verify possible associations between zoonoses (sporotrichosis, leishmaniasis and leptospirosis), the non-parametric chi-square test was performed, verifying whether the absolute frequency of a variable differs significantly from the expected absolute frequency distribution. The test statistic is given by the equation.

$$\chi^2 = \sum \frac{(f_o - f_e)^2}{f_e} \quad (7)$$

The respective statistical analyzes were performed after tabulating the data, in spreadsheets (Excel), in the Jamovi Software (version 2.3), with the R Core Team language (version 4.1), in the R Studio Software (4.2.2) and GeoDa Software (version 1.2) and QGIS software, specifically MMQGIS.

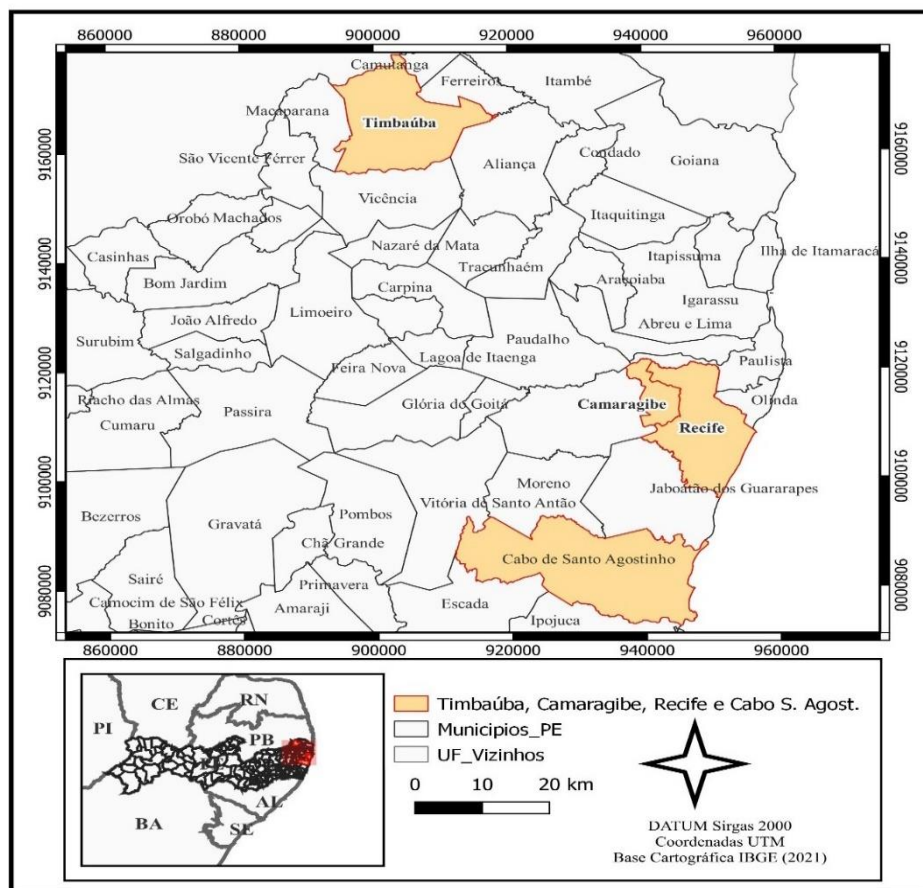
Place of research

The data set was made available under the consent of Centro Veterinário Santa Cândida, Centro Médico Veterinário – CEMEVET, Centro Médico Veterinário do Cabo, Clínica Veterinária Nortvet and Hospital Veterinário – HOVET, in the State of Pernambuco/Brazil. The data was collected based on procedures that were performed at the medical clinic, from 2011 to 2020, considering the diagnosis regardless of the

technique used for sporotrichosis, totaling 713 animals treated, and subsequently submitted to treatment with therapeutic follow-up.

Therefore, the research, facing its objective, refers to the exploratory-descriptive type, and, due to its point of view, as qualitative research. It still consists of the quantitative method, giving the opportunity to verify findings and scientific evidence using statistical analysis given its quantification. Figure 1 shows the geographic location of the State of Pernambuco/Brazil, highlighting the municipalities of Timbaúba, Cabo de Santo Agostinho, Camaragibe and Recife.

