Human-pet Relationship, Pet Abandonment, and Clinical Correlation for Patients Infected with Dermatophytosis of the Glabrous Skin

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ABSTRACT

Objective: The study on human-pet relationship and pet abandonment among dermatophytosis patients is limited. This study aims to review these correlations.

Materials and Methods: A two-year retrospective cross-sectional study was conducted. Case record forms were reviewed for clinical manifestations, fungal identification, human-pet relationships, and changes in the relationships after dermatophytosis diagnosis.

Results: A total of 230 dermatophytosis patients from the Dermatology outpatient clinic, Siriraj Hospital, were included. The mean age was 41.9 ± 19.1 years and 51.3% were female. Among 170 cases with positive fungal culture, zoophilic dermatophytosis from *M. canis* infection was identified in 15.9% which was predominately found in females and manifested as shorter duration of onset, and higher involvement on exposed areas when compared to anthropophilic dermatophytosis. Most (71%) of patients with *M. canis* infection classified themselves as pet-lovers. The relationship with pets had changed after the dermatophytosis diagnosis in 41% of them which was statistically different from 8.8% in non-pet lovers ($P = 0.001$). The overall pet abandonment rate was 26.6%. The abandonment rate was 40.9% among non-pet lovers, while 30.6% was reported among pet lovers.

Conclusion: Zoophilic *M. canis* infection was associated with rapid onset and on predominant-exposed areas. Some pets could be asymptomatic, so identification of the reservoirs of dermatophytosis is important in the treatment process and helps prevent future recurrence. Paying attention to human-pet relationships and pet abandonment is critical. Knowledge about dermatophytosis transmission, and appropriate pet management should be advised to decrease abandonment.

Keywords: Dermatophyte; animals; Trichophyton; Microsporum; pet (Siriraj Med J 2023; 75: 92-98)

INTRODUCTION

Dermatophytosis is a common skin disease affecting humans. Depending on their reservoirs, the causative pathogens are classified into 3 groups: anthropophilic, zoophilic, and geophilic dermatophytes.[1] The anthropophilic dermatophytes are comprised of *Trichophyton rubrum, Epidermophyton floccosum, Trichophyton violaceum, Trichophyton tonsurans, Trichophyton mentagrophytes* var.

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http://dx.doi.org/10.33192/smj.v75i2.260745

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interdigitale etc. The zoophilic dermatophytes consisted of *Microsporum canis, Trichophyton mentagrophytes* var. *mentagrophytes (T. mentagrophytes), Trichophyton verrucosum etc.*[2] Zoophilic dermatophytes are transmitted to humans from animals, which are major reservoirs. These forms of dermatophytosis tend to cause inflammatory infections and atypical skin lesions in humans.[3,4] The causative organisms vary geographically. *M. canis* and *T. verrucosum* are the most common causative pathogens of zoophilic dermatophytosis in Southern European and Arabic countries.[5,6] Moreover, the incidence of superficial skin infections with *M. canis* has significantly increased, suggesting that zoophilic dermatophytosis will eventually become a major health problem.[5-8] Animal specificity has been reported for the zoophilic species of dermatophytes. Cats and dogs, for example, are the main reservoirs of *M. canis*, which is common in Thailand. In tropical countries, people usually wear short sleeves and pants, which may increase the area exposed to infection. Contact between humans and animals is the chief influence in cases of zoophilic dermatophytosis.[9,10] The animal-borne diseases could result in owners abandoning their pets.

The primary objective of this study was to investigate the human-pet relationship and pet abandonment in terms of the former emotional bonds and the psychological consequences after a diagnosis of a fungal infection. In addition, the clinical manifestations of dermatophytosis caused by zoophilic pathogens were also compared with anthropophilic dermatophytes.

MATERIALS AND METHODS

Study design

The study protocol was approved by the Siriraj Institutional Review Board (COA no. Si 564/2017). This was a 2-year, retrospective cross-sectional chart review. All data were recruited from the case record form of the outpatient fungal infection clinic, Department of Dermatology Siriraj Hospital, a tertiary hospital in Thailand, as every patient who visited our clinic was normally asked the questions via face-to-face interviews and then recorded in the case record form. Those patients diagnosed with dermatophytosis were included in this study. The diagnosis had been confirmed by clinical manifestation and mycological laboratory investigations, including potassium hydroxide preparation and/or fungal culture of dermatophytosis. All specimens were obtained from suspected glabrous skin lesions.

