

Feline sporotrichosis in Rio de Janeiro: Space-time analysis of the main enzootic region in Brazil (1998–2018)

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Abstract

Feline-transmitted sporotrichosis caused by *Sporothrix brasiliensis* is an important zoonosis in Brazil, with Rio de Janeiro representing a major endemic area. This study analyzed the spatiotemporal distribution of feline sporotrichosis cases diagnosed at Fiocruz between 1998 and 2018. An ecological study was conducted using cases confirmed by fungal culture. Residential addresses were georeferenced, and spatial distribution was assessed using kernel density estimation and Kulldorff's space-time scan statistics. Of 5,113 diagnosed cases, 4,502 were successfully georeferenced and included in the spatial analyses. Thirteen significant space-time clusters were identified between 1998 and 2012, mainly in economically disadvantaged areas of Rio de Janeiro and neighboring municipalities in the Baixada Fluminense. Most affected cats were young, male, mixed-breed, and unneutered. Repeated occurrences at the same locations were frequent, and most were recorded within a one-year interval, indicating marked spatial and temporal aggregation. No significant clusters were detected after 2012, possibly reflecting changes in referral patterns following decentralization of veterinary care. These findings highlight persistent high-risk areas and support geographically targeted surveillance and control strategies for feline sporotrichosis in endemic urban settings.

Introduction

Feline-transmitted sporotrichosis, caused by *Sporothrix brasiliensis*, represents the main route of zoonotic transmission in Brazil, particularly in Rio de Janeiro, the most affected state (Rabello et al. 2022). The progressive spread of the disease within Brazil and to other South American countries has raised concern about its geographic expansion (Do Prado et al. 2023; Etchecopaz et al. 2021; Thomson et al. 2023). Despite the long-standing enzootic scenario, long-term spatiotemporal analyses in the main affected region remain scarce (Ferreira et al. 2025; Figueiredo et al. 2022).

This study aimed to analyze the spatiotemporal distribution of feline sporotrichosis in the Metropolitan Region of Rio de Janeiro over a 20-year period, identifying areas of highest risk for occurrence of the disease.

Materials and Methods

An ecological design was adopted, including feline sporotrichosis cases diagnosed by fungal culture at the Laboratório de Pesquisa Clínica em Dermatozoonoses em Animais Domésticos (Lapclin-Dermzoo), Instituto Nacional de Infectologia Evandro Chagas (INI), Fundação Oswaldo Cruz (Fiocruz), Rio de Janeiro, Brazil, between 1998 and 2018. Cases were georeferenced according to the residence address of each animal using a standardized process that included address correction and geocoding through the Bing Maps API in R, followed by manual verification and completion using Google Maps when necessary.

Spatial distribution was explored using kernel density estimation with a 5-km radius. Space-time clusters were identified using the space-time permutation model implemented in SaTScan 9.7, based on the

space-time scan statistic proposed by Kulldorff (1997). Cases were aggregated by year, and clusters were retrospectively evaluated across seven three-year periods (1998–2000 to 2016–2018). The maximum spatial cluster size was restricted to a 1-km radius to detect epidemiologically meaningful areas for surveillance. Significant clusters were mapped using ArcGIS 10.2.

Results

A total of 5,113 feline sporotrichosis cases were diagnosed during the study period. After excluding unavailable records and cases without sufficient address information, 4,502 cases (88.1%) were successfully georeferenced and included in the spatial analyses.

The number of cases increased over time, reaching a peak in 2010 (502 cases), with a temporary decline between 2013 and 2015 (Fig. 1). Most affected animals were male (68.1%), young (< 48 months), mixed-breed (88.9%), and unneutered (77.4%).

Kernel density maps revealed a progressive spatial expansion of the disease, particularly toward municipalities bordering the city of Rio de Janeiro, including Duque de Caxias, Nilópolis, Nova Iguaçu, and São João de Meriti (Fig. 2). In contrast, few cases were observed in higher-income areas such as Zona Sul, Barra da Tijuca, and Recreio dos Bandeirantes, which together accounted for only 1.0% of all cases.

Space-time scan analysis identified 13 significant clusters ($p < 0.05$), including five primary clusters and eight secondary clusters. The earliest primary cluster (1998–2000) was located in the Penha neighborhood (Zona Norte), with a relative risk (RR) of 2.31. No significant clusters were detected in the periods 2013–2015 and 2016–2018 (Table 1).

Table 1
Space-time clusters of cases of feline sporotrichosis diagnosed at Lapclin-Dermzoo/INI/Fiocruz from 1998 to 2018.

