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RESEARCH ARTICLE

DERMATOPHYTOSIS: ETIOLOGICAL AGENTS AND ASSOCIATED RISK FACTORS

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Abstract

Dermatophytes are fungi that grow and multiply in keratinized tissues (skin, hair and nails) causing infections that are commonly referred to as "Tinea" or "ring-worm". This study was aimed to identify the dermatophytes that commonly isolated from dermatophytoses patients and to study the relationship between dermatophytosis and the risk factors that might associated with dermatophytoses patients in Khartoum State, Sudan. Three hundred samples were collected from patients who were apparently suffering from dermatophytoses. Patients were questionnaired pertaining to age, sex, family history, animal contact, residence, type of infection, season. From the collected specimens, 180 (60%) of cases were positive for isolating of dermatophytes. Tinea corporis was the most common type of dermatophytoses. The sequence of effect factors among patients were shown that : age (11-20), sex (males), chronicity of infection, summer season, animal contact and rural residence were the most parameters that increased the occurrence of the dermatophytoses.

Keywords: Dermatophyte, Tinea, Risk factors of dermatophytoses, Sudan.

1. Introduction:

Dermatophytes are superficial filamentous fungi that invade and feed on keratinized tissues like, skin, hair, and nails, causing an infection [1-3].The group of dermatophytes comprises 52 keratin-degrading species divided into nine genera of which *Trichophyton* (usually affecting skin, hair and nails), *Microsporum* (usually affecting skin, hair) and *Epidermophyton* (usually affecting skin) cause infection in human [4, 5]. These fungi thrive on skin that is warm and moist, but may also survive directly on the outsides of hair shafts or in their interiors [6]. Dermatophytoses are mycoses caused by pathogenic fungi that generally trigger superficial infections in animals and particularly in human [7]. Dermatophytoses infections are often referred to clinically "Tinea" or "ringworm" [8]which is a globe health issue in tropical areas with temperature, humidity, overcrowding, and poor sanitation [9] The dermatophytosis types divided according to site of infections into: Tinea capitis (infection of the head scalp), Tinea cruris (affects the groin area), Tinea corporis (occurs on the body surface), Tinea manuum (limited to the hands),Tinea pedis (occurs in the feet) and Tinea unguium (infects to nails). Dermatophytosis is prevalent in areas with warm, humid climate, and predisposing factors include tight dressing, shoes and frequent exposure to contaminated locker rooms and shower stalls. It most commonly occurs in summer months, in young men, and occlusive footwear [10, 11]. A general predominance of dermatophyte infections in males may be due to inhibition of the fungi in women by progesterone [12], but the particular infecting agents also may affect gender distribution [13].The prevalence of dermatophytes is variable in the different regions of the world and within the same country due to factors such as climate, socioeconomically and hygienic conditions of the population, urbanization, immunological system of the host, fungal characteristics and therapeutic actions [14]. Dermatophytic infections is commonly spread in family members, especially in the case of Tinea capitis and Tinea pedis [3]. Several investigators have shown that animals play an important role in the transmission of dermatophytes [6]. The degree of inflammation depends on the particular fungus and the host response [15, 16]. This study aimed to identify the dermatophytes that commonly isolated from dermatophytoses and to study the relationship between dermatophytoses and some risk factors that might associated with increasing its prevalence of infection in Khartoum, Sudan. Parameters studied were age, sex, family history, exposure to animals, residence, type of infection and season.