Figure 1 – Geographic location of the Municipalities of Timbaúba, Cabo de Santo Agostinho, Camaragibe and Recife, State of Pernambuco/Brazil.



Source: Authors (2024)

The State of Pernambuco has the geographic coordinates (Latitude: 8° 04' 03" s; Longitude: 34° 55' 00" w), as for the municipalities: Timbaúba (Latitude: 7° 30' 11" s; Longitude: 35° 18' 50" w), Cabo de Santo Agostinho (Latitude: 8° 17' 15" s; Longitude: 35° 2' 7" w), Camaragibe (Latitude: 8° 1' 14" s; Longitude: 34° 58' 54" w), and Recife (Latitude 8° 04' 03" s; Longitude 34° 55' 00" w).

RESULTS AND DISCUSSIONS

Table 1 show the descriptions of records of clinical care at Veterinary Center Santa Cândida (Timbaúba), Veterinary Medical Center (Camaragibe), Veterinary Medical Center (Cabo de Santo Agostinho), Nortvet Veterinary Clinic (Recife) and Veterinary Hospital (Recife), respectively, taking into account confirmed cases for sporotrichosis, from 2011 to 2020 and as for the Veterinary Hospital, shows the general attendance records, considering three zoonosis (sporotrichosis, leishmaniasis and leptospirosis), and same study period (Table 2).

Table 1 - Confirmed cases of sporotrichosis

Veterinary Center Santa Candida (Timbauba)					Veterinary Medical Center (Cabo de Santo Agostinho)					
Period Year	Confirmed Cases				Period Year	Confirmed Cases				
	Canine Gender		Feline Gender			Canine Gender		Feline Gender		
	M	F	M	F		M	F	M	F	
2018	0	0	17	7	2019	0	0	12	8	
2019	0	0	10	5		2020	0	0	66	29
2020	0	0	24	13			TOTALS			
03	0	0	51	25	02	0	0	78	37	
MEAN	0	0	17	8,33	MEAN	0	0	39	18,5	
Veterinary Medical Center (Camaragibe)					Veterinary Clinic Nortvet (Recife)					
Period Year	Confirmed Cases				Period Year	Confirmed Cases				
	Canine Gender		Felino Sexo			Canine Gender		Feline Gender		
	M	F	M	F		M	F	M	F	
2011	0	0	3	0	2011	0	0	9	2	
2012	0	0	4	0	2012	0	0	12	1	
2013	0	0	2	1	2013	0	0	8	2	
2014	0	0	4	0	2014	0	0	9	4	
2015	0	0	6	0	2015	0	0	8	3	
2016	0	0	1	0	2016	0	0	14	2	
2017	0	0	1	1	2017	0	0	14	7	
2018	0	0	3	4	2018	0	0	20	7	
2019	0	0	13	1	2019	0	0	23	11	
2020	0	0	11	6	2020	0	0	22	7	
TOTALS					TOTALS					
10	0	0	48	13	10	0	0	139	46	
MEAN	0	0	4,8	1,3	MEAN	0	0	13,9	4,6	

Source: Authors (2023)

Table 2 – Confirmed cases for sporotrichosis at the Veterinary Hospital (Recife), confirmed records and 2015 to 2020. And total registered clinical visits, considering the zoonoses: sporotrichosis, leishmaniasis and leptospirosis, confirmed records from 2015 to 2020.

Period Year	Veterinary Hospital (Recife)					
	Confirmed Cases					
	Canine/Gender			Feline/Gender		
	M	F	M	F	M	F
2015	0	0	4	0		
2016	0	0	13	9		
2017	4	4	22	12		
2018	2	2	115	47		
2019	1	2	15	9		
2020	5	4	6	2		
	TOTALS					
06	12	12	175	79		
MEAN	2	2	29,17	13,17		

Period Year	Attendance	With Diagnosis	Without Diagnosis	Various Diagnoses	Esp	Leish	Lep
2015	402	272	130	267	4	1	0
2016	3264	1924	1340	1868	22	17	17
2017	3664	1923	1741	1844	42	17	20
2018	3430	1920	1510	1652	166	75	26
2019	430	265	165	227	17	19	2
2020	430	265	165	227	17	19	2
	TOTALS						
06	12292	6942	5350	6424	278	170	69
MEAN	2048,67	1157	891,67	1070,7	46,5	28,33	11,5

Esp (Sporotrichosis); Leish (Leishmaniasis); Lep (Leptospirosis)

Source: Veterinary Hospital (Recife)

Only two animal health service units provided data for the period studied, that is, from 2011 to 2020, the others provided data from two, three and six years, respectively. Considering the infection prevalence on adult male cats. It is possible to notice that in 2018 there was a significant increase in the number of animals diagnosed with sporotrichosis, as well as the other zoonosis. Characteristics of an outbreak probability of occurrence.

