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Prevalence of Fungal Infections that isolated from different sites in Diyala Province / Iraq

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Abstract: *Ringworms, also known as superficial and cutaneous mycoses, primarily affect the skin's outermost layer and its appendages, such as hair and nails.* ***Methods****:Two hundred four fungal infections from Dermatologist physician cases that diagnosed by routine tests with various age for both sexes were collected from different sites of Diyala governorate, during the period from March to May 2022.* ***Results****: Dermatophyte infections were the most common, accounting for 44.1% of cases, followed by superficial infections at 34.3%, while opportunistic mycosis constituted 21.5%. Otomycosis was the most common among superficial mycoses, and Tinea capitis was the predominant form of dermatomycosis. Statistical analysis revealed that females had a higher rate of fungal infections (FIs) than males overall. Superficial mycoses were more prevalent in females than in males. Notably, infections to the skin of the hand with Tinea nigra were more frequent in males than females, with highly significant differences (p = 0.01). Regarding age groups, fungal infections were most prevalent in the younger age group (1-10 years), while the older age group (41-50 years) had the least number of infections, showing very high significant differences. Tinea versicolor was common in young people and adults, including teenagers, while Tinea capitis was more frequent in children. The study demonstrated very high significant differences (p = 0.001) in the prevalence of fungal infections based on the area of residence. Ba'aqubah region had the highest rate of fungal infections, accounting for 35.8% of all cases, followed by the Canaan region with a rate of 15.7%, and Bab Al-Darb with 9.8%. The following areas had lower rates: Tahrir, Shafta, Jurf Al-Melh, Al-Khalis, Buhriz, Umm Al-Kerafs, and Al-Mufraq.* ***Inclusion****: Statistical analysis indicated no significant differences between the types of FIs for the same residential area*

.**Keywords*: Dermatomycosis; Opportunistic mycosis; Ringworms; Superficial mycosis, Tenia***

1.Introduction

Most fungi are multicellular eukaryotic organisms found in all environments throughout the world. From fungi visible to the naked eye, such as mushrooms, to microscopic yeasts (unicellular) and molds, they exist in many forms [1]. the fungal kingdom predicted

to includes at least six million eukaryotic species, approximately 625 fungal species have been reported to infect vertebrates, 200 of which can be human associated, either as commensals and members of our microbiome or as pathogens that cause infectious diseases [2].

Despite doubts, funding for research on fungal illnesses is inadequate compared to that allocated for other infectious diseases with similar fatality rates [3]. For instance, records of syphilis, influenza, and Chagas disease date back more than a century [4], while the recognition of invading fungi as significant medical pathogens only occurred in the 1980s [5]. As eukaryotic pathogens, fungi share host cells, which limits the development of antifungal compounds. Moreover, fungal pathogens can undergo morphogenic transformations during infection and affect multiple tissues in a single patient, depending on the host's immune status. These characteristics distinguish fungi from other infections [4].

More than 150 million acute fungal infections occur globally each year, leading to approximately 1.7 million deaths annually. It is concerning that these numbers are consistently on the rise, attributed to various social and medical changes over the past decades that have fueled the spread of fungal infections. Additionally, the prolonged therapeutic application and prophylactic use of antifungal drugs in high-risk patients have facilitated the emergence of (multi)drug-resistant fungi, including the highly virulent Candida strain. Consequently, fungal infections pose an increasingly severe global threat [6].

Fungi spread widely in the environment surrounding humans and cause many diseases and are it still a neglected topic by public health authorities even though most deaths from fungal diseases are avoidable. Serious fungal infections occur as a result of other health problems including asthma, AIDS, cancer, organ transplants, and corticosteroid treatments [1, 7]. Fungal diseases are prevalent and often lead to disease outbreaks, particularly in tropical countries [8]. Fungal infections, or mycoses, are traditionally categorized based on the affected part of the body into superficial, subcutaneous, and systemic types. While non-dermatophyte molds (NDM) can occasionally cause infections, superficial and cutaneous mycoses, commonly known as ringworms, are primarily restricted to the outermost layer of the skin and its appendages, such as hair or nails. The primary causative agents for these mycoses are *Candida* and *Malassezia* species [8, 9].

