Short Communication

For reprint orders, please contact: reprints@futuremedicine.com

Future MICROBIOLOGY

Epidemiological features and geographical expansion of sporotrichosis in the state of Pernambuco, northeastern Brazil

Cybelle E Silva[1], Carlos AT Valeriano[2], Cláudia E Ferraz[3,4], Rejane P Neves[2], Manoel ME Oliveira[5], Júlio CAL Silva[6], Vera Magalhães[3,4] & Reginaldo G Lima-Neto*[,1,2,3,4]

[1]Postgraduate Program in Biotechnology, Center for Biosciences, Federal University of Pernambuco (UFPE), Pernambuco, Av. Prof. Moraes Rego, 1235 – Cidade Universitária, Recife – PE, 50670-901, Brazil

[2]Postgraduate Program in Fungal Biology, Center for Biosciences, UFPE, Pernambuco, Brazil

[3]Hospital of Clinics, UFPE, Recife, Pernambuco, Brazil

[4]Department of Tropical Medicine, Center for Medical Sciences, UFPE, Pernambuco, Brazil

[5]Laboratory of Taxonomy, Biochemistry & Bioprospecting of Fungi, Oswaldo Cruz Institute (FIOCRUZ), Rio de Janeiro, Av. Brasil, 4365 – Manguinhos, Rio de Janeiro – RJ, 21040-900, Brazil

[6]Clinical Research Platform, FIOCRUZ, Rio de Janeiro, Brazil

*Author for correspondence: Tel.: +55 819 9147 9644; reginaldo.limant@ufpe.br

Aim: Cases of sporotrichosis are emerging in several states of Brazil, especially in the southeast. Recently, sporotrichosis has been reported in the state of Pernambuco in the northeastern region. The goal of this study was to shed new light on sporotrichosis in terms of the geographic distribution of human cases and provide an overview of sporotrichosis associated with zoonotic transmission. **Patients & methods:** From March 2017 to November 2019, 179 patients were diagnosed with sporotrichosis. Georeferencing analysis, spatial distribution and epidemiological features of all cases are described. **Results:** The data show the dynamics of accelerated transmission of sporotrichosis across urban and coastal areas of the state of Pernambuco. **Conclusion:** There is a need to decentralize health services and implement a One Health approach to this emerging disease.

First draft submitted: 1 June 2021; Accepted for publication: 2 November 2021; Published online: 23 November 2021

Keywords: epidemiology • georeferencing • socioeconomic conditions • *Sporothrix*

Sporotrichosis is a disease with global distribution and high incidence in tropical and subtropical areas [1–3]. Currently, it is considered endemic in Latin America and Asia [4,5] and causes cutaneous (fixed, lymphocutaneous and disseminated) and extracutaneous (ocular, pulmonary, neurological, osteoarticular and immunoreactive) infections by a dimorphic fungus of the *Sporothrix* genus. Usually, the infection consists of suppurating subcutaneous nodules located near lymphatic channels. In some cases, it can spread to other organs and promote disseminated infection [6]. The fungal agent *Sporothrix schenckii* was considered a single species until 2007 when Marimon and coworkers described three new cryptic species: *Sporothrix brasiliensis, S. globosa* and *S. mexicana* [7]. Since then, some studies have proposed a taxonomic revision, and three more species associated with clinical cases have been reported: *Sporothrix pallida, Sporothrix chilensis* [8,9] and *Sporothrix luriei* [10]. *Sporothrix schenckii* (*senso stricto*), *S. brasiliensis*, *S. globosa* and *S. luriei* make up the pathogenic clade of the genus *Sporothrix* [11,12].

Sporotrichosis was a mycosis known as rose gardeners' disease because pathogen inoculation occurred mainly through contaminated soil and plants, such as in the case of rose thorn wounds [13]. However, the scenario has changed from small to large outbreaks due to zoonotic transmission [11,14]. Primarily in Rio de Janeiro, Brazil, more than 5000 cases of animal contamination with zoonotic transmission have been registered since 1998. This transmission is spread from contaminated cats to humans through scratching or biting, contact with secretions from ulcerated lesions and through feline respiratory secretions during coughing and sneezing, and the most prevalent species is *S. brasiliensis* [15,16].

Figure 1. The state of Pernambuco, Brazil.