About the questions, to respondents, the experience on the professional exercise corresponds to the medical and surgical clinic, whose periods, four doctors close to 20 years and one with more than 30 years of experience on their behalf.

Sporotrichosis occurs with different manifestations, in the cutaneous form with fixed lesions, dermal or subcutaneous nodules type, with lymphocutaneous manifestation shows itself with injuries on diverse subcutaneous nodules and on the disseminated cutaneous manifestation it shows itself with various injuries throughout the animal's body in crusts, pus and blood (Assis et al., 2022). The animals treated at the collection points have injuries, 100%, on limb and nasal regions (n=5/5), and added to the auricular region, 60% (n=3/5).

As for the disease diagnosis, it was stated that it can be given by the direct clinical exam 20% (n=1/5), and by complementary exams, being 100% (n=5/5) for cytological exams, and 20% (n=1/5) for the microbiological, on the studies of Costa et al., (2021), the complementary exams are fundamental for diagnostic precision. However, the gold pattern resides on the isolation of the fungus with fungal culture. Despite its excellency, it is not an option of choice given the time of response around 20 days, justifying the choice of the cytological exam that represented 80% of the answers, defended by Bison, Parentoni and Brasil (2020), as a gold pattern.

The technique chosen to collect the examined material is by imprint, PAF and swab. Silva et al. (2019) defends collection by swab as a safe method, which reduces the chances of accidents. The imprint and PAF techniques add up as efficient forms of procedure, considering that the cytological diagnosis is fast and cheap, corroborate Oliveira et al. (2020).

The reports point to *Sporothrix* spp as the main cause for sporotrichosis in many domestic animals, in Brazil, as well as it was attributed in 100% (n=5/5) that this is the fungus gender diagnosed on clinical and laboratory procedures, relating the habit of biting and scratching as main ways of transmissibility. During the researches of França et al. (2022), it was attributed to the domestic animals, especially felines, the gender *Sporothrix* Spp, once these animals are susceptible to it for having licking, excavating and hiding dejects, biting and sharpening the nails on logs as habits.

To carry out the treatment and reach the cure, the respondents unanimously affirm the need for 6 months, strictly following the medical guidelines. Observing this term in the studies by Silva et al. (2019). On the other hand, there are studies that refer to the treatment time as a case-by-case dependent period, but with recommendations that after proven clinical cure, drug treatment is maintained for another month (Michelon et al., 2019).

It can be observed that the control of the zoonosis is related to the continuity of the diagnosed treatment, whose withdrawal or abandon of the disease treatment by the tutors contribute to the dissemination of the disease or the animal's death. To the respondents 100% (n=5/5), the tutors follow sometimes, strictly, the prescribed treatment and that have little knowledge about the disease, 100% (n=5/5). In Brizeno, Silva and Bassoli (2020), the abandonment to the treatment occurs with elevated frequency, characterized by factors such as therapeutical mistake or high medicine costs.

As for the question about sporotrichosis as a zoonosis, it incurs that there are difficulties to the diagnosis, treatment and preventive care. The technical managers affirmed that the diagnoses are burdensome, lack of free animal service units, high-cost treatments for some tutors, which for monetary issues abandon or not even start the treatment.

There are stray animals, providing the dissemination of the disease due to the mating and fighting habits, scratchings and bitings. In addition to the difficulty of managing the medication, due to the animal's resistance, as well as for having semi domiciled animals, allied with the necessity of procedures to a precise diagnosis and a treatment follow-up.

The treatment protocol is given by the gold standard, in the use of oral itraconazole, and varying doses (100 mg/kg), orally for felines >2kg and itraconazole (50 mg/kg), orally for felines <2kg, depending on each case. The average period of treatment until cure is six months.