Superficial fungal infections include common tinea of the skin, such as *Tinea corporis, Tinea cruris*, *Tinea nigra, pedis* and *T. barbae*, yeast infections such as *pityriasis versicolor*. Subcutaneous types include mycetoma and chromoblastoma, which generally affect the tissues in and under the skin [10]. Skin microflora is home to *Malassezia* spp., which are responsible for conditions like seborrheic dermatitis, *Malassezia folliculitis*, and *pityriasis versicolor* (PV) [11].

Candidiasis is caused by *Candida* spp. They vary from superficial infections of the skin and mucous membranes to systemic illnesses that can be fatal [12] Oral thrush, oropharyngeal candidiasis, vaginal candidiasis, cutaneous candidiasis, paronychia, onychomycosis, and chronic mucocutaneous candidiasis are just a few of the clinical symptoms of superficial and cutaneous *Candida* infections [13]. More severe systemic fungal infections include *Cryptococcus*, histoplasmosis, *Pneumocystis pneumonia*, aspergillosis and mucormycosis disease [14]. Dermatophytes, Fungi often cause opportunistic and chronic infections or systemic forms, especially in immunosuppressed individuals [15].

Dermatophytes are classified as geophilic, zoophilic, and anthropophilic fungus based on their typical habitat, Certain zoophilic and

geophilic species have evolved to enter human tissue, while anthropophilic forms are better adapted to infect humans; these species typically affect children and the elderly [9].

Many countries exhibit a high prevalence of *Trichophyton* species, with *T. rubrum* and *T. tonsurans* being the most common causes of tinea corporis (ringworm), tinea unguium (onychomycosis), and tinea capitis (scalp inflammation), respectively [9, 15]. *Trichophyton rubrum* was the most frequently isolated pathogen in numerous regions except the scalp. Over time, new dermatophyte species have emerged, especially *T. benhamiae* [16].

Dermatophyte species are transmitted through direct contact with soil, animals, and infected individuals [17].

Due to the increase of fungal infections around world generally; this study focused on the distribution of superficial and dermatomycoses infections in Diyala governorate in Iraq, to determine which infections are most prevalent and its relation with age groups and linking them with the gender factor, in addition to investigate the spread of fungal infections and their relationship to the patients' residential area in Diyala during 2022.

2. Methodology

Two hundred four infection cases with different age groups (1- 50 years) from both gender were collected from different areas in Diyala governorate, Iraq, it diagnosed as fungal infections from Dermatologist physician during the period from March to May 2022.

Demographic information of the patients were descriptively analyzed and study the distributions of fungal infections according types, age groups, gender and according to patients area. The data were then imported into SPSS and Microsoft Excel for further analysis. To ascertain the association between the demographic variables, a Chi-square test was employed.

1. Results and Discussion

3.1 Distribution of cases according to fungal infections (FIs):

The fungal infections were divided into three basic groups: superficial mycosis, dermatomycosis and opportunistic mycosis each section include more than one infection. Out of 204 case; 90 (44.1%) were diagnosed as dermatophyte infection, followed by superficial infection 70 (34.3%), whereas opportunistic mycosis was 44 with percentage 21.5% (figure 1).

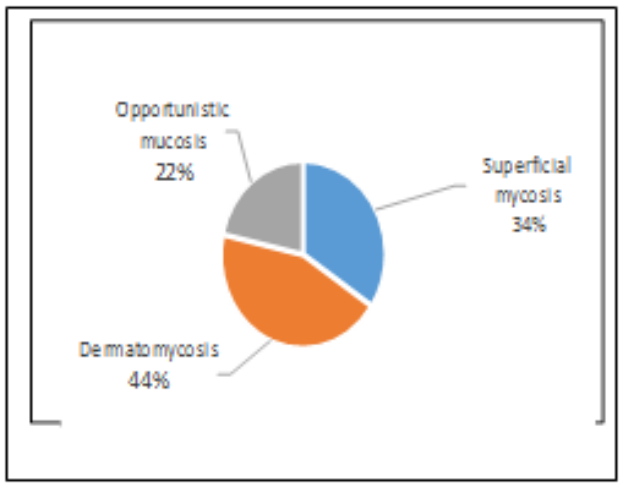

figure 1: Distribution of cases according to fungal infections

Distribution of fungal infections (FI) according to the type of mycosis

this statistical research was classified FIs according to the types of mycosis and included the results in table 1 that show the percentages of each infection.