The clinical manifestation and history of having pets were reviewed. The relationship between the owners and their pets was described in 4 aspects, including the affection of the owners for their pets before the dermatophytosis diagnosis, the area where the owners let their pets live in the house, the frequency of animal contact, and physical interaction with their pets. The emotional affection for the pets was graded subjectively by the owners as no, minimal, moderate, high, and extreme affection. Those who labeled themselves to have no or minimal affection for pets were grouped as "non-pet lovers", and those labeled to have moderate, high, and extreme affection were "pet-lovers". The areas where the pets live were classified as the bedroom, outdoor, indoor (any other areas out of the bedroom), and a cage. The frequency of animal contact was graded by the owners as never, sometimes, almost every day, and every day. The physical interaction with the pets was categorized as touch, and hug or kiss.

Their relationship with pets changed after the dermatophytosis diagnosis and the management of the pets after the skin infection diagnosis were also routinely recorded in the case record form of our clinic. Pet abandonment was divided into 2 groups: "no abandonment", when the owners showered their pets more frequently and/or took their pets to visit vets, and "abandonment", when the owners never made physical contact with their pets again.

Statistical analysis

Chi-squared and Fisher's exact tests were used to compare the sites of skin lesions and the relationships between the animals and the owners. Logistic regression was used to analyze the factors associated with dermatophytosis. The statistical analyses were performed with the program IBM SPSS Statistics for Windows, version 18 (IBM Corp., Armonk, N.Y., USA). A significance *P* value of 0.05 was used.

RESULTS

Two hundred and thirty patients were included in this study. The mean age was 41.9 ± 19.1 years, with approximately half of the patients being female (51.3%). Among 130 current pet owners, the most common type of pets reported was dogs-only (46.9%), followed by cats-only (19.2%), and both dogs and cats (13.9%). Based on the 170 confirmed fungal cultures, 27 (15.9%) patients were definitely diagnosed with zoophilic dermatophytosis from *M. canis* infection, whereas 143 patients (84.1%) were reported as anthropophilic dermatophytosis. Comparisons of the demographic and clinical data were presented in Table 1. Females (88.9%) accounted for a significantly higher proportion of zoophilic infections from *M. canis* than males (11.1%; $P = 0.006$). In the case of zoophilic infections, the median duration from

TABLE 1. Factors associated with anthropophilic and zoophilic *M. canis* infections.

Factors	Dermatophytes		Crude Odd Ratio (95% CI)	*P* value	Adjusted Odd Ratio (95% CI)	*P* value
	Anthropophilic N = 143	Zoophilic caused by *M. canis* N = 27				
Sex: n (%)						
Female	60 (42.0)	24 (88.9)	11.07 (3.19–38.45)	< 0.001	11.49 (2.02–65.19)	0.006
Male	83 (58.0)	3 (11.1)	1		1	
Age: years ± SD	38.0 ± 18.0	27.9 ±19.2	0.97 (0.95–0.99)	0.011	0.99 (0.95–1.03)	0.564
Having pets: n (%)						
No	74 (54.8)	2 (7.7)	1		1	
Yes	61 (45.2)	24 (92.3)	14.56 (3.31–64.06)	< 0.001	12.31 (2.21–68.66)	0.004
Unknown	8	1				
Sites: n (%)						
Unexposed areas	77 (67.0)	5 (20.0)	1		1	
Exposed areas	38 (33.0)	20 (80.0)	8.11 (2.82–23.26)	< 0.001	6.41 (1.63–25.25)	0.008
Undetermined	28	2				
Duration of onset of lesion: n (%)						
≤ 1 month	56 (39.7)	23 (92.0)	17.46 (3.96–76.97)	< 0.001	14.24 (2.36–85.81)	0.004
> 1 month	85 (60.3)	2 (8.0)	1		1	
Uncertain	2	2				

"Unexposed areas" of glabrous skin is defined as the trunk, upper arms, and upper legs; "exposed areas" of glabrous skin is defined as the face, neck, forearms, and lower legs; "undetermined areas" is defined as non-glabrous skin or thickened and hard keratin, including the palms, soles, hair, and scalp.