A more recent sporotrichosis endemic area in Brazil is the northeast region, in particular the state of Pernambuco, and this area is associated with zoonotic transmission, which has been officially reported since becoming a mandatory notification in 2015 [17–20]. Nevertheless, few states in Brazil require compulsory notification of this disease at the moment [20]. Unfortunately, the expansion of sporotrichosis involves precarious sanitary and social conditions all over the country. High reproductive rates of felines facilitate the spread of the fungus even more. According to the last national health survey carried out by the Brazilian Institute for Geography and Statistics (IBGE, Ministry of Economy, Brazil), the northeast region has about 7,384,110 cats, being the region of Brazil with the highest number. In Pernambuco, there are 927,127 cats. The authors believe that these numbers are another justification for the increase in human sporotrichosis in the state [21].

The early twenty-first century was very important for the study of sporotrichosis because global epidemiological data were described [1,4,11,14,16,20,22–24]. An outbreak of feline sporotrichosis in northeastern Brazil was reported for the first time in 2018 [17]. However, there are no studies that describe the human sporotrichosis profile and epidemiological data in this region [18,19]. Therefore, in this article, new light is shed on sporotrichosis in Pernambuco (PE) in terms of the geographical distribution of human cases, and an overview of sporotrichosis with zoonotic transmission in the state of PE is provided. Geoprocessing tools were used for the sporotrichosis geo-epidemiology study and were obtained from geoprocess maps.

Materials & methods

Ethics statements

This research was submitted to the Human Research Ethics Committee of the Center for Health Sciences at the Federal University of Pernambuco (UFPE, Brazil) under protocol CAAE 70369117.5.0000.5208, and received approval under protocol number 071133/2017. The study was conducted in accordance with the Helsinki declaration.

Design & site of study

This is a retrospective and descriptive study with data collected from medical records and laboratory reports over 31 months. The study took place at the Hospital of Clinics (HC/UFPE) in the city of Recife, State of Pernambuco, northeastern Brazil. HC/UFPE is the teaching hospital of the Federal University of Pernambuco and has 418 beds. Analysis was performed by outpatient data access from patients attended by the Dermatological Service at the HC/UFPE, from 1 March 2017 to 30 November 2019. The Dermatological Service attends patients from all over the state of Pernambuco with a flow of between 900 and 1000 patients per month. The patients were diagnosed with sporotrichosis by the association between clinical features and laboratory data, such as direct microscopic examination, fungal culture on Mycosel agar and histopathological analyses.

The state of Pernambuco covers an area of 98,068,021 km^2, with an estimated population of 9,473,266 (Figure 1). Its urbanization rate corresponds to 80.17% of the whole population, so the majority of citizens, around 7,052,210 million people, live in urban areas. Pernambuco comprises 35% of the gross domestic product (GDP)

Table 1. Increase in sporotrichosis cases in patients attended by the Dermatological Service at the Hospital of Clinics/Federal University of Pernambuco (2016–2019).

Year	Cases/year	Cases/month	Increase from 2017 (%)
2016	9	0.75	-
2017†	36	3	-
2018	95	7.91	163
2019‡	48	4	33.33

†Starts from March 2017.
‡Until November 2019.

of the northeastern region. This wealth is distributed between 185 municipalities. The metropolitan region of the state capital, Recife, is composed of 15 cities, namely Abreu e Lima, Araçoiaba, Cabo de Santo Agostinho, Camaragibe, Goiana, Igarassu, Ilha de Itamaracá, Ipojuca, Itapissuma, Jaboatão dos Guararapes, Moreno, Olinda, Paulista, São Lourenço da Mata and Recife, which, being the capital, enjoys the most socioeconomic development in the state. Pernambuco's climate is humid, tropical in the coastal areas and semiarid in the countryside. Its Human Development Index (IDH) is 0.673, considered medium in the total IDH range when compared with other states of Brazil. However, its Gini Index is 0.62, which demonstrates the high inequality and vulnerability of the population. Residents of the state are 48.1% male and 51.9% female, and 70% are ages 15–64 years old. The data were obtained from the Brazilian Institute for Geography and Statistics (IBGE) [21].

Georeferencing spatial analysis

Individual addresses of patients with clinically proven sporotrichosis were obtained from medical records and used for georeferencing analysis. Free Google Earth Pro software was applied for the identification of latitude and longitude parameters. The Latlong online geographic tool (www.latlong.net) was used for insert coordinates of each patient's address in a shapefile of Pernambuco. Digital localization was displayed on a map and marker point centers were used to indicate locations. This shapefile is used in geographic information system (GIS) environments. The map showed the absolute frequency of cases in the municipalities of Pernambuco.

Statistics

The tables describe qualitative variables, and statistical analyses were performed using absolute and relative frequencies. Quantitative variables were assessed using mean and standard deviation. The calculation regarding the increase in cases was carried out using a simple mathematical rule of three, with 1 March 2017 as a starting point.