Finally, it is pertinent to mention that the disease control passes, according to the Technical Managers, through a series of strategies by the public power, such as developing projects that involve the society participation, taking information with the use of mass media. In the studies and research of Brizeno, Silva and Bassoli (2020) the control of sporotrichosis resides on the lack of public actions, involving or not stray animals' castration, and population education.

Michelon et al. (2019) corroborates the importance of developing educational actions, from information about the disease, going through epidemiological awareness and the correct handling of animals under treatment, as well as responsible person. Figure 2 shows the exploratory spatial analysis of cases of sporotrichosis, considering all registered and tabulated cases of the units referring to the research locus.

Figure 2 – Map of spatial analysis of confirmed cases of sporotrichosis in the state of Pernambuco, considering the findings from 2011 to 2020.



Source: Authors (2023)

It is noticeable that the municipalities of Jaboatão dos Guararapes, Paulista and Timbauba with the registry of the disease on the interval (20 - 40), for the municipalities of Cabo de Santo Agostinho and Camaragibe with registries in the interval (40 - 60) and the municipality of Recife with an expressive number of registries superior to 80 cases.

In this exploratory spatial analysis, it is possible to observe the space considering the characteristics from the local where the zoonoses occurred. It consists of a grouping of tools that explore and model processes through distribution in spaces known as geographical phenomenon.

In the studies of Felix, Da Silva e Faria (2020) exploratory spatial analysis was used as a technique to the detection of losing points, not electric energy techniques, whose results point to the necessity of mapping and discursion of sub areas with larger aggregate of rental properties.

This way, the characteristics and relations between diverse variables are measured, considering the location on where the phenomenon occurs, expliciting the characteristic data. This model of analysis can be used in various areas of knowledge and not only epidemiological, but criminal, geologic, agronomic, ecologic, among others (Vivaldini et al., 2019).

The contingency of the data obtained with the non-parametric test, result of the chi-square test that verified the possible divergences between the observed and expected frequencies of the diagnostic variables for zoonoses. The test result ($X^2 = 333$), and p-value (< 0.001) shows that there is a significant difference between the observed and expected frequencies. Among them, the incidence of sporotrichosis in felines stands out (98.1%), for the canine species the zoonosis leishmaniasis prevails (51.6%).

With the descriptive statistical analysis, the total number of registered cases, by municipality of occurrence, with a diagnosis of sporotrichosis (mean, median, standard deviation, minimum and maximum) was considered, then the normality test on the statistics of Shapiro-Wilk was carried, addressing the indicators (HDI, Population and Demographic Density), according to the IBGE Census (2010), of the research locus and period of ten years (2011 to 2020). Then, the test was performed Spearman Correlation.

The normality test of residuals tested the hypotheses: H0: the residuals of the variable under study come from a population with normal distribution ($p \geq 0.05$); H1: the residuals of the variable under study do not come from a population with normal distribution ($p < 0.05$).

Given that the residuals of the variables Sporotrichosis, Population and Demographic Density ($p < 0.05$) respectively, do not follow normality, the non-parametric statistical method was used, verifying the correlations between the variables with the Spearman Correlation statistical test (Table 3).

Table 3 - Correlation Matrix between variables Sporotrichosis, HDI, Population and Demographic Density

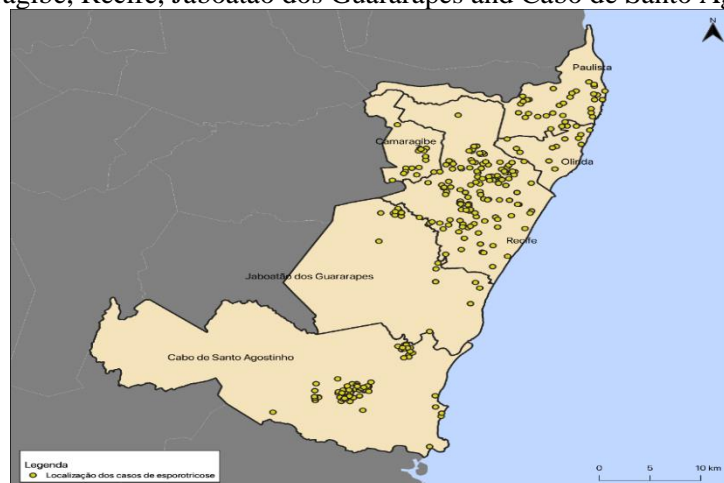
		HDI	Demographic Density	Sporotrichosis	Population
HDI	<i>Rho de Spearman</i>	—			
	<i>p-value</i>	—			
Demographic Density	<i>Rho de Spearman</i>	0.951	—		
	<i>p-value</i>	1.67e-8	—		
Sporotrichosis	<i>Rho de Spearman</i>	0.732	0.660	—	
	<i>p-value</i>	0.00127	0.00542	—	
Population	<i>Rho de Spearman</i>	0.901	0.812	0.773	—
	<i>p-value</i>	1.96e-6	1.95e-4	4.43e-4	—