Table 1: Distribution of fungal infections according to the type of mycosis

Superficial mycosis

The most common and widespread group of mycotic diseases are called superficial infections (SFIs). Each country's reports on the diseases' distribution and causes differ, but the three main clinical categories of SFIs are dermatophytosis, superficial candidiasis, and pityriasis versicolor (tinea versicolor) [15].

Infections		Number (%)
Superficial mycosis	otomycosis	21 (30 %)
	Tinea versicolor	18 (26 %)
	Tinea nigra	16 (23 %)
	white piedra	15 (21 %)
Total		70 (34.3%)
Dermatomycosis	Tinea capitis	29 (32%)
	Tinea corporis	16 (18 %)
	Tinea unguium	17 (19 %)
	Tinea pedis	28 (31 %)
Total		90 (44.1%)
Opportunistic mycosis	Cutaneous candidiasis syndrome / intertrigo	2 (5 %)
	Oral thrush	20 (45 %)
	cutaneous candidiasis/ dipper thrush	22 (50 %)
		44 (21.5%)
Total		204

In this study; SFIs included groups of infections represented by otomycosis, which was the most frequent by 30% of the total 70 (SFI), followed by infections of the surface layer of the skin represented by Tinea versicolor 26%, then Tinea nigra by 23%, while the hair shift infection with White piedra ranked last with 21%. The statistical analysis ($p > 0.05$) displayed that there were no significant differences between the types of SFIs in general as appeared in table 2.

Table 2: Statistical analysis by Chi-square test for superficial infections

SFI	Observed N	Expected N	Residual
otomycosis	21	17.5	3.5
Tinea versicolor	18	17.5	.5
Tinea nigra	16	17.5	-1.5
white piedra	15	17.5	-2.5
Total	70		
Chi-Square	1.200[a]		
df	3		
Asymp.sig.	0.753		

a 0 cells (0.0%) have expected frequencies less than 5. The minimum expected cell frequency is 17.5.

The percentage of SFIs ranges between 20-25% [18]. Fungal surface infections vary by a number of factors such as the geographical area, climate, medical history, wars, quality of health care, poor personal hygiene, artificial nails, metabolic disorders, and biological therapy, in addition to the level of services and social factors for the area [17, 19].

Dermatomycosis

Out of 90 cutaneous infections, 32% were Tinea capitis fallowed by 31%Tinea pedis then Tinea unguium were 19%, whereas 18% were diagnosed as Tinea corporis. Table 3 show that there is no difference between the observed results and the expected results at the 0.05 level of significance. These results were higher than what was reached by [20], who noticed that the

tinea corporis was the highest with a percentage of 62.2% due to differences in the environment and the number of isolates were taken. Dermatomycoses are common and widespread in humans and animals. Individuals of all ages are infected with fungal skin infections, whether they are young or adult men or women. These infections depend on several factors, including the site of infection, the immune response of the host and the type of causative agent in addition to many Other factors such as the rate of movement, travel and lifestyle in general may be affected by the epidemiology of dermatomycoses [21]. According to [22] and consistent with earlier research [7], dermatophytosis was the second most prevalent kind of SFI (34.8%). However, 82%, 74%, and 83.2% of dermatophytosis were found in epidemiologic investigations conducted in China, Turkey, and Germany, respectively [23, 16 and 24].

Table 3: statistical analysis by Chi-square test for dermatomycosis

dermatomycosis	Observed N	Expected N	Residual
Tinea capitis	29	22.5	6.5
Tinea corporis	16	22.5	-6.5
Tinea unguium	17	22.5	-5.5
Tinea pedis	28	22.5	5.5
Total	90		
Chi-Square	6.444[a]		
df	3		
Asymp. Sig. Chi-Square	0.092		

a 0 cells (0.0%) have expected frequencies less than 5. The minimum expected cell frequency is 22.5.