2. Materials and Methods

Three hundred patients clinically diagnosed as having Tinea infections and referred to dermatology clinics were mycologically investigated. These cases were classified according to clinical presentation into: Tinea capitis, Tinea pedis, Tinea corporis, Tinea manuum, Tinea unguium and Tinea cruris. A full detailed of questionnaire was designed for each patient with specific emphasis to age, sex, residence, animal exposure, family history of skin diseases, acute or chronic infection depending on the clinical data and recurrence of infection in addition to the date of infection according to the season. The specimens were collected depend on clinical examination of the lesion as suspected infected patients with dermatophytoses [17].The surface of the infected area was first rubbed with a cotton swab impregnated with 70 % ethyl alcohol to remove surface contaminants organisms [18]. Each collected sample was divided into two portions; one portion was used for direct microscopic examination, while the second portion was used for culturing. Parts of the scales and hairs from the active lesions of patients were mounted in a drop of 20 % KOH [19]. After 5 minutes with gentle heating without boiling of the solution, the wet preparation was examined for the presence of fungal elements and their diagnostic morphology [20] . Then the other portion was cultured on Sabouraud's Dextrose Agar supplemented with chloramphenicol and cyclohexamide, the inoculated plates were incubated at 30°C for up to 4-6 weeks and were daily examined for the colony formation [21]. The recovered dermatophyte were identified based on macroscopic and microscopic examination of the culture isolated. The macroscopic examination was based on rate of growth, texture, surface color and reverse color. Microscopic examination was carried out using wet mount method [22]in which a small portion of the colony transferred to a clean slide and mounted with a drop of lactophenol cotton blue, then under high power objective lens seen the hyphea, spores and conidia shape.

3. Results

3.1. *Number and percentage of positive dermatophytes growth from the types of dermatophytosis*

Dermatophytes were recovered from 180 samples constituting (60%) of the total number (table 1). Ninety six cases were identified as Tinea corporis, dermatophytes were isolated from 58 of them representing (60.4%), while Tinea unguium came second as recorded in 74 (24.7%) patients, only 44 (59.5%) cases gave positive isolation of dermatophytes. Tinea capitis came third and recorded in 70 cases, 42 (60%) of them gave positive growth of dermatophytes. Tinea pedis and Tinea manuum were encountered in lower degrees where they were found in 40 and 14 cases, respectively. Only 24 (60%) and 9 (64.3%) of cases showed isolation of dermatophytes respectively. Tinea cruris infection was the lowest where it was found in 6 cases, 3 (50%) gave positive isolation of dermatophytes.

Table (1): Number and percentage of positive growth dermatophytes from the types of dermatophytosis

Dermatophytoses	Number and percentage of cases	Number and percentage of positive dermatophytes growth	Number and Percentage of negative dermatophytes growth
Tinea corporis	96 (32%)	58 (60.4%)	38 (39.6%)
Tinea unguium	74 (24.7%)	44 (59.5%)	30 (40.5%)
Tines capitis	70 (23.3%)	42 (60%)	28 (40%)
TineaPedis	40 (13.3%)	24 (60%)	16 (40%)
Tinea mannum	14 (4.7%)	9 (64.3%)	5 (35.7%)
Tinea cruris	6 (2%)	3 (50%)	3 (50%)
Total	**300**	**180 (60%)**	**120**

3.2. *Number and percentage of isolation of dermatophytes genera from different dermatophytoses patients*

As shown in table (2) the highest number of dermatophytes in Tinea corporis specimens was *Trichophyton* which constitute 36 (62%) of the dermatophytes isolates. Tinea unguium showed isolation of *Trichophyton* as 32 (72.3%). Tinea capitis showed isolation of *Microsprum* as 26 (61.9%) while Tinea pedis showed equal number of *Epidermophyton* and *Trichophyton* as 12 (50%) for each genera. Tinea mannum and Tinea cruris showed isolation of *Trichophyton* as 9 (100%) and 2 (66.7%), respectively. It was clear that, *Trichophyton spp* was the most genus responsible for Tinea infection 106/180 (59%), followed by *Microsporum spp* 45/180 (25%) and *Epidermophyton* as 29/180 (16%).

Table (2): Number and percentage of isolation of dermatophytes genera from different dermatophytosis patients

Dermatophytes genera	Number and percentage of isolations						
	Tinea corporis	Tinea unguium	Tinea capitis	Tinea pedis	Tinea mannum	Tinea cruris	Total
Epidermophyton	3 (5.2%)	12(27.3%)	1 (2.4%)	12(50%)	0	1 (33.3%)	29(16%)
Microsoprum	19(32.8%)	0	26(61.9%)	0	0	0	45(25%)
Trichophyton	36 (62%)	32(72.3%)	15(35.7%)	12(50%)	9 (100%)	2 (66.7%)	106(59%)
Total	**58**	**44**	**42**	**24**	**9**	**3**	**180**