Source: Authors (2023)

Among the variables HDI, population and demographic density with sporotrichosis, there is a positive moderate correlation, that is, the bigger these indicators, the registry of diseases increases. It is understood that HDI consists of items such as literacy, education, wealth, infrastructure, among others, aiming to evaluate the social wellbeing of a given population (Alberti et al., 2021). In Neto et al. (2021), urban infrastructure issues have a narrow relation with the municipality HDI.

With google maps geo codification, it was possible to obtain the georefering of addresses, and build a point location map of disease cases, considering the municipalities in which we obtained the full addresses (Figure 3).

Figure 3 - Point location map of sporotrichosis cases in the municipalities of Paulista, Olinda, Camaragibe, Recife, Jaboatão dos Guararapes and Cabo de Santo Agostinho

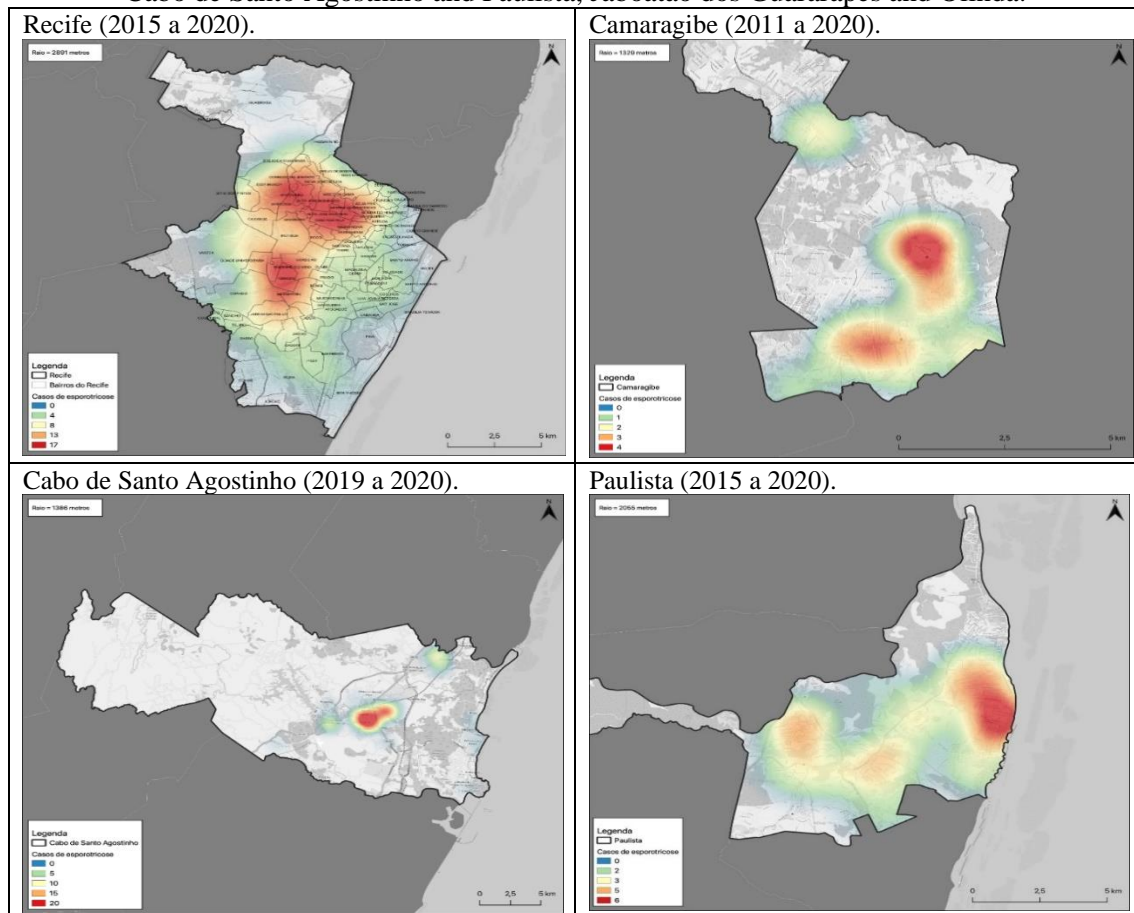


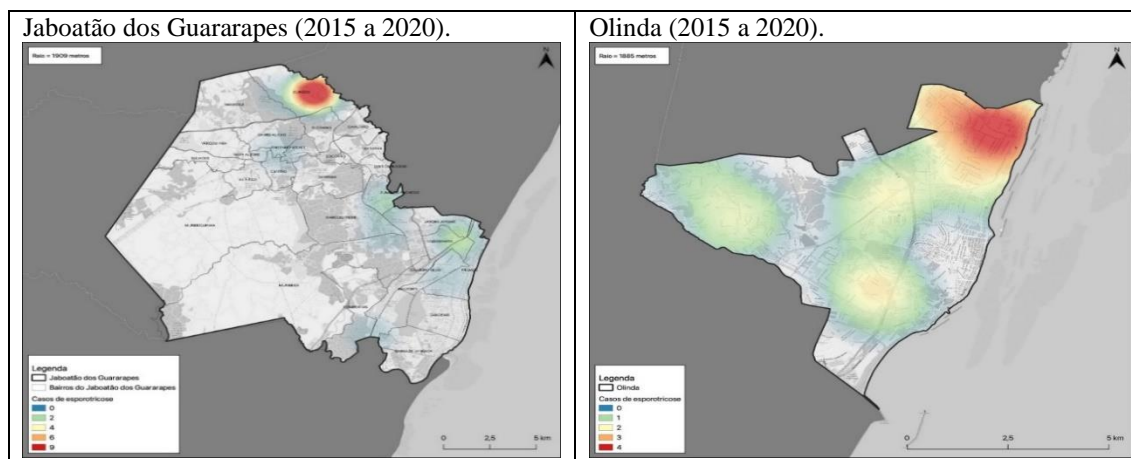
Source: Authors (2023)

The municipality of Recife shows a greater distribution of cases of sporotrichosis, followed by the municipalities of Paulista and Olinda. On the other hand, Cabo de Santo Agostinho showed a greater concentration of the disease in the neighborhoods (Centro, Cohab, Ponte dos Carvalhos, Garapu, São Francisco, Santo Inácio, Ipojuca e Charneca) and in Camaragibe (Timbi and Santana). It should be inferred that there is not a way to relate the focal points of sporotrichosis with incidence and prevalence rates, once the total population of domestic animals per municipality is not known.

In the figure 4, using the statistical method of Kernel Density Estimation, with different radiuses, it was possible to look at the main areas with the main focus of occurrence of sporotrichosis on domestic animals whose locality data helped building the respective heat maps.

Figure 4 - KDE map of cases of the disease in the municipalities of Recife and Camaragibe, Cabo de Santo Agostinho and Paulista, Jaboatão dos Guararapes and Olinda.





Source: Authors (2023)

Within a 2891 meters radius, the largest quantities of registered cases of sporotrichosis are in the neighborhoods of Macaxeira, Casa Amarela, Alto José Bonifácio, Alto José do Pinho, Água Fria, Apipucos, Engenho do Meio, Torrões, San Martin and Tamarineira. These neighborhoods are located in a small distance from the Veterinary Hospital, given this proximity there is a higher access of tutors seeking veterinary treatment for their pets. For the municipality of Camaragibe, within a radius of 1,329 meters, higher incidence of cases in the neighborhoods of Timbi, Centro de Camaragibe, Vila da Fábrica, Novo Carmelo and Céu Azul.