Period	Cluster	Radius (km)	Year	Cases	Expected cases	RR	p-value	Location
1998–2000	1 (primary cluster)	0.00	1999	16	6.91	2.31	0.000	Penha – Rio de Janeiro
	2	0.93	2000	20	12.32	1.62	0.017	Centro - Nilópolis
	3	0.35	1999	8	3.46	2.31	0.022	Parque Analândia – São João de Meriti
2001–2003	1 (primary cluster)	0.00	2001	9	1.01	8.94	0.000	Comendador Soares – Nova Iguaçu
	2	0.00	2001	6	0.67	8.94	0.001	Pechincha – Rio de Janeiro
2004–2006	1 (primary cluster)	0.90	2006	10	2.52	3.96	0.002	Manguinhos – Rio de Janeiro
	2	0.97	2006	9	2.13	4.22	0.004	Bonsucesso – Rio de Janeiro
	3	0.95	2006	6	1.16	5.15	0.037	Jardim Sumaré – São João de Meriti
	4	0.74	2006	9	2.52	3.57	0.037	Centro - Nilópolis
2007–2009	1 (primary cluster)	0.35	2007	6	1.23	4.86	0.027	Caioaba – Nova Iguaçu
	2	0.93	2007	7	1.85	3.78	0.049	Parque Lafaiete – Duque de Caxias
2010–2012	1 (primary cluster)	0.72	2012	12	4.04	2.97	0.005	São José – Belford Roxo
	2	0.74	2011	7	1.68	4.17	0.018	Campo Grande – Rio de Janeiro
2013–2015	0	-	-	-	-	-	-	-
2016–2018	0	-	-	-	-	-	-	-

Analysis of repeated occurrences at the same location showed that 1,657 cases (36.8%) occurred at shared addresses, distributed across 586 locations. Most locations presented two or three cases, although some sites recorded up to 49 cases. In 74.85% of these locations, cases occurred within an interval of up to one year, indicating marked temporal aggregation.

Discussion

This study represents the first application of space-time scan analysis to evaluate the spatiotemporal dynamics of feline sporotrichosis in the state of Rio de Janeiro. The results describe the distribution and main epidemiological characteristics of cases diagnosed at INI/Fiocruz, a major referral center for mycoses in Brazil, between 1998 and 2018.

The epidemiological profile observed in the present study, with a predominance of young, male, unneutered, and mixed-breed cats, is consistent with previous studies on feline sporotrichosis (Pereira et al. 2014; Davies and Troy 1996; Han and Kano 2021). These characteristics may be associated with behavioral factors, including greater mobility and aggressive interactions among male cats, which may favor transmission through scratches and bites.

Spatial analysis revealed a progressive expansion of the disease from the municipality of Rio de Janeiro to neighboring municipalities in the Baixada Fluminense region, forming a belt of transmission similar to patterns previously described in human and canine sporotrichosis (Figueiredo et al. 2022; Silva et al. 2012). In contrast, few cases were recorded in higher-income areas of the city, where cats may more frequently live indoors with limited access to the streets. In economically disadvantaged areas of the capital and in the Baixada Fluminense municipalities, houses are the predominant type of dwelling (Silva et al. 2012; Schubach et al. 2005), which may facilitate greater outdoor access by cats.

Clusters detected in neighborhoods such as Penha, Mangueiras, and Bonsucesso were located in economically disadvantaged areas with a predominance of houses and greater potential access of animals to the outdoor environment. In addition, these neighborhoods are located close to INI/Fiocruz, which may have facilitated access to veterinary care during the early years of the epidemic. The absence of significant clusters after 2013 may also reflect changes in referral patterns following the decentralization of veterinary services in 2014, when the municipality of Rio de Janeiro began offering free diagnosis and treatment.

One of the main findings of this study was the high proportion of cases occurring at identical locations, indicating marked spatial aggregation. This pattern is compatible with heterogeneous transmission dynamics described in superspreading phenomena, in which a relatively small proportion of hosts may contribute disproportionately to transmission (Lloyd-Smith et al. 2005; Woolhouse et al. 1997). However, the present study did not directly assess transmission chains or identify individual superspreaders. High densities of cats within households, often combined with unrestricted outdoor access and limited veterinary care, may contribute to sustained transmission and the occurrence of multiple cases at the same address.

A clear temporal aggregation was also observed. Most cases recorded at the same locations occurred within relatively short intervals: approximately 75% were identified within one year and about 80% within two years. Longer intervals of more than four years were observed in approximately 20% of cases. These patterns may reflect repeated introduction of susceptible animals, persistent local transmission, or environmental persistence of *Sporothrix* spp., although the relative contribution of these mechanisms could not be determined in the present study. Environmental detection of *Sporothrix* remains limited, and further studies in areas with persistent clustering could help clarify the role of environmental sources (Rabello et al. 2022; Poester et al. 2018).