Results

The expansion and growth trend of sporotrichosis in Pernambuco between 1 March 2017 and November 30th, 2019 are shown in Table 1 & Figure 2, respectively. During this time, the Dermatological Service at the HC/UFPE reported 179 cases of sporotrichosis confirmed by fungal culture. In 2018, an increase of 163% in the number of sporotrichosis cases compared with 2017 occurred. The increase was more discreet in 2019, reaching 33.33% in comparison with 2017.

A georeferencing study from these data was carried out to contribute to the understanding of geographical sporotrichosis expansion and zoonotic transmission, as shown in Figure 3. Municipalities of the metropolitan region of the state capital and the coastal areas host the largest number of sporotrichosis cases. The main urban areas affected were the cities of Recife with 46.4% (83/179) of the patients positive, and Olinda with 17.3% (31/179), as summarized in Table 2.

Regarding education, the data confirmed by IBGE, showed that 45.8% (82/179) of patients affected by sporotrichosis finished high school (Table 3). Only 11.7% (21/179) of the patients had a first degree, and this percentage is likely related to the fact that healthcare is carried out by the Brazilian Public Health System, namely SUS, and is sought more by low-income people.

In this study, most patients (91.1%; 163/179) diagnosed with sporotrichosis had previous contact with sick cats through scratching or biting (Table 3). Regarding gender and age, males represented 29.05% (52/179) of the patients and females represented 70.95% (127/179), with an overall average age of 42.7 years (Table 3). Sixty-six percent (119/179) of sporotrichosis patients attended in the Dermatological Service at the HC/UFPE were diagnosed with the lymphocutaneous form, with an average time of 5.5 weeks for seeking medical and therapeutic

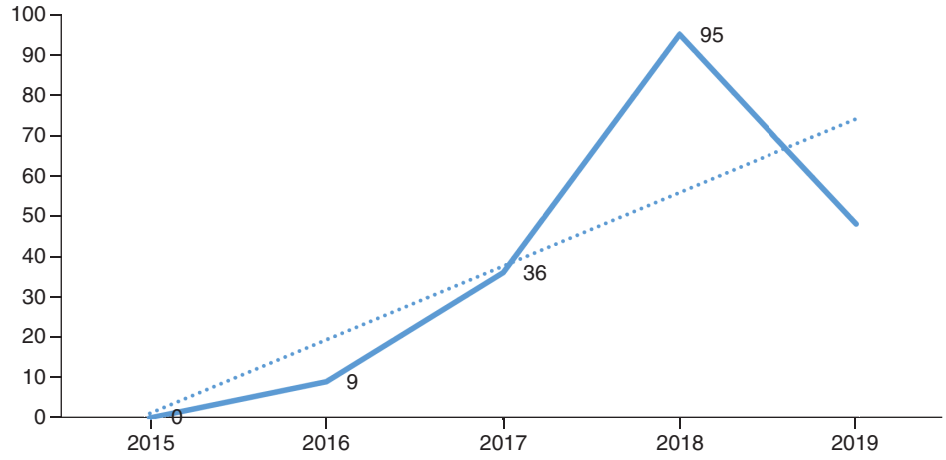

Figure 2. Trendline growth based on human cases of sporotrichosis diagnosed by the Dermatological Service at the Hospital of Clinics/Federal University of Pernambuco (2015–2019).

Table 2. Distribution of human sporotrichosis cases in Pernambuco, according to municipality, from patients attended by the Dermatological Service at the HC/UFPE (2017–2019).

Municipality	Patients (n)	%
Abreu e Lima	4	2.2
Água Preta	1	0.6
Cabo de Santo Agostinho	5	2.8
Camaragibe	19	10.6
Carpina	1	0.6
Igarassu	1	0.6
Ipojuca	1	0.6
Jaboatão dos Guararapes	18	10.1
Olinda	31	17.3
Paulista	13	7.3
Recife	83	46.4
Vitória de Santo Antão	2	1.1

assistance. The fixed form was the second most reported form at 29% (52/179) of cases and consisted of a single lesion without spreading through lymphatic channels. The disseminated form was the least reported, at only 4.4% (8/179). In accordance with current guidelines, most patients received itraconazole (94.97%; 170/179). The antifungal drugs used are summarized in Table 3. All the patients recovered and were discharged.

Discussion

Reported cases of feline sporotrichosis and human outbreaks related to zoonotic transmission were described for the first time in Brazil during 1998 [14,22–24]. Since then, geographical expansion of sporotrichosis has occurred in the whole country [25]. However, many regions only report feline cases, and zoonotic transmission to humans likely goes unnoticed [11]. The number of cases diagnosed at the Dermatological Service/HC/UFPE increased between 2015 and 2018, and the fall thereafter may reflect the decentralization of healthcare for cases of sporotrichosis to the municipal level, which started in mid-2018. Another reason is the One Health approaches implemented by the government of the State of Pernambuco for epizooty control. Even so, expansion continued in the state with a significant emerging trend of human outbreaks.