In the municipality of Cabo de Santo Agostinho, within a radius of 1386 meters, there is a higher incidence of sporotrichosis in the Sapucaia, Centro and São Francisco neighborhoods. For the municipality of Paulista, within a radius of 2055 meters, the neighborhoods of Janga, Nossa Senhora do Ó, Nossa Senhora da Conceição, Poty and Pau Amarelo, have higher incidences of sporotrichosis.

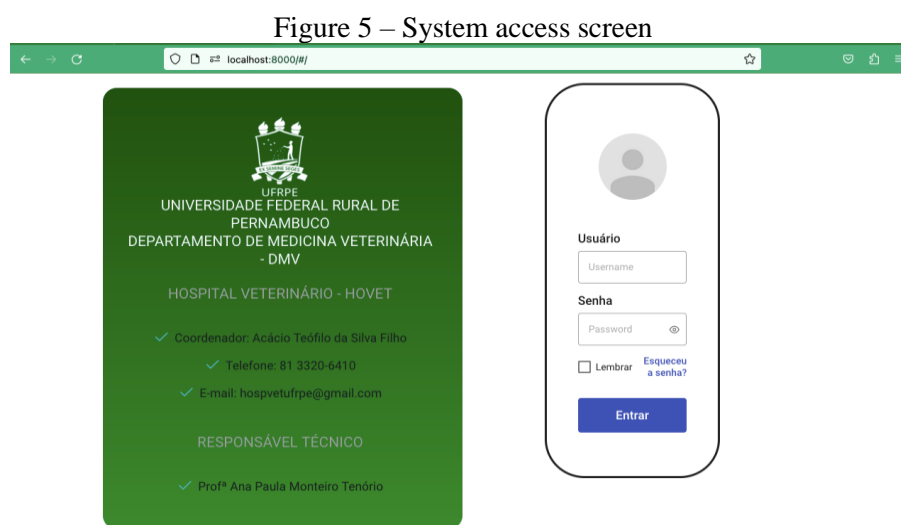
The municipality of Jaboatão dos Guararapes points to the Curado neighborhood with the largest quantity of registered and confirmed cases of sporotrichosis, within a 1909 meters radius. Jardim Jordão, Guararapes, Piedade and Cajueiro Seco showed registers of up to two cases of the disease.

In Olinda, the neighborhoods of Rio Doce, Jardim Atlântico, Bairro Novo and Jatobá have the highest records of sporotrichosis, within a radius of 1885 meters.

The lack of information when completing the clinical form leads us to a condition of possible evidence cases of sub notification. The addresses data were collected in only two collecting points (Recife and Cabo de Santo Agostinho). However, various incomplete addresses, as well as lack of registers in the established period contribute to limiting the research.

Proposal for a Management Plan

With the creation of the Veterinary Registration System Software, information around the address data of tutors and their animals, it will be more effective when filling out the clinical records. This way, it will be possible to map and georeference the occurrence location of any zoonosis, specially sporotrichosis, that is not yet known as a notifiable disease, in the state of Pernambuco, in animals. In Figure 5, the system access screen can be seen, which must be filled in with the username (attendant, veterinarian or administrator) and password.



Source: Authors (2023)

After logging in, before starting a new service, the attendant must register the tutor on the system. With mandatory data, such as CPF and Postal Code. It should be observed that during the register of a new tutor, the address data is consulted in an external system.

When the tutor is duly registered, it is possible to register the pet and keep the tutor's address to the animal or assign the animal a different address data. On these options, vaccine information is registered, informing the date of vaccination and the next one. The system already has some registered vaccines, with the option of adding a new one.

Considering the completion of the animal's registration, it is imperative to register its vaccines, selecting the database with registered vaccines or adding a new one, informing the application date and next date. Once the registrations of tutors and animals are completed, care for the animal begins, at which time medical advice is determined: treatment change, appointment or return. If the orientation is a return, information on the last appointments performed on this animal is generated, recording the clinical condition of the animal for a new appointment.

The service is displayed in front of the registered animals, and the attendant will be given permission to issue documents (prescriptions, exams and zoonosis notification form). The veterinarian is allowed to open an appointment, and, for each tab change, the information filled in is saved automatically, preventing loss of information.

When accessing the 'clinical examination' tab, it is mandatory to fill in all the values on the screen, being optional to fill in the 'observation' field on any of the tabs. On the next tab, are the field values filled in by the standard procedure - 'no change', changing or not, depending on the veterinarian's guidance.