The case series recorded at Lapclin-Dermzoo/INI/Fiocruz represents a substantial proportion of feline sporotrichosis cases diagnosed in Rio de Janeiro during the study period. Until 2014, INI was the only institution in the state that systematically provided free diagnosis, clinical monitoring, and treatment of affected animals. This referral pattern should be considered when interpreting the spatial distribution of cases, particularly in areas located closer to the institution.

Overall, these findings support geographically targeted surveillance and control strategies in areas with persistent clustering of feline sporotrichosis, particularly in densely populated urban settings with large free-roaming cat populations.

Declarations

Competing Interests

The authors have no relevant financial or non-financial interests to disclose.

CRedit authorship contribution statement

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Conceptualization; Methodology; Formal Analysis; Investigation; Writing – Original Draft; Visualization.

Daniel C. P. Câmara

Writing – Review & Editing.

Isabella D. F. Gremião

Writing – Review & Editing.

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Mônica A. F. M. Magalhães

Resources; Writing – Review & Editing; Supervision; Project Administration; Funding Acquisition.

Sandro A. Pereira

Resources; Writing – Review & Editing; Supervision; Project Administration; Funding Acquisition.

Ethics Statement

This retrospective study was based exclusively on data obtained from existing veterinary medical records and did not involve any prospective intervention in animals.

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Author Contribution

A.B.F.F. contributed to conceptualization, methodology, formal analysis, investigation, preparation of the original draft, and visualization. M.A.F.M.M. contributed to resources, review and editing of the manuscript, supervision, project administration, and funding acquisition. D.C.P.C., L.S.P., and I.D.F.G. contributed to review and editing of the manuscript. S.A.P. contributed to resources, review and editing of the manuscript, supervision, project administration, and funding acquisition. All authors reviewed and approved the final manuscript.

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Data Availability

The datasets analyzed during the current study are available from the corresponding author on reasonable request.