Fig 1. Tinea cruris, presenting with well-defined scaly erythematous annular plaques with hyperpigmentation on non-exposed areas. Anthropophilic dermatophyte *T. rubrum* was identified.



Fig 2. Tinea faciei from animal-transmitted infection, presenting with multiple, discrete, well-defined, erythematous annular plaques with excoriation on exposed areas. Zoophilic dermatophyte *M. canis* from her cat was the causative organism.

the onset of symptoms to the hospital-visit date was 10 days IQR (7, 14) which was statistically shorter than that for anthropophilic infections (median 90 days, IQR 30, 365, $P < 0.001$). Zoophilic dermatophytes were found at exposed areas (80%) of the body more than anthropophilic dermatophytes (33%; $P = 0.008$).

The pet and owner relationships were compared between anthropophilic and zoophilic infection, as shown in Table 2. The results demonstrated that the closer their relationship was, defining as the display of most/extreme affection, a high frequency of contact, and behavior of hugging or kissing their own pets, the higher the owners

TABLE 2. Relationship between the pet and patient associated with dermatophyte infections.

Relationships	Dermatophytes		Odds ratio (95% CI)	*P* value
	Anthropophilic N = 143	Zoophilic caused by *M. canis* N = 27		
Affection for the pet, n (%)				
Minimal, none	21 (47.7)	1 (5.0)	1	
Moderate	16 (36.4)	8 (40.0)	10.5 (1.2–92.7)	0.034
Most, extreme	7 (15.9)	11 (55.0)	33.0 (3.6–303.4)	0.002
NA	99	7		
Frequency of contact, n (%)				
Never, sometimes	28 (62.2)	3 (15.8)	1	
Every day, almost	17 (37.8)	16 (84.2)	8.8 (2.2–34.7)	0.002
NA	98	8		
Type of touch, n (%)				
Touch	29 (74.4)	8 (42.1)	1	
Hugging/kissing	10 (25.6)	11 (57.9)	4.0 (1.3–12.7)	0.019
NA	104	8		
Location of the animals, n (%)				
Outdoor	20 (44.4)	4 (21.1)	1	
Indoors (general)	18 (40.0)	11 (57.9)	3.1 (0.8–11.3)	0.095
Indoors (bedroom)	5 (11.1)	4 (21.1)	4.0 (0.7–21.8)	0.109
In a cage	2 (4.4)	0 (0.0)	–	–
NA	98	8		

NA = not available.

took a zoophilic infection risk. The causative organisms were categorized and compared by the patients' gender. As a result, *T. rubrum, T. mentagrophytes* complex, and *M. canis* were the three most common dermatophytes found (53.4%, 26.1% and 11.7%, respectively). More female patients were infected with the zoophilic *M. canis* than males ($P < 0.001$) whereas the anthropophilic *T. rubrum* was mostly found in males ($P < 0.001$).

There were 161 patients with documented data regarding pets. Seventy-six patients (47.2%) did not have pets. The number of patients who had pets in the zoophilic dermatophytosis disease group (92.3%) was significantly higher than those with anthropophilic dermatophytosis (45.2%; $P = 0.005$). Dermatophyte species isolated from the owners of many kinds of pets were demonstrated in Table 3. It was also found that 61.9% of the patients infected with *M. canis* reported that their pets got hair loss or skin inflammation.