Once the service is finished, it is possible to issue reports in the system: visits by outpatient clinic, exams by type, service by type and specialty report. The latter refers to the mandatory notification form for zoonoses (Figure 6), attributed with emphasis on sporotrichosis that follows the proposal to make it visible and publicize information to be agreed with the municipal governments where the notification occurs.

Figure 6 – Zoonosis notification form.
 UNIVERSIDADE FEDERAL RURAL DE PERNAMBUCO
 DEPARTAMENTO DE MEDICINA VETERINÁRIA
 HOSPITAL VETERINÁRIO
 FICHA DE NOTIFICAÇÃO – N°

Ficha Clínica n°: 2023	Médico Veterinário e Registro: José Eduardo Silva	Data do Atendimento: 20/Mar/2023
Dados Gerais		
Tipo de notificação <input checked="" type="checkbox"/> Caso Individual <input type="checkbox"/> Suspeita de Surto		
Agravado/Doença Esporotricose		
Município de notificação Recife		Código IBGE (do endereço) 123
Nome do Animal de Estimação Ducky	Raça Angorã	Sexo <input checked="" type="checkbox"/> Macho <input type="checkbox"/> Fêmea
Idade 4	Espécie Felino	Porte <input checked="" type="checkbox"/> P <input type="checkbox"/> M <input type="checkbox"/> G
Nome do Tutor ODRAUDE AVLIS		Nº CPF 012
Município Recife	Bairro Bongi	Saneamento <input type="checkbox"/> Sim <input type="checkbox"/> Não
Logradouro Rua Mariz Vilela, 25, Apt 1101		
Ponto de referência pppp		CEP 50720270
Telefone undefined		Ocupação
Dados do Notificante		
Nome		
Cargo/função		Carimbo e Assinatura

Rua Dom Manoel de Medeiros, S/N – Dois Irmãos – Recife/PE – CEP: 52.171-900
 Tel: (81) 3320-6441 / 3320-6410

Source: Authors (2023)

The loss of registration information and clinical history of animals and tutors, structures the managerial concern in maintaining an effective, updated and essential database for good management in the collection of information necessary for the study of geospatialization and georeferencing the geographic points of the peculiarities of each neighborhood or municipality where sporotrichosis occurs.

Aligned to the database there can be developed educational and instructional actions for tutors and professionals from the veterinary medicine field, as well as students, about the zoonosis and its impacts and preventive care in social and academic environments.

CONCLUSION

The feline species, diagnosed with sporotrichosis, prevails in adult males. It can be justified by behavioral habits such as fights, mating, in addition to being semi-domiciled animals, most of the time. Whose treatment follows the gold pattern (itraconazole).

The inaccuracy when completing the animal medical record (clinical record), at the veterinary hospital, is what causes a limitation of the research regarding the evidence of underreported data. As well as it makes it impossible to accurately base information, for the elaboration of maps and georeferencing of the points and coordinates of cases.

The dissemination of zoonoses finds coverage in the uninformed population about treatments, breeding behavior, transmissibility, combined with the fact of population planning by castration, given the lack of population control, especially of stray animals.

Geospatialization is a powerful method when identifying points, foci or not, of disease incidence. Enabling the collection of information and data that generate indicators such as the evolution of quantity, prevalence and incidence, observing the socio-environmental conditions of the place, guardians and living conditions for the animals. However, there was a lot of registration data recorded with a lack of relevant information, tutors, animals and, above all, diagnosis.

The Veterinary Registration System, as a proposal for a management plan, presents itself as an advantage in the generation of reliable information on source data, diagnoses and therapists, among other information. Therefore, the SRV's strong point is the preparation of a notification form for any zoonosis diagnosed at the Veterinary Hospital of UFRPE, generating identification data, possible for georeferencing.

The Zoonoses Notification Form is a probative document to be sent to the Animal Health Services, as well as to the municipal health departments of the municipalities. Contributing to the generation of information, an important step for public health actions. Indicating the possibility of inserting sporotrichosis as a notifiable disease in animals in the state of Pernambuco, recognized and regulated by legal acts, such as Resolution No. 50/2013, of the Ministry of Agriculture, Livestock and Supply – MAPA. Therefore, it is a matter of public health, supported by public policies and in the interest of society.

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