Socioeconomic issues, poverty, urban agglomeration and poor basic sanitation could be the main causes of expansion and increase in sporotrichosis in Pernambuco, as argued by Gremião *et al.* [20] regarding the endemic area of Rio de Janeiro. In addition, low per capita income is a feature of the population and contributes to the vulnerability of patients with sporotrichosis. According to IBGE, more than half of adults in Brazil have not

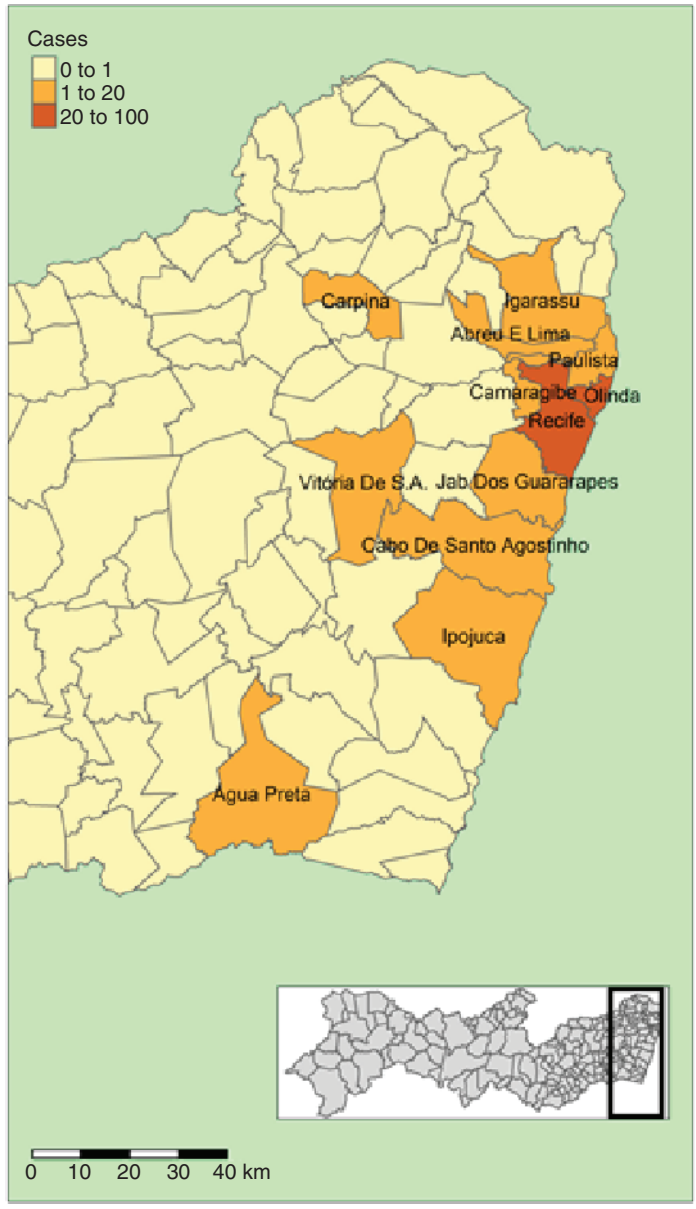

Figure 3. Geographical expansion of sporotrichosis in the state of Pernambuco, northeastern Brazil, according to the home location of patients attended by the Dermatological Service at the HC/UFPE (2017–2019).

completed high school, around 51.2% and equivalent to 69.5 million people [21]. The Brazilian northeast has the worst literacy rates in the country.

Many epidemiological studies show that in some countries sporotrichosis is predominantly associated with agricultural and gardening activities, and men are most affected [1,26]. However, it is important to emphasize that there is considerable variation in world population contexts. For example, in Brazil, the biggest sporotrichosis outbreak started in 1998 in the state of Rio de Janeiro and was related to zoonotic transmission through felines. The vast majority of infections were in women who had contact with domestic cats [14,15,19,20]. The predominance of human sporotrichosis in adult women has been reported by other researchers regarding endemic sporotrichosis in Rio de Janeiro [27,28]. Adult women do household tasks and look after their cats at home, so zoonotic transmission can easily occur. When domestic cats are infected, women are exposed to the disease because they tend to take care of their injuries, and usually clean the cat's sleeping place. They often report having been scratched and bitten in an attempt to offer the animal medication. Another reason that we believe contributes to women being the sex most affected by human sporotrichosis is that, traditionally, they seek medical care more quickly and frequently. On the other hand, men tend to neglect health assistance. However, it is important to highlight that in several studies men who work in gardening and farming were the most affected [29,30].