3.3. *Number of different isolated dermatophytes species from dermatophytosis patients*

As shown in table 3, patients that suffering from Tinea corporis showed isolation of tweleve species of dermatophytes. *M. canis* was the highest one as 15/58 followed by *T. soudanense* as 11/58 and *T. verrocosum* as 9/58.Tinea unguium patients showed isolation of seven species of dermatophytes *E. floccosum* and *T. schoenilinii* isolated as 12/44 for each of them which represented half of cases.Tinea capitis patients showed isolation of *M. auoduini* as 9/42 followed by *M. canis* 7/42 and *T. verrucosum* as 5/42. Table 3 also showed that patients suffering from Tinea pedis revealed the isolation of only four species of dermatophytes . *E. floccosum* as 12/24 almost half of the patients showed positive isolation for this dermatophytes , *T. mentagrophytes* and *T. tonsurans* isolates as five for each of them and the lowest one was *T. rubrum* as two from the 24 positive isolates. Tinea manuum patients showed isolation of one species of dermatophytes. *T. mentagrophytes* as 9/9 positive isolates On the other hand, the same table showed isolation of two species of drtmatophytes from patients suffering from Tinea cruris as *T. rubrum* 2/3 and *E. floccosum* 1/3. It obseved that *E. floccosum* (Fig. 1)was the dominant species followed by *T. mentagrophytes* (Fig. 2).

Table (3): Dermatophyte species recovered from spacimens on SDA with chloramphenicole and cyclohexamide at 30°C.

Dermatophytoses / Dermatophytes	Tinea corporis		Tinea unguium		Tinea capitis		Tinea pedis		Tinea mannum		Tinea cruris		Total	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
floccosum	3	5.2	12	6.7	1	0.5	12	50	0	0	1	33.3	**29**	**16**
auoduini	0	0	0	0	9	21.4	0	0	0	0	0	0	**9**	**5**
M. canis	15	25.9	0	0	7	16.7	0	0	0	0	0	0	**22**	**12.2**
M. ferrigineum	0	0	0	0	4	9.5	0	0	0	0	0	0	**4**	**2.2**
M. gypseum	4	6.9	0	0	3	7.1	0	0	0	0	0	0	**7**	**3.9**
M. nanum	0	0	0	0	3	7.1	0	0	0	0	0	0	**3**	**1.7**
concentricum	7	12.1	0	0	0	0	0	0	0	0	0	0	**7**	**3.9**
T. mentagrophytes	3	5.2	7	3.9	2	4.8	5	20.8	9	5	0	0	**26**	**14.4**
T. rubrum	2	3.5	4	9.1	0	0	2	8.3	0	0	2	66.7	**10**	**5.6**
T. schoenleinii	2	3.5	12	27.3	0	0	0	0	0	0	0	0	**14**	**7.8**
T. soudanense	11	19	0	0	3	7.1	0	0	0	0	0	0	**14**	**7.8**
T. tonsurans	1	1.7	3	6.8	3	7.1	5	20.8	0	0	0	0	**12**	**6.7**
T. verrucosum	9	15.5	1	2.3	5	12	0	0	0	0	0	0	**15**	**8.3**
T. violaceum	1	1.7	5	11.4	2	4.8	0	0	0	0	0	0	**8**	**4.4**
Total	**58**	**32.2**	**44**	**24.5**	**42**	**23.3**	**24**	**13.4**	**9**	**5**	**3**	**1.6**	**180**	**100**

Fig.1: E. floccosum

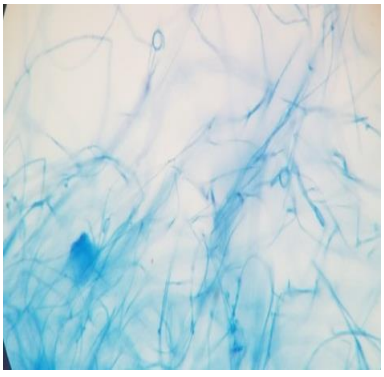

Fig.2: T. mentagrophytes

3.4. *The impact of age groups on the acquiring of dermatophytoses*

As shown in table 4, the highest distribution of dermatophytoses was found in the age group 11-20 years which constituted 27.2 % of the total dermatophytoses. The age group 1-10 years came in the second where 23.9 % of the total dermatophytoses was recorded in this group. On the other hand , the lowest percentage of occurrence of dermatophytoses was recorded in the age group more than 40 years (6.1%).