Opportunistic mycoses

Fungal opportunistic infections were recorded as 44 (21.5%) out of 204 case diagnosed as candidiasis, with a total of 22 (50%) out of 44 cases were dipper thrush, followed by oral thrush with a rate of 20 (45%), and the other infection was under the chest area (Cutaneous candidiasis syndrome / intertrigo) and it was at a rate of 5%, the large discrepancy in the rate of the last infection in relation to oral thrush and diaper rash is attributed to the lack of pathological cases taken within the statistical study, statistical analysis show there were significant differences between the observed results and the expected results at the 0.05 level of significance as in Table 4.

Table 4: Statistical analysis by Chi-square test for opportunistic mycoses

infection3	Observed N	Expected N	Residual
Cutaneous candidiasis syndrome / intertrigo	2	14.7	-12.7
Oral thrush	22	14.7	7.3
cutaneous candidiasis/ dipper thrush	20	14.7	5.3
Total	44		
Chi-Square	16.545[a]		
df	2		
Asymp. Sig.	0.000		

a. 0 cells (0.0%) have expected frequencies less than 5. The minimum expected cell frequency is 14.7.

Prevalence of fungal infections by gender

The data of this research collected randomly included both sexes were 87 (42.6%) male and 117 (57.4%) were female, as it was noticed that females had a higher rate of FIs than males in general with significant differences, it also showed that there were significant differences between males and female to the basic groups of mycosis collectively in this study. The superficial mycosis in females were higher than in males, noting that the infections to the skin of the hand with Tinea nigra was more frequent in males

than females with highly significant differences (p = 0.01**), as 11 (68.75%) cases out of 16 were The observed in males compared to 5 (31.25%) for females as appeared inTable 5.

These results are consistent with the previous results, as cases of superficial infection were recorded in France, Italy and China, in that both sexes are equal in terms of infection rate [25]. As for Iran, the incidence of infection in men was more, and this contradicts the current results [26] and reconciles with a study conducted in Chile and South Korea [27, 28].

Rashidian *et al*. [20] demonstrated that out of 139 cases, 26 (18.70%) had mycological confirmation of dermatologophytosis. Men were primarily affected, despite the fact that there was a statistically negligible difference between the male and female patients.

The incidence of tinea cruris, tinea pedis and tinea corporis in male patients was higher than that in female patients [24], it may be related to male physiological structure, more active habits, and exuberant secretion of sweat glands and sebaceous glands, which is more conducive to the growth of dermatophytes.

In the current study; The cause of high white piedra in women may be due to the lack of good ventilation of the hair most of the time for reasons related to wearing the veil (Hijab), the length of the hair, or the failure to dry the hair well, which generates a moist medium suitable for the growth of fungi, as well as the case for dermatomycosis due to lack of exposure to sunlight in addition to the environment humidity.

Table 5: Prevalence of fungal infections by gender

mycosis	Gender		Total	P value
	male	Female		
Superficial mycosis	otomycosis	6 (28.6 %)	15 (71.4 %)	21	0.001***
	Tinea versicolor	6 (33.3)	12 (66.7 %)	18	0.01**
	Tinea nigra	11(68.75%)	5(31.25%)	16	0.01**
	white piedra	5(33.3 %)	10(66.7%)	15	0.05*
total		28 (40%)	42 (60%)	70	
dermatomycosis	Tinea capitis	16(55.2%)	13(44.8%)	29	>0.05
	Tinea corporis	7(43.75%)	9(56.25%)	16	>0.05
	Tinea unguium	8(47.1 %)	9(52.9 %)	17	>0.05
	Tinea pedis	10(35.7%)	18(64.3%)	28	0.05*
total		41 (45.6 %)	49 (54.4 %)		
Opportunistic mycosis	Cutaneous candidiasis syndrome / intertrigo	-	2(100 %)	2	1.00
	Oral thrush	9(45%)	11(55 %)	20	>0.05
	cutaneous candidiasis/ dipper thrush	9(41%)	13(59 %)	22	>0.05
Total		18 (41%)	26 (59%)		
total		87(42.6%)	117(57.4%)	204	0.05*
P value		>0.05	0.05*	0.001***	

3.4 distribution of fungal infections according to the age groups

The age groups were divided into five age groups (mean=10 years within one period). Table 6 shows that the highest percentage of different fungal infections was within the younger age group (1-10) by 30.4%, followed by the age group (21-30) by 28.9%, while the older age group was (41-50) was 4%.