After the diagnosis of dermatophytosis, the overall patients reported showering their pets more frequently was 60.7%, took their pets to visit the vet 16.1%, and never made physical contact with their pets again 23.2%. Sixty-one patients were classified as pet-lovers who reported their status change with pets. Twenty-five of them (41.0%) reported that the relationship with pets changed after the dermatophytosis diagnosis which was statistically different from 8.8% in non-pet lovers ($P = 0.001$), as shown in Table 3. One of the factors which contributed to these significant changes in the relationship might be due to the management of pets after the diagnosis. The patients who classified themselves as pet lovers took their pets to visit the vet more than those non-pet lovers. As a result, non-pet lovers demonstrated a 40.9% abandonment rate while the abandonment rate of pet-lovers was only 30.6% ($P = 0.421$). Overall recurrence rate was 24.7%, and pet-lovers (17.5%) had a significantly lower rate than non-pet lovers (38.2%; $P = 0.024$).

DISCUSSION

Similar to the previous study, *T. rubrum* was found to have the highest prevalence, followed by *T. mentagrophytes* complex and *M. canis*.[11] Dermatophyte

TABLE 3. Behavior of owner after the diagnosis of dermatophytosis.

Management after diagnosis of dermatophytosis	Affection with pet		*P* value
	Pet-lover	Non-pet lover	
Relationship with pets changed, n (%)	(N= 61)	(N=34)	0.001
Yes	25 (41.0)	3 (8.8)	
No	36 (59.0)	31 (91.2)	
Management of pets, n (%)	(N= 37)	(N=22)	0.003
Shower pets more frequently	9 (24.3)	12 (54.5)	
Took pets to visit the vet	17 (45.9)	1 (4.5)	
Never made any more physical contact	11 (29.7)	9 (40.9)	
Abandonment of pets, n (%)	(N= 36)	(N= 22)	0.421
Yes	11 (30.6)	9 (40.9)	
No	25 (69.4)	13 (59.1)	
Recurrence, n (%)	(N= 63)	(N=34)	0.024
Yes	11 (17.5)	13 (38.2)	
No	52 (82.5)	21 (61.8)	

infections transmitted via animals are common. Nowadays, dermatophytosis transmitted by pets and livestock through contact is likely to affect children and young adults.[12] Zoophilic dermatophytes are considered to be causative pathogens, especially *M. canis*, of which cats and dogs are the main reservoirs.[12-18] In this study, 92.3% of the patients infected with *M. canis* owned pets. Among these pets, the majority were reported to be symptomatic, but not all of them. As reported in previous studies, the infected pets could be totally asymptomatic.[19] The correlation between zoophilic infections and the factors of sex and age depends on the dermatophyte species and the type of animal, such as a pet or livestock.[5,20] Female owners had the highest prevalence of zoophilic dermatophytosis, correlated with previous studies.[21] In addition, the more intimacy between patients and their pets, the more chance patients would be infected with zoophilic *M. canis*, as this current study showed that pet-lovers were significantly closer to their pet than non-pet lovers, and *M. canis* was also found significantly in them. In the current study, the owners of cats-only had a significantly higher prevalence of *M. canis* (60.0%) than those with dogs-only (11.4%), with $P < 0.001$. This corresponds well with the previous study: cats infected by *M. canis* caused significant environmental contamination, shedding viable, airborne, fungal elements.[16,22] Dogs have been reported to play a lesser role in the environmental spreading of *M. canis*, contaminating surfaces but never the air.[13,23,24]

Previous studies have investigated the relationship between causative pathogens and tinea infections. *T. rubrum* was found to predominately cause tinea corporis, tinea cruris, and tinea pedis, whereas *M. canis* commonly caused tinea capitis because exposed areas (such as the scalp, beard, face, and arms) are prone to zoophilic dermatophyte infection.[21,25] As with our investigation, those findings demonstrated significant correlations between exposed areas and zoophilic dermatophytosis, and between unexposed areas and anthropophilic dermatophytosis.

The research on the human-animal relationship in patients with zoophilic dermatophytosis was limited. Most patients (70.5%) showed no changes in the human-pet relationship after the diagnosis of an animal-transmitted infection. However, the relationship status was influenced by how the patients behaved with their animals. The change in relationship rate for non-pet lovers was significantly lower than those of pet lovers. It may be due to self-awareness and knowledge of the infection in pet-lovers. They had a better understanding of the transmission of zoophilic infections so they kept more distance between themselves and their pets, as shown in the recurrence rate of pet-lovers which was less than non-pet lovers. Therefore, it is essential for patients to be educated that zoophilic dermatophytosis is curable,[26] and the level of awareness of animal abandonment should be raised. Treatment of pets by veterinarians is needed because the infected pets are reservoirs of dermatophytes and can spread the infection to both humans and other pets.