Table(4): The impact of different age group on the occurrence of dermatophytoses

Age group	Number and percentage of dermatophytoses						
	Tinea corporis	Tinea unguium	Tinea capitis	Tinea pedis	Tinea manuum	Tinea cruris	Total
1-10	20 (34.5%)	10(22.7%)	10(23.8%)	2(8.3%)	1(11.1%)	0	43(23.9%)
11-20	10 (17.2%)	10(22.7%)	19(45.2%)	3(12.5%)	7(77.8%)	0	49(27.2%)
21-30	8(13.8%)	13(29.6%)	8(19.1%)	9(37.5%)	1(11.1%)	0	39(21.7%)
31-40	17(29.3%)	11(25%)	3(7.1%)	6(25%)	0	1(33.3%)	38(21.1%)
>40	3(5.2%)	0	2(4.8%)	4(16.7%)	0	2(66.7%)	11(6.1%)
Total	**58**	**44**	**42**	**24**	**9**	**3**	**180**

3.5. *The impact of different parameters on the occurrence of dermatophytoses*

Results showed that 68.3% of patients that considered positive for the isolation of dermatophytes were in contact with animals, 70.6 % of them came from rural areas and 78.9% of them were suffering from chronic stage of the dermatophytosis infection. On the other hands, it was clear from table (5) that the majority of the positive cases was acquired the infection during summer season as 52.8% of them showed infection in this season followed by autumn season as 27.8%, the least positive isolation was shown in samples collected on winter season (19.4%). Table 5 also showed that 67.8% of patients had no family history of dermatophytoses and 62.2% of the were male.

Table (5): The impact of different parameters on the occurrence of dermatophytoses

Parameters	Number of isolation	Percentage of isolation	Parameters	Number of isolation	Percentage of isolation
Type of dermatophytoses			**Sex**		
-Tinea corporis	58	32.2%	-Male	112	62.2%
-Tinea unguium	44	24.4%	-Female	68	37.8%
-Tinea capitis	42	23.3%	**Family history**		
-Tinea pedis	24	13.3%	-No	122	67.8%
-Tinea mannum	9	5%	-Yes	58	32.2%
-Tinea cruris	3	1.7%			
Exposure to animals			**Residence**		
-Yes	123	68.3%	-Rural	127	70.6%
-No	57	31.7%	-Urban	53	29.4%
Type of infection			**Season**		
-Acute	38	21.1%	-Summer	95	52.8%
-Chronic	142	78.9%	-autumn	50	27.8%
			-winter	35	19.4%

4. Discussion

The studies on Dermatophytoses have received much attention in recent years because of the increasing incidence of the difficult to treat mycotic infections worldwide [23]**.** Dermatophytosis is the most common infectious dermatologic condition throughout the world [24].

In the present study, 60% of samples showed positive culture growth of dermatophytes and this result correlated with [25, 26]**.** The findings of this study according to site of dermatophytosis infection stated that, Tinea corporis was the most common (19.3 %) these findings are comparable to the findings of [23, 26, 27] who found that Tinea corporis was the most common type of dermatophytoses. On the contrary, [28] found that Tinea pedis and Tinea capitis were the most common clinical types of dermatophytses in primary school children. On the other hand, [29] concluded that Tinea corporis and Tinea capitis were the most prevalent clinical presentations identified in their study.

In this study the most frequent isolated dermatophytes genera was *Trichophyton spp.* 106/180 followed by *Microsporum spp*. 45/ 180 then *Epidermophyton* 29 /180. These findings were in agreement with**.** [29] who found that *Trichophyton* was the most common genus isolated from dermatophytoses followed by *Epidermophyton.* On the contrary, [9] in their study found that *Microsporum* was the predominant genus followed by *Trichophyton*. This variation is mainly due to the difference in the geographical distribution of different dermatophytes [29].