Table 3. Epidemiological and educational features of human sporotrichosis cases attended by the Dermatological Service at the HC/UFPE, Pernambuco, Brazil, (2017–2019).

Epidemiological data of patients	Patients (n)	%
Sex		
– Female	127	70.95
– Male	52	29.05
Contact with sick cats by scratching or biting	163	91.1
Education		
– Illiterate	4	2.2
– Literate	40	22.3
– Basic education	32	17.9
– High school	82	45.8
– Undergraduate higher education (first degree)	21	11.7
Clinical manifestation		
– Fixed	52	29.05
– Lymphocutaneous	119	66.48
– Disseminated	8	4.47
Average age	–	42.7 years (SD: 17.4)
Average time to seek assistance	–	5.5 weeks
Antifungal therapy		
Itraconazole	170	94.97
Terbinafine	7	3.91
Potassium iodide-saturated solution	1	0.56
Amphotericin B deoxycolate	1	0.56

Sick cats, mainly male, not neutered and strays, can become vectors for humans. Hiding in plants, digging holes and covering their feces with soil, marking territory with their claws on trees, and fighting or playing with each other, are ways in which cats become infected [31]. Furthermore, studies prove the presence of *Sporothrix* spp. not only in the cat's lesions, but also in its oral cavity and nails [32,33]. One hypothesis for the outbreak in northeastern Brazil is environmental characteristics favorable to the growth of the fungus, with average temperatures of 25–27°C and humidity above 80% [20]. Another reason that could help to explain the zoonotic transmission and consequent outbreak of sporotrichosis in Pernambuco is related to tourism. In Pernambuco, there are many attractive beaches for tourists and during the summer season, there is a substantial increase in the local population of these coastal regions. At the end of the summer, many animals are abandoned by visitors, the vast majority without being neutered, which quickly increases the cat population [34].

The species isolated from this study have not yet been identified. However, we expect that most cases will be related to *Sporothrix brasiliensis*, according to some identifications published by our research group [17–19]. Nevertheless, the possibility of the introduction and circulation of different species belonging to the pathogenic clade of *Sporothrix* can be related to the increase in the number of cases in Pernambuco, as observed in Rio de Janeiro. Genomic identifications in further studies must be prioritized.

Several studies point out that the main clinical manifestation of sporotrichosis is the lymphocutaneous form in 80% of cases, and lesions appear from 2 to 4 weeks after trauma, with papulonodular appearance and ulceration tendency associated with the release of purulent secretion in immunocompetent patients [23–35]. Otherwise, the disseminated form is identified as multiple lesions that appear at the same time, and usually affects immunosuppressed patients [26,27]. However, our research group has documented disseminated sporotrichosis cases in immunocompetent individuals as a result of contact with cats [17–19]. The frequency in the current findings is in accordance with several epidemiological studies [1,29–31,36].

The prevalence of the lymphocutaneous form within the Brazilian population may be related to certain factors, such as the size and depth of the inoculum transmitted by cats' scratches or bites, the strain's resistance to heat and the host's immune response. Mackinnon *et al.* [37] point out the influence of climate on the appearance of one clinical manifestation over the other. In their study, Uruguay, México and the USA presented incidences of the lymphocutaneous form greater than 80%, while in Colombia and Venezuela fixed forms predominated. This suggests that variations in temperatures may have an influence on sporotrichosis, and high temperatures can inhibit fungal growth, or at least its spread. However, no seasonal difference has been described by other researchers [38].

Conclusion

This work is the first to retrospectively describe the geo-epidemiological characteristics of sporotrichosis in the state of Pernambuco, Brazil. Much work remains for a complete epidemiological view of sporotrichosis in the state and georeferencing data should be improved. However, this study is a pioneer in demonstrating the spread of sporotrichosis in humans, primarily transmitted by sick domestic cats. In some aspects, we find similarities with other studies performed in Brazil. For example, the current data demonstrate that women are the most affected by sporotrichosis, and the main clinical manifestation is the lymphocutaneous form. Moreover, the increase in cases in the region occurred due to zoonotic transmission, similar to the situation in the state of Rio de Janeiro, Brazil, and the time to seek assistance was an average 5.5 weeks between contact with the fungus and clinical diagnosis at the Dermatological Service. Itraconazole has been widely used due to its known safety and effectiveness in the treatment of sporotrichosis and its availability in the public health system in Pernambuco. In addition, healthcare decentralization for diagnosis and treatment, and the achievement of One Health approaches for epizooty control have been important public health measures taken by government institutions. Lastly, animals abandoned by their owners and tourists in coastal areas are another reason for the increase in sporotrichosis cases in Pernambuco.

