

Prevalence and Factors Associated with Tinea Pedis and Tinea Unguium among Diabetic Patients in Saudi Arabia

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ABSTRACT

Background: Chronic hyperglycemia in diabetes mellitus impairs cellular immunity, phagocytic activity, and polymorphonuclear leukocyte function, resulting in a higher incidence of cutaneous fungal infections with more severe clinical manifestations.

Objective: This paper aimed to evaluate the prevalence and factors associated with tinea pedis and tinea unguium among diabetic patients.

Methodology: AA descriptive cross-sectional study was conducted among Saudi adults aged 18 and above from all the regions of Saudi Arabia. Data were collected conveniently via structured questionnaires. Factors associated with the incidence of tinea unguium and tinea pedis were identified through Pearson's chi-square test, and univariate and multivariate logistic regression analysis with p-value < 0.05 considered statistically significant.

Results: We included 2,952 participants, with 52% being female, 56.4% type 1 diabetes, and 41.3% aged 18-30 years. Around 61% were unaware of tinea pedis, 15.1% reported a previous diagnosis of tinea pedis. Younger individuals (18–30 years) and unmarried participants showed higher infection rates, while normal Body Mass Index (BMI) individuals were more affected compared to obese participants. Pet ownership and participation in sports such as swimming and basketball were significant risk factors. Immunosuppressive therapy and peripheral vascular disease increased risk. Regular nail trimming was protective, whereas sock use was associated with an increased risk; frequent foot inspection was also linked to higher infection rates.

Conclusions: Tinea pedis and tinea unguium were prevalent among type 1 diabetes patients with poor glycemic control. Adopting better foot care and diabetes management practices can be helpful in reducing these infections.

Keyword: Tinea pedis, Tinea unguium, Diabetes mellitus, Saudi Arabia, Prevalence, Fungal infection.

Introduction

Diabetes mellitus is considered the most prevalent and significant chronic metabolic disease, defined by persistently high blood sugar levels.

According to the World Health Organization (WHO) data, Saudi Arabia is the second in the Middle East and seventh in the world based on the prevalence rate of diabetes mellitus, with an increasing pattern observed

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recently [1,2]. Skin disorders are common among diabetic patients. Due to vascular and immune compromises, they remain more susceptible to tinea pedis. There is a wide variation in the prevalence of dermatological conditions, ranging between 51.1% and 97% [3]. In KSA, more than 50% of diabetic patients were also infected with tinea pedis, commonly known as athlete's foot [5,6]. Onychomycosis of the nail is caused by dermatophytes called tinea unguium, the most prevalent fungal infection in diabetic patients [7]. Several factors are associated with fungal infection, such as obesity, insufficient diabetic foot care, uncontrolled blood glucose, and peripheral vascular disease [8]. Moreover, onychomycosis and tinea pedis are strong predictors for developing foot ulcers [10]. The aim of this study was to evaluate the prevalence and factors associated with tinea pedis and tinea unguium among diabetic patients.

Methods

Study Design and Population: A descriptive cross-sectional study was conducted from April to December 2024 among Saudi diabetic adults across all regions of Saudi Arabia. The study was approved by the Scientific Research Ethics Committee at Al-Baha University (IRB: IRB/MED/BU-FM/2024/119). Informed consent was obtained from all participants. Inclusion criteria were Saudi adults aged ≥ 18 years diagnosed with diabetes. Exclusion criteria included non-Saudis, non-diabetics, and incomplete questionnaires. **Sampling Technique and Sample Size:** The non-probability convenience sampling method was used to select the participants. The underestimated sample size was (385). The estimation was calculated by the Raosoft website for sample size calculation with a 5% margin of error and 95% confidence level based on Saudi Arabia's population of 13,382,962. **Assumptions:** (i) 50% prevalence of expected rate and perception among adult citizens of Saudi Arabia, (ii) 95% confidence interval (CI), (iii) 5% margin of error, and (iv) 10% non-response rate. To ensure that our findings have higher external validity and greater generalizability, we decided to collect more samples than our calculated sample size ($n = 2952$). **Data collection methods and tools:** We developed a questionnaire inspired by two validated surveys (6,11). The survey was in the Arabic language and distributed through social media platforms. The participants could go ahead after accepting to participate voluntarily, and all responses were collected online and anonymously. The questionnaire is composed of four sections. The first section is socio-demographic information. The second section is regarding Diabetes mellitus (DM)-related information

and peripheral vascular disease (PVD) diagnosis; section three is regarding tinea pedis-related information, and the fourth section is regarding Tinea unguium-related information.

Statistical Analysis

The data analysis was performed using R (version 4.4.1, 2024). Categorical variables were summarized as frequencies and percentages. Relationships among socio-demographic variables, diabetes-related factors, and the presence of tinea pedis or tinea unguium, as well as foot care practices were investigated using Pearson's chi-square test. Univariate logistic regression was used to identify factors increasing the likelihood of tinea pedis or tinea unguium and then significant variables were included in the multivariate logistic regression model. P value ≤ 0.05 was considered significant.