In our results, the most frequent species were *E. floccosum, T. mentagrophytes* and *M. canis.* Different results about the etiological agents of dermatophytoses were recorded by different researchers. In this respect, *T. rubrum* was found to be the most common organism causing human dermatophytoses in India [30]. However, [20, 31] found that *T. violaceum* was the most common dermatophyte in Tripoli, Libya and Addis Ababa, Ethiopia. [32] found that *M. canis* and *T. violaceum* were the most frequent dermatophytes isolated in Yemen. [33] reported that *T. rubrum* was the predominant species in Rajkot. [25] and [28] reported that *T. mentagrophytes* as the predominant species in India. [34] found that *T. tonsurans* was the most frequent dermatophytes followed by *M. canis* in Egypt. [26] found that the most common species was *T. mentagrophytes* followed by *T. tonsurans* then *E. floccosum*. while [35] recorded that *T. soudanense and M. cookie* were the most frequent isolated dermatophytes. In this respect, it was clear that the most prevalent species of dermatophytoses differ strikingly from one geographic locality to another and change often from decade to decade [36],

In our findings, *M.canis*, *T. soudanense* and *T. verrucosum* were the main causer of Tinea corporis.

[37] found that *M. canis* was the most common in Tinea corporis patients. In this study, *E. floccosum* and *T. schoelinii* appeared to be the main causer of *Tinea unguium*, [38] recorded that *M. canis* was the main causer for this disease. On the other hand, [32] found that *T. mentagrophytes* and *T. rubrum* were the most causers of *Tinea unguium*. In Tinea capities, *M. audouini and M. canis* were the main causer agent in this study. Variable results were recorded by different researchers in this respect, *T. tonsurans, T. violaceum, T. rubrum and M. canis* were found to be the main causers of tinea capitis by [38]**.** In Tinea manuum, *T. mentagrophytes* proved to be the only causer in our study. [38] found that *T. concentricum, T. soudanense and T. tonsurans* were the main causers of *Tinea manuum*. In *Tinea pedis E. floccosum* was recorded as the main causer for these diseases in this investigation. [32] found that *T. rubrum, T. tonsurans* and *T. mentagrophytes* were the most common in *Tinea pedis* patients while [39] reported that tinea pedis was caused by *T. violaceum* and *M. canis*. During this study, *T. rubrum* was proved to be the main causer of *Tinea cruris*, in this respect. [40] found that *E. floccosum* was the most common in *Tinea cruris* patients, while [41] recorded that *T. rubrum* was the most common in *Tinea cruris* patients. The obtained data disagree with those of [32] who found that *C. albicans* was the most common causative agent of *Tinea cruris*.

In the present study the highest prevalence of dermatophytoses was found in the age group of 11-20 years old (27.2 %). This age group represents age of activity so this group is more exposed to contaminated soil and animals, poor personal hygiene habits and poor environmental sanitation might act as risk factor for occurrence of this fungal disease. In addition, human contact among children is more frequent in this age than in early childhood [42]. In similar studies, [43] found that the age group 11-20 years old was the most susceptible to Tinea infections, whereas [34, 29] recorded that patients below 10 years old were more infected with dermatophytosis. Different results were published by different researchers' all over the world. [44] found that dermatophytosis were most prevalent in patients up to the age of 9 years, while [25, 23] recorded that the maximum number of patients with dermatophytosis was seen in the age group 21 - 30 years old. [26] recorded that dermatophytosis were most prevalent among those aged between 20-40 years.

The present investigation indicated that dermatophytosis were more prevalent in males (62.2 %) than in females (37.8 %). This might be attributed to the fact that males are more exposed to contamination with dermatophytes than female due to more involvement in outdoor activities leading to increased sweating and more proliferation of fungi [45] **,** the lower incidence in females could be attributed to their reluctance to seek medical advice, especially in rural areas where there may be a lack of female doctors or specialists and the results are in agreement with those of [29, 46]. On the other hand, [31] found that females were more frequently infected by dermatophytosis than males. This gender difference was attributed to progesterone as it is thought to play a major role in preventing dermatophyte multiplication *in vitro* [47]**.**

The results of this study showed that there was clear difference in the prevalence of dermatophytosis among patients with no history of skin diseases (67.8 %) and patients who had history of skin diseases (32.2 %), in similar study, [48] found that history of dermatophytosis within family was computed as independently variables associated with dermatophytosis. [49] reported that the infection was considerably high among patients with characteristics involving family history of dermatophytosis.