Table 6: Distribution of fungal infections according to the age groups

mycosis		Age groups					Total N (%)	p value
		Children and young persons		Adult				
		1-10	11-20	21-30	31-40	41-50		
Superficial mycosis	otomycosis	0	6	10	5	0	21	p>0.05
	Tinea versicolor	1	6	5	6	0	18	P<0.05*
	Tinea nigra	1	4	11	0	0	16	P<0.001***
	white piedra	2	8	3	1	1	15	P<0.001***
	total	4	24	29	12	1	70	
dermatomycosis	Tinea capitis	15	4	4	6	0	29	P<0.001***
	Tinea corporis	0	3	7	6	0	16	p>0.05
	Tinea unguium	0	2	7	7	1	17	P<0.01**
	Tinea pedis	1	5	12	10	0	28	P<0.01**
	total	16	14	30	29	1	90	
Opportunistic mycosis	Cutaneous candidiasis syndrome / intertrigo	0	0	0	0	2	2	1.00
	Oral thrush	20	0	0	0	0	20	1.00
	dipper thrush	22	0	0	0	0	22	1.00
	total	42				2	44	
	total	62(30.4%)	38(18.6%)	59(28.9%)	41(20.1%)	4(2%)	204(100%)	P<0.001***
	p value	P<0.001***	P<0.05*	P<0.05*	P<0.05*	p>0.05	P<0.05*	

The least number of infections with very high significant differences, which indicates that age has an effect on the predisposition to infection with various fungal diseases as a result of the different physiological factors and the different nature of the body, in addition to the methods of body care and observance of hygiene, different activity and frequent exposure to pathogens.

Tenia versicolor was common in young people and adults in addition to teenagers who were in an immature stage of psychology and physiology, and were more interested in their appearance and how they look. Frequent recurrence of the disease is easy to burden the psyche of young people and has a significant impact on their development.

Tenia capitis was more frequent in children with age group (1-10) which agree with [24] which may be related to children's poor resistance and close contact with pets such as cats and dogs.

These results are consistent with the findings of [29] and [30] who found that the age group 21-30 had the highest incidence, followed by the group 31-40 with a percentage of (24.37 and 23.55%). respectively).

The results of [31] showed that the burden of fungal skin disease was the highest in younger patients, but the prevalence rate was the highest in the elderly population. It also agreed with what was stated by [22], where the study found that group 20-41 is the most frequent fungal infection.

The reason for this is due to the fact that people of these ages engage in various types of activities, which exposes them to innate factors. The reason for the decrease in the percentage to a large extent in the older age group may be due to the small number of samples taken in the study and its incompatibility with the rest of the ages. The high percentage in ages 1-10 was mostly oral infections and diaper rash due to the reason that most of the ages ranged between one year to two years, and as it is known that this group is the most affected group with oral candidiasis due to the use of formula feeding bottles and wearing diapers, In addition to low immunity in young people

So, the Statistical analysis showed that there were significant differences between the basic infection groups collectively with ages as in figure 2

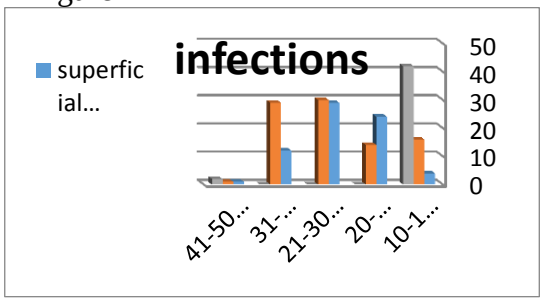

Figure 2: Distribution of the basic infection groups collectively with ages

Prevalence of fungal infections by area of residence

The current study showed that there are very high significant differences (p = 0.001***) in the prevalence of fungal infections according to the area of residence, as the Ba'aqubah region had the highest rate of infections with fungi of all cases with a rate of 73 (35.8%), followed by the Canaan region with a rate of 32 (15.7%), then Bab Al-Darb 20 (9.8%), then Tahrir, Shafta, Jurf Al-Melh, Al-Khalis, Buhriz, Umm Al-Kerafs, and then Al-Mufraq (see Table 7).