Future perspective

The authors believe that northeastern Brazil is the newest sporotrichosis hotspot, and only two out of nine states in this region have included sporotrichosis as a notifiable disease. From our point of view, the clinical-epidemiological status of sporotrichosis will be better clarified in the future, and this study will have been a pioneer in establishing profiles and providing georeferencing data, which may help improve sanitary measures by public health authorities. Furthermore, we emphasize the importance of antifungal susceptibility-focused research which will increase in the next few years to improve management of the disease, mainly in cases of the disseminated and atypical forms.

Summary points

- This work is the first study of a sporotrichosis epidemic in northeastern Brazil with an increase of 163% between 2017 and 2018.
- The first-line drug chosen for treatment was itraconazole in almost 95% of cases.
- The inclusion of human sporotrichosis in the notifiable diseases list in 2015 has not been enough to control the spread of this disease.
- Ninety-one percent of patients reported previous contact with cats.
- A comprehensive sporotrichosis control program involving human and animal cases is mandatory to solve this issue.
- Updates on sporotrichosis outbreaks that are ongoing in other northeastern states are needed to help set a national public health policy.

Author contributions

CE Silva: The acquisition, analysis or interpretation of data for the work; final approval of the version to be published. Accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. CA Tibúrcio Valeriano: The acquisition, analysis or interpretation of data for the work; final approval of the version to be published. CE Ferraz: The acquisition, analysis or interpretation of data for the work; drafting the work and revising it critically for important intellectual content; final approval of the version to be published; accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. R Pereira Neves: Drafting the work and revising it critically for important intellectual content; final approval of the version to be published. MM Evangelista Oliveira: Substantial contributions to the conception and design of the work; drafting the work and revising it critically for important intellectual content; final approval of the version to be published. JC Alves de Lima e Silva: Substantial contributions to the conception and design of the work; drafting the work and revising it critically for important intellectual content; final approval of the version to be published. V Magalhães: Drafting the work and revising it critically for important intellectual content; final approval of the version to be published R Gonçalves de Lima Neto: Substantial contributions to the conception and design of the work; drafting the work and revising it critically for important intellectual content; final approval of the version to be published. Accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

Acknowledgments

The authors wish to thank the Dermatological Service from the Hospital of Clinics at the Federal University of Pernambuco, the reference health service in sporotrichosis in the state of Pernambuco, for providing the patient data.

Financial & competing interests disclosure

This research was partially funded by the Fundação de Amparo a Ciência e Tecnologia do Estado de Pernambuco – FACEPE (grant APQ-0295-2.12/20). R Gonçalves de Lima-Neto is a fellow researcher by the CNPq/MCTI/Brazil (grant 310822/2018-1). The authors have no other relevant affiliations or financial involvement with any organization or entity with a financial interest in or financial conflict with the subject matter or materials discussed in the manuscript apart from those disclosed.

No writing assistance was utilized in the production of this manuscript.

Ethical conduct of research

The authors state that they have obtained appropriate institutional review board approval from the Committee of Ethics in Research for all human experimental investigations. In addition, informed consent has been obtained from the participants involved. All patients agreed to sign an informed consent after the dermatologist doctor had explained the research objectives to them.

Reference

Papers of special note have been highlighted as: • of interest; •• of considerable interest

1. Chakrabarti A, Bonifaz A, Gutierrez-Galhardo MC, Mochizuki T, Li S. Global epidemiology of sporotrichosis. *Med. Mycol.* 53(1), 3–14 (2014).

• **Important considerations concerning the current epidemiology of sporotrichosis in the world.**

2. Rasamoelina T, Maubon D, Raharolahy O *et al.* Sporotrichosis in the highlands of Madagascar, 2013-2017. *Emerg. Infect. Dis.* 25(10), 1893–1902 (2019).

3. Grisolia JC, Santos LA, Coelho LML *et al.* Seroepidemiological survey on sporotrichosis-infection in rural areas of the south of Minas Gerais State, Brazil. *Brazilian J. Microbiol.* 52(1), 41–47 (2021).

4. Zhang Y, Hagen F, Stielow B *et al.* Phylogeography and evolutionary patterns in *Sporothrix* spanning more than 14,000 human and animal case reports. *Persoonia Mol. Phylogeny Evol. Fungi.* 35(1), 1–20 (2015).

5. Etchecopaz AN, Lanza N, Toscanini MA *et al.* Sporotrichosis caused by *Sporothrix brasiliensis* in Argentina: case report, molecular identification and *in vitro* susceptibility pattern to antifungal drugs. *J. Mycol. Med.* 30(1), 100908 (2020).