Our findings showed that high prevalence of dermatophytosis was found in patients who had domestic animals or exposed to them (68.3%), the infection of most patients may be caused by zoophilic dermatophytes. Zoonotic consequences are facilitated by poor compliance with hygiene and health regulations [25], animals serve as reservoirs of the zoophilic dermatophytes [6]. On the other hand, a study from India by [50] reported that an animal contact was not significantly associated with transmission of dermatophytoses. This variation may be due to the difference in the study participants in the culture of relations with pet animals [51].

In this study, high prevalence of dermatophytosis was found in patients who live in rural area (70.6 %) than those who live in urban area (29.4 %). These findings agree with those [52] and [25] Environmental and hygienic differences between urban and rural areas, otherwise people who live in rural area are low socioeconomic group who are unaware of the disease and do not take any treatments so presented with lesions at multiple sites. This also explains the chronicity of lesions in these cases [53]. Moreover, it could be because of their

more involvement in agricultural activities exposing them to animals and adverse weather conditions, less hygiene awareness, neglected early lesions, improper treatment in initial phases of disease [54]. However, [29] recorded that the high prevalence of dermatophytosis was found in urban area. This variation may be due to differences in access to medical care from place to place [55].

The present study clearly showed that chronic infection of dermatophytosis was shown in (78.9%) compared with acute infection (21.1 %). [56] concluded the same results , this finding can be explained that the patients with chronic infections may be have exhausted immune system which enhance exposure to sub-clinical infection carriers in the school and at home. In addition, they may be unable to maintain hygiene, hence prone to repeated and frequent disease [57].

Our findings stated that, patients were more infected by dermatophytosis in summer season as (52.8%) of the samples. Previous studies showed that the high prevalence of dermatophytosis varies according to season or living conditions [58], exposure to high temperature with high humidity may affect in the prevalence of dermatophytosis [59]. [60] found that dermatophytosis occur more commonly in countries with a hot and humid climate.

Conclusion

This study concluded that the type of dermatophytes are differ according to the dermatophytoses and there are risk factors that facilitate the occurrence of dermatophytes.

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مقالة بحثية

مرض الفطريات الجلدية السطحية: العوامل الإمراضية وعوامل الخطورة المصاحبة

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المُلخّص

الفطريات الجلدية هي فطريات تنمو وتتكاثر في الأنسجة المقترنة (الجلد، الشعر، والأظافر) مسببة إصابات يشار إليها عادةً باسم "السعفة" او "الدودة الحلقية". هدفت هذه الدراسة إلى التعرف على الفطريات الجلدية المعزولة بشكل عام عن مرضى الفطريات الجلدية ودراسة العلاقة بين المرض بالفطريات الجلدية وعوامل الخطورة التي قد تترافق مع مرضى الفطريات الجلدية في ولاية الخرطوم، السودان. تم جمع ثلاثمائة عينة من المرضى الذين كانوا يعانون على ما يبدو من مرض الفطريات الجلدية، تم استبيان المرضى حسب العمر، الجنس، التاريخ العائلي، الاتصال بالحيوانات، مكان الإقامة، نوع العدوى، الموسم. من العينات التي تم جمعها، كانت 180 (60%) من الحالات موجبة العزل للفطريات الجلدية. السعفة الجلدية هي أكثر أنواع الفطريات الجلدية شيوعاً. وقد أظهر تسلسل عوامل الخطورة بين المرضى أن: العمر (11-20)، الجنس (الذكور) الإصابات الحادة، في موسم الصيف، ملامسة الحيوانات، والإقامة في الريف هي أكثر العوامل التي أدت إلى زيادة الإصابة بالفطريات الجلدية.

الكلمات المفتاحية: الفطريات الجلدية، السعفة، عوامل خطر الإصابة بالفطريات الجلدية، السودان.

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