The study had several limitations. Firstly, since this was a retrospective chart review, some data were incomplete or derived from recall histories. Secondly, Because *T. mentagrophytes* complex is a species complex consisting of 5 species, including *T. interdigitale* as the anthropophilic species and *T. mentagrophytes* as the zoophilic species, the diagnosis can be ambiguous due to phenotypic variations. The molecular technique that helps to differentiate *T. interdigitale* from *T. mentagrophytes* was not routinely used to reveal the identity of the causative species. They were therefore grouped as *T. mentagrophytes* complex and were included only in the descriptive analysis of the prevalence of the dermatophyte species. Regarding sample size calculation, it was calculated based on prevalence of zoophilic dermatophytosis among those with dermatophytosis. However, sample size of subgroup population was not evaluated. Finally, fungal cultures from the pets were not obtained to prove the causative relationship.

In summary, the nature of the relationship between the patients and the pets was the chief influence in the type of dermatophytosis. Dermatologists should be aware that zoophilic infections can have a rapid onset and mainly affect the exposed body parts. Although some pets were reported to be asymptomatic, identification of the reservoirs of dermatophytosis is important in the treatment process and helps prevent future recurrence. A close relationship between humans and pets is also an important factor that leads to appropriate pet management after diagnosis of zoophilic dermatophytosis, resulting in good treatment outcomes and minimizing the risk of recurrence.

ACKNOWLEDGMENTS

All authors declare that there were no conflicts of interest. We thank Dr. Chulaluk Komoltri for her statistical advice. We also thank Rungsima Kiratiwongwan, MD and Supisara Wongdama, MD, for their kind support.

Conflicts of interest: None declared

Funding sources: This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit-sectors.