While there were no significant differences between the types of FIs for the same residential area, the differences ranged between the significant up to the very high significant for the single infection type according to the area of residence.As a result of the lack of studies on the prevalence of fungal infections in Diyala Governorate, it was found difficult to compare and interpret the results of the differences. This statistical study conceder the first in the governorate

Most likely, the reason for its spread in the city of Ba'aqubah is due to overcrowding and frequent contact with shops, markets and restaurants, which leads to the transmission of some diseases that are transmitted by direct contact through contact or the spread of scales in relation to superficial infections. As for its spread in the kanaan region, it is attributed to the fact that the region is one of the areas with poor infrastructure that helps the spread of diseases, as well as being one of the areas that contain irregular poultry and sheep and cattle sheds, as is the case with the rest of the regions. The spread of fungal infections is generally attributed to the large presence of domestic animals, sheep and livestock, in addition to loose dogs and cats that are hosts and vectors of fungi that cause diseases and fungal infections, and that agree with [17] That reported; pathogens that causes fungal infections are transmitted through soil, animals and infected persons.

Table 7: Prevalence of fungal infections by area of residence

	mycosis	Living area											
		Ba'aquba h	AL_Tahrir	Shafta	AL_ Mufr aq	Buhriz	Al-kh alis	Bab aldarb	Om alker afs	Jurf almel h	Kana an	to tal	P value
Superficial mycosis	otomycosis	5	2	2	1	2	0	2	1	2	4	21	>0.05
	Tinea versicolor	4	0	1	1	2	0	3	1	2	4	18	0.05*
	Tinea nigra	1	0	2	0	1	0	5	1	2	4	16	0.05*
	white piedra	2	0	1	0	2	0	3	2	2	3	15	0.01**
Total		12	2	6	2	7	0	13	5	8	15	70	
Dermatomycosis	Tinea capitis	14	2	1	1	0	0	3	1	2	5	29	0.001***
	Tinea corporis	5	2	1	1	0	1	2	0	1	3	16	0.05*
	Tinea unguium	7	2	0	0	0	2	1	1	0	4	17	0.01**
	Tinea pedis	12	3	1	0	2	2	1	1	1	5	28	0.001***
Total		38	9	3	2	2	5	7	3	4	17	90	
Opportunistic mycosis	Cutaneous candidiasis syndrome / intertrigo	2	0	0	0	0	0	0	0	0	0	2	1.00
	Oral thrush	11	3	0	0	0	6	0	0	0	0	20	0.001***
	cutaneous candidiasis/ dipper thrush	10	4	5	2	1	0	0	0	0	0	22	0.01**
total		22	7	5	2	1	6	0	0	0	0	44	
Total of totals		73(35.8%)	18(8.8%)	14(6.9%)	6(2.9%)	10(4.9%)	11(5.4%)	20(9.8%)	8(3.9%)	12(5.9%)	32(15.7%)	204(100%)	0.001***

Conclusions

This study concludes that Dermatophyte infections, particularly *Tinea capitis*, were the most common infections in Diyala Province, Iraq. The prevalence of superficial mycosis was higher in females compared to males. Additionally, it was observed that the younger age group exhibited the highest prevalence of fungal infections. Furthermore, the distribution of fungal infections was found to be influenced by the region, with Ba'aqubah region having the highest rate of infections.

Conflict of Interest

The authors declare that there are no conflicts of interest regarding the publication of this manuscript

Ethical consideration Approval

The authors decelerate that this study got the approval from Biotechnology Department, Collage of Science, and Department of Animal Production, Collage of Agriculture, University of Diyala.

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