6. Bonifaz A, Tirado-Sánchez A. Cutaneous disseminated and extracutaneous sporotrichosis: current status of a complex disease. *J. Fungi* 3(6), 1–13 (2017).

7. Marimon R, Cano J, Gené J, Sutton DA, Kawasaki M, Guarro J. *Sporothrix brasiliensis*, *S. globosa*, and *S. Mexicana*, three new *Sporothrix* species of clinical interest. *J. Clin. Microbiol.* 45(10), 3198–3206 (2007).

8. Rodrigues AM, Cruz Choappa R, Fernandes GF, de Hoog GS, de Camargo ZP. *Sporothrix chilensis* sp. nov. (Ascomycota: ophiostomatales), a soil-borne agent of human sporotrichosis with mild-pathogenic potential to mammals. *Fungal Biol.* 120(2), 246–264 (2016).

9. Valeriano CAT, de Lima-Neto RG, Inácio CP *et al.* Is *Sporothrix chilensis* circulating outside Chile? *PLoS Negl. Trop. Dis.* 14(3), 1–11 (2020).

•• **First description of *Sporothrix chilensis* in Brazil, and second description in the world.**

10. Marimon R, Genè J, Cano J, Guarro J. *Sporothrix luriei*: a rare fungus from clinical origin. *Med. Mycol.* 46(6), 621–625 (2008).

11. Rodrigues AM, Della Terra PP, Gremião ID, Pereira SA, Orofino-Costa R, de Camargo ZP. The threat of emerging and re-emerging pathogenic *Sporothrix species*. *Mycopathologia* 185(5), 813–842 (2020).

• **Important considerations regarding the current knowledge of the taxonomy, ecology, prevalence and molecular epidemiology due to *Sporothrix* pathogenic species.**

12. Lopes-Bezerra LM, Mora-Montes HM, Zhang Y *et al.* Sporotrichosis between 1898 and 2017: the evolution of knowledge on a changeable disease and on emerging etiological agents. *Med. Mycol.* 56, S126–S143 (2018).

13. Gutierrez-Galhardo MC, Freitas DFS, do Valle ACF, Almeida-Paes R, de Oliveira MME, Zancopé-Oliveira RM. Epidemiological aspects of sporotrichosis epidemic in Brazil. *Curr. Fungal Infect. Rep.* 9(4), 238–245 (2015).

14. Pereira SA, Gremião IDF, Kitada AAB, Boechat JS, Viana PG, Schubach TMP. The epidemiological scenario of feline sporotrichosis in Rio de Janeiro, State of Rio de Janeiro, Brazil. *Rev. Soc. Bras. Med. Trop.* 47(3), 392–393 (2014).

• **Important considerations concerning the role of sick cats in the zoonotic transmission of sporotrichosis.**

15. Rodrigues AM, de Melo Teixeira M, de Hoog GS *et al.* Phylogenetic analysis reveals a high prevalence of *Sporothrix brasiliensis* in feline sporotrichosis outbreaks. *PLoS Negl. Trop. Dis.* 7(6), e2281 (2013).

16. Silva GM, Howes JCF, Leal CAS *et al.* Surto de esporotricose felina na região metropolitana do Recife. *Pesqui. Veterinária Bras.* 38(9), 1767–1771 (2018).

17. Lacerda Filho AM, Cavalcante CM, Da Silva AB *et al.* High-virulence cat-transmitted ocular *Sporotrichosis*. *Mycopathologia.* 184(4), 547–549 (2019).

•• **First description of zoonotic sporotrichosis in Pernambuco, Northeast Brazil.**

18. Valeriano CAT, Ferraz CE, Oliveira MME *et al.* Cat-transmitted disseminated cutaneous sporotrichosis caused by *Sporothrix brasiliensis* in a new endemic area: case series in the northeast of Brazil. *JAAD Case Reports.* 6(10), 988–992 (2020).

•• **First description of disseminated sporotrichosis in Pernambuco, Northeast Brazil.**

19. Lima IMF, Ferraz CE, Lima-Neto RG, Takano DM. Case report: sweet syndrome in patients with sporotrichosis: a 10-case series. *Am. J. Trop. Med. Hyg.* 103(6), 2533–2538 (2020).

•• **First description of acute febrile neutrophilic dermatosis (Sweet syndrome) in sporotrichosis patients in Brazil.**

20. Gremião IDF, Marques M, Oliveira E, de Miranda LHM, Freitas DFS, Pereira SA. Geographic expansion of sporotrichosis, Brazil. *Emerg. Infect. Dis.* 26(3), 621–624 (2020).