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Figures

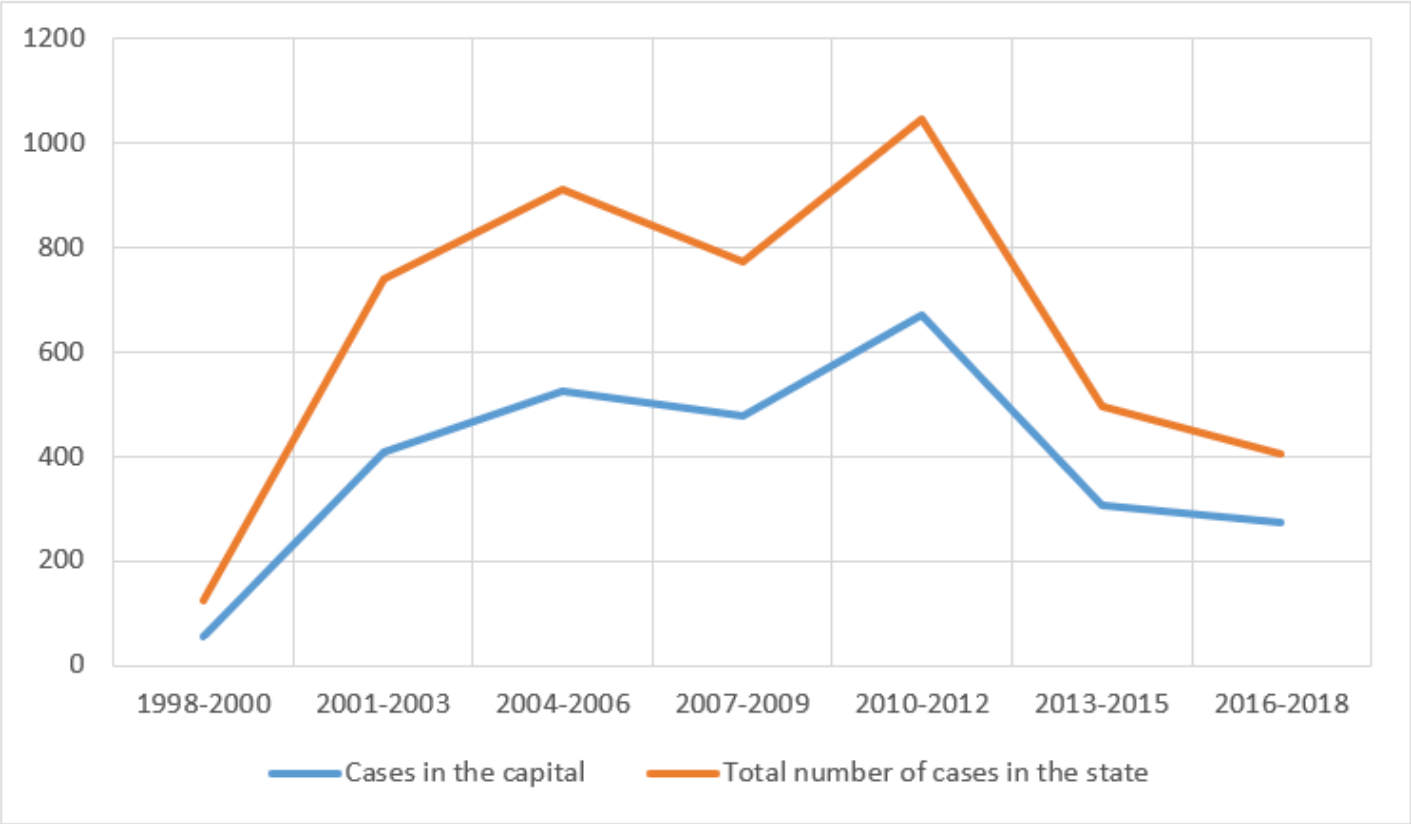


Figure 1

Time series of feline sporotrichosis cases diagnosed at Lapclin-Dermzoo/INI/Fiocruz according to study period

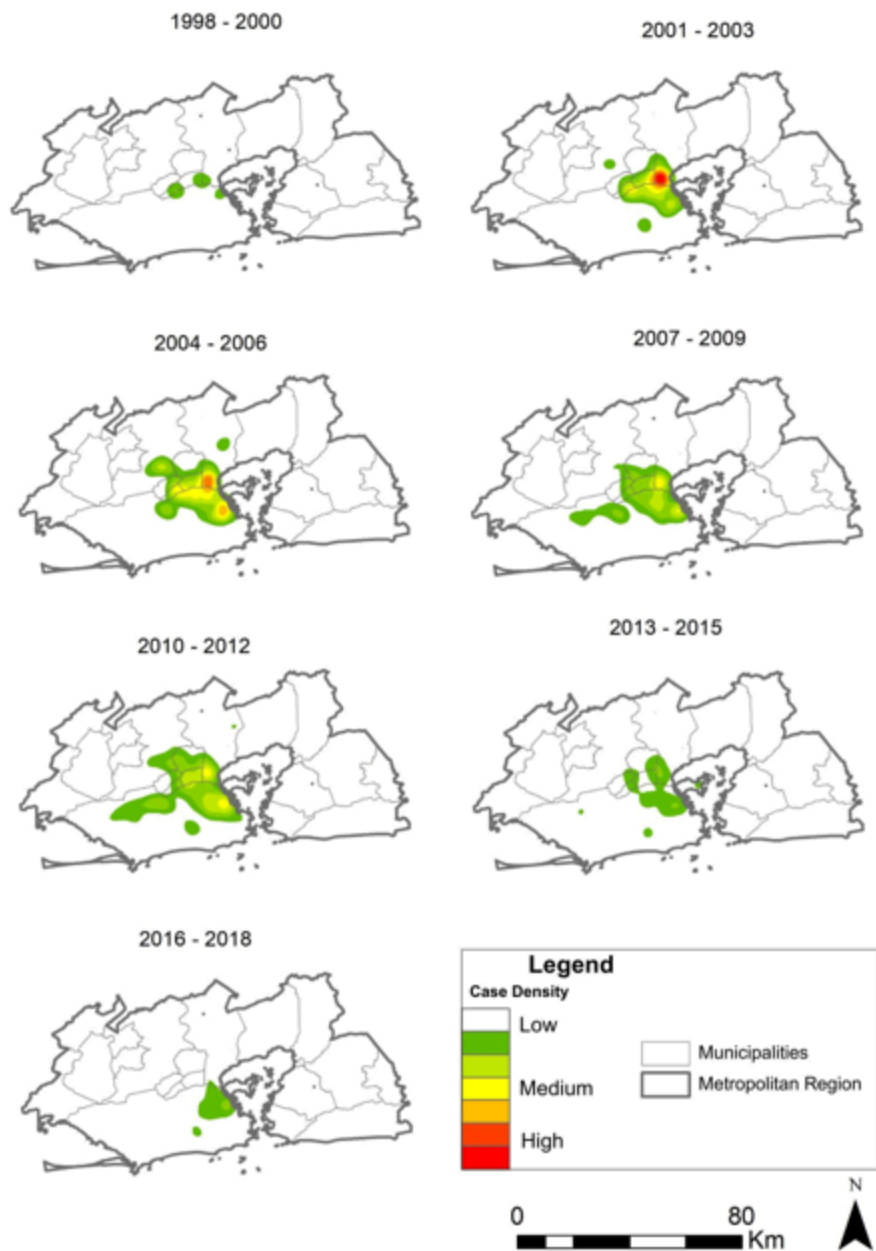


Figure 2

Kernel density map obtained by georeferencing of feline sporotrichosis cases in the Metropolitan Region of the state of Rio de Janeiro (1998-2018)