REFERENCES

1. Pires CA, Cruz NF, Lobato AM, Sousa PO, Carneiro FR, Mendes AM. Clinical, epidemiological, and therapeutic profile of dermatophytosis. An Bras Dermatol 2014;89(2):259-64.
2. Craddock LN, SM S. Superficial Fungal Infection. In: Kang S, Amagai M, Bruckner AL, Enk AH, Margolis DJ, McMichael AJ, et al., eds. Fitzpatrick's Dermatology, 9th ed: McGraw-Hill, 2019. p. 2927.
3. Weitzman I, Summerbell RC. The dermatophytes. Clin Microbiol Rev 1995;8(2):240-59.
4. Bunyaratavej S, Kiratiwongwan R, Limphoka P, Lertrujiwanit K, Leeyaphan C. Pattern Recognition using Morphologies of Anthropophilic and Zoophilic Dermatophytosis Lesions: Comparison between Final-Year Medical Students and Dermatology Residents. Siriraj Med J 2020;72(6):488-91.
5. Aghamirian MR, Ghiasian SA. Dermatophytoses in outpatients attending the Dermatology Center of Avicenna Hospital in Qazvin, Iran. Mycoses 2008;51(2):155-60.
6. Seebacher C, Bouchara JP, Mignon B. Updates on the epidemiology of dermatophyte infections. Mycopathologia 2008;166(5-6):335-52.
7. Cai W, Lu C, Li X, Zhang J, Zhan P, Xi L, et al. Epidemiology of Superficial Fungal Infections in Guangdong, Southern China: A Retrospective Study from 2004 to 2014. Mycopathologia 2016;181(5-6):387-95.
8. Rashidian S, Falahati M, Kordbacheh P, Mahmoudi M, Safara M, Sadeghi Tafti H, et al. A study on etiologic agents and clinical manifestations of dermatophytosis in Yazd, Iran. Curr Med Mycol 2015;1(4):20-5.
9. Chermette R, Ferreiro L, Guillot J. Dermatophytoses in animals. Mycopathologia 2008;166(5-6):385-405.
10. Havlickova B, Czaika VA, Friedrich M. Epidemiological trends in skin mycoses worldwide. Mycoses 2008;51 Suppl 4:2-15.
11. Bunyaratavej S, Limphoka P, Kiratiwongwan R, Leeyaphan C. Survey of skin and nail fungal infections by subject age among thai adults and the etiological organisms. Southeast Asian J Trop Med Public Health SE 2019;50(6):1118-31.
12. Nenoff P, Handrick W, Krüger C, Vissiennon T, Wichmann K, Gräser Y, et al. Dermatomykosen durch Haus- und Nutztiere. Der Hautarzt 2012;63(11):848-58.
13. Cafarchia C, Romito D, Sasanelli M, Lia R, Capelli G, Otranto D. The epidemiology of canine and feline dermatophytoses in southern Italy. Mycoses 2004;47(11-12):508-13.
14. Halsby KD, Walsh AL, Campbell C, Hewitt K, Morgan D. Healthy animals, healthy people: zoonosis risk from animal contact in pet shops, a systematic review of the literature. PLoS One 2014;9(2):e89309.
15. Katoh T, Maruyama R, Nishioka K, Sano T. Tinea corporis due to *Microsporum canis* from an asymptomatic dog. J Dermatol 1991;18(6):356-9.
16. Mancianti F, Nardoni S, Corazza M, D'Achille P, Ponticelli C. Environmental detection of *Microsporum canis* arthrospores in the households of infected cats and dogs. J Feline Med Surg 2003;5(6):323-8.
17. Shiraki Y, Hiruma M, Matsuba Y, Kano R, Makimura K, Ikeda S, et al. A case of tinea corporis caused by *Arthroderma benhamiae* (teleomorph of *Tinea mentagrophytes*) in a pet shop employee. J Am Acad Dermatol 2006;55(1):153-4.
18. Stull JW, Peregrine AS, Sargeant JM, Weese JS. Household knowledge, attitudes and practices related to pet contact and associated zoonoses in Ontario, Canada. BMC Public Health 2012;12(1):553.
19. Kobwanthanakun W, Bunyaratavej S, Leeyaphan C. Tinea corporis from *Microsporum canis*: A case report in 2 patients from 1 asymptomatic feline. Thai J Dermatol 2018;34(4):299-304.
20. Iorio R, Cafarchia C, Capelli G, Fasciocco D, Otranto D,

GiangasperoA. Dermatophytoses in cats and humans in central Italy: epidemiological aspects. Mycoses 2007;50(6):491-5.
21. Bunyaratavej S, Limphoka P, Kiratiwongwan R, Leeyaphan C. Comparison of patient and clinical differences between superficial skin infections due to *Microsporum canis* and *Trichophyton rubrum*. Southeast Asian J Trop Med Public Health SE 2020;51(1).
22. Limphoka P, Bunyaratavej S, Leeyaphan C. Fingernail onychomycosis caused by *Microsporum canis* in a teenager. Pediatr Dermatol 2021;38(2):524-5.
23. Cafarchia C, Romito D, Capelli G, Guillot J, Otranto D. Isolation of *Microsporum canis* from the hair coat of pet dogs and cats belonging to owners diagnosed with *M. canis* tinea corporis. Vet Dermatol 2006;17(5):327-31.
24. Moriello KA, Coyner K, Paterson S, Mignon B. Diagnosis and treatment of dermatophytosis in dogs and cats.: Clinical Consensus Guidelines of the World Association for Veterinary Dermatology. Vet Dermatol 2017;28(3):266-e68.
25. Ali-Shtayeh MS, Yaish S, Jamous RM, Arda H, Husein EI. Updating the epidemiology of dermatophyte infections in Palestine with special reference to concomitant dermatophytosis. J Mycol Med 2015;25(2):116-22.
26. Bunyaratavej S, Kiratiwongwan R, Suphatsathienkul P, Munprom K, Matthapan L, Supcharoenkul S, et al. Effect of Different Shampoos and Contact Time on *Microsporum canis* Infected Hair: In vitro Model Study. Thai J Dermatol 2020;36(4):150-6.