• **Important considerations about geographic expansion of zoonotic sporotrichosis in Brazil.**

21. Brazil, Ministry of Economy, Brazilian Institute for Geographs and Statistics (IBGE). *Brazil in Figures* 27, 1–480 (2019)

22. Barros MB, Schubach AO, Schubach TMP, Wanke B, Lambert-Passos SR. An epidemic of sporotrichosis in Rio de Janeiro, Brazil: epidemiological aspects of a series of cases. *Epidemiol. Infect.* 136(9), 1192–1196 (2008).

23. Lyon GM, Zurita S, Casquero J *et al.* Population-based surveillance and a case-control study of risk factors for endemic lymphocutaneous sporotrichosis in Peru. *Clin. Infect. Dis.* 36(1), 34–39 (2003).

24. Schubach TMP, Schubach A, Okamoto T *et al.* Evaluation of an epidemic of sporotrichosis in cats: 347 Cases (1998–2001). *J. Am. Vet. Med. Assoc.* 224(10), 1623–1629 (2004).

25. Brandolt TM, Madrid IM, Poester VR *et al.* Human sporotrichosis: a zoonotic outbreak in Southern Brazil, 2012–2017. *Med. Mycol.* 57(5), 527–533 (2019).

26. Oyarce JA, García C, Alave J, Bustamante B. Caracterización epidemiológica, clínica y de laboratorio de esporotricosis en pacientes de un hospital de tercer nivel en Lima-Perú, entre los años 1991 y 2014. *Rev. Chil. Infectol.* 33(3), 315–321 (2016).

27. Lecca LO, Paiva MT, de Oliveira CSF *et al.* Associated factors and spatial patterns of the epidemic sporotrichosis in a high density human populated area: a cross-sectional study from 2016 to 2018. *Prev. Vet. Med.* 176(3), 104939 (2020).

28. Schubach TMP, Valle ACF, Gutierrez-Galhardo MC *et al.* Isolation of *Sporothrix schenckii* from the nails of domestic cats (Felis catus). *Med. Mycol.* 39(1), 147–149 (2001).

29. Macêdo-Sales PA, Souto SRLS, Destefani CA *et al.* Domestic feline contribution in the transmission of *Sporothrix* in Rio de Janeiro State, Brazil: a comparison between infected and non-infected populations. *BMC Vet. Res.* 14(1), 1–10 (2018).

30. Poester VR, Souza A, Isabel M *et al.* Sporotrichosis in Southern Brazil, towards an epidemic? *Zoo. Public Health* 65(7), 815–821 (2018).

31. Duangkaew L, Yurayart C, Limsivilai O, Chen C, Kasorndorkbua C. Cutaneous sporotrichosis in a stray cat from Thailand. *Med. Mycol. Case Rep.* 23(12), 46–49 (2019).

32. da Silva MBT, de Mattos Costa MM, da Silva Torres CC *et al.* Esporotricose urbana: epidemia negligenciada no Rio de Janeiro, Brasil. *Cad. Saúd. Publi.* 28(10), 1867–1880 (2012).

33. Takenaka M, Yoshizaki A, Utani A, Nishimoto K. A survey of 165 sporotrichosis cases examined in Nagasaki prefecture from 1951 to 2012. *Mycoses* 57(5), 294–298 (2014).

34. Orofino-Costa R, Rodrigues AM, de Macedo PM, Bernardes-Engemann AR. Sporotrichosis: an update on epidemiology, etiopathogenesis, laboratory and clinical therapeutics. *An. Bras. Dermatol.* 92(5), 606–620 (2017).

35. Bonifaz A, Vázquez-González D. Diagnosis and treatment of lymphocutaneous sporotrichosis: what are the options? *Curr. Fungal Infect. Rep.* 7(3), 252–259 (2013).

36. Song Y, Li SS, Zhong SX, Liu YY, Yao L, Huo SS. Report of 457 sporotrichosis cases from Jilin province, northeast China, a serious endemic region. *J. Eur. Acad. Dermatol. Venereol.* 27(3), 313–318 (2013).

37. Mackinnon J, Conti-Diaz I, Gezuele E, Civila E, Luz S. Isolation of *Sporothrix schenckii* from nature and considerations on its pathogenicity and ecology. *Sabouraudia* 7(1), 38–45 (1969).

38. De Lima Barros MB, De Oliveira Schubach A, Francesconi Do Valle AC *et al.* Cat-transmitted sporotrichosis epidemic in Rio de Janeiro, Brazil: description of a series of cases. *Clin. Infect. Dis.* 38(4), 529–535 (2004).