Results

Characteristics of the sample: The initial total number of responses was 9,688. After excluding non-diabetic participants, the final sample size was 2,952. (Table 1) shows the characteristics of our study sample, including diabetes-related features. The majority of the sample was female (52%) and had diabetes type 1 (56.4%). The young age group (18-30 years old) comprised 41.3% of the total sample, with married people accounting for 48.5%. More than half of the studied subjects (58.3%) hold a university degree or higher. In terms of body mass index (BMI), 38.5% were within the normal range, whereas 28.6% were obese. Peripheral vascular disease was diagnosed in 563 participants, representing 19.1% of the overall study population. (Figure 1) shows that 29.5% had good control, 32.2% had HbA1C between 6.6% and 7.5%, while 15.4% had levels above 8.5%. Foot care practices, (Table 2) summarizes the foot care practices among our sample. Regarding foot care practices, the majority of participants (62.3%) reported regularly inspecting their feet for scars, peeling, dryness, or blisters. Additionally, 83.1% of the sample routinely used nail clippers. A significant proportion (66.5%) indicated that they typically wore socks to protect their feet. With respect to foot hygiene, 82% of respondents reported washing their feet three or more times daily. In terms of footwear, 25.8% stated that they avoid wearing tight shoes, whereas more than 30% reported wearing tight shoes for over four hours per day. Moreover, (Figure 2) shows that most participants reported good foot care practice, 62.3% checked their feet regularly, and 83.1% and 66.5% reported using nail clippers regularly and wearing socks, respectively. Tinea pedis and Tinea unguium

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knowledge and attitudes. As shown in (Table 2), the majority of responders (60.6%) are unaware of tinea pedis (commonly referred to as athlete's foot). However, 15.1% reported a previous diagnosis of tinea pedis, while 12.9% indicated that a family member had been diagnosed with the condition. Regarding foot inspection, 35.6% of participants identified inflammatory signs between their toes, such as redness, itching, peeling, or cracking, and 22.5% reported the presence of blisters on their toes. Familiarity with tinea unguium was relatively low, with only 32.7% of respondents indicating awareness. Among the participants, 12.8% reported a previous infection, and 11% noted a family history of the condition. Concerning nail changes, 19.3% observed foul odors and alterations in the color or shape of their toenails. Significant factors associated with the presence of tinea pedis and tinea unguium: (Table 3) presents the chi-square results for the significant variables associated with the diagnosis of tinea pedis or tinea unguium. Younger age groups (18–30 years) were significantly more likely to develop tinea pedis or tinea unguium ($p < 0.001$), while married individuals exhibited a lower likelihood. Underweight or normal BMI individuals demonstrated significantly higher infection rates compared to obese participants ($p < 0.001$). Pet ownership was a significant factor associated with both conditions ($p < 0.001$), and participants engaging in swimming or basketball showed a higher susceptibility to tinea pedis ($p < 0.001$). Participants with type 1 diabetes and those diagnosed for less than one year were significantly associated with tinea infections ($p < 0.05$). Individuals reporting normal glucose levels on four or fewer days per week had a significantly higher likelihood of infection ($p < 0.001$). The use of immunosuppressive medications and diagnosis of peripheral vascular disease significantly increased the odds of developing tinea pedis and tinea unguium ($p < 0.001$). Association between foot care practices and the development of tinea pedis: (Table 3) also illustrates the association between foot care practices and the occurrence of tinea pedis. Regular foot inspection was significantly associated with higher rates of tinea pedis ($p < 0.001$) compared to individuals who did not inspect their feet. In contrast, regular use of nail clippers was linked to a significantly lower likelihood of developing tinea pedis ($p < 0.001$). Similarly, wearing socks consistently was significantly associated with a higher incidence of tinea pedis ($p = 0.003$). On the other hand, daily foot washing did not show a significant association with tinea pedis ($p = 0.109$). Significant

variables associated with the presence of tinea pedis (Table 4) presents the significant factors associated with tinea pedis and tinea unguium based on multivariate analysis after adjustment for confounders. Football players had increased odds of developing tinea pedis (Odds Ratio (OR): 2.02, 95% CI: 1.53–2.66, $p < 0.001$), and basketball players were also at higher risk (OR: 1.79, 95% CI: 1.30–2.45, $p < 0.001$). Regular running or jogging lowered the likelihood of tinea pedis (OR: 0.60, $p < 0.001$), while swimming was not significant ($p = 0.805$). Corticosteroid use increased risk of both infections. Peripheral arterial disease strongly increased odds of tinea pedis (OR: 4.85, $p < 0.001$). Infrequent glucose monitoring raised tinea unguium risk (OR: 1.47, $p = 0.032$).

Discussion

Tinea Tinea pedis and tinea unguium are the most common fungal skin infections in daily practice [12]. Certain underlying conditions increase the risk of disease extension, immunodeficiency, and diabetes mellitus. The chronic hyperglycemia in diabetes mellitus impairs cellular immunity, phagocytic activities, and polymorphonuclear leukocytes, which result in frequent incidence of cutaneous fungal infections with more severe clinical manifestations compared to the non-diabetic population [13–15]. Therefore, the present study was conducted to determine the prevalence of and factors linked to tinea pedis and tinea unguium among diabetic patients in Saudi Arabia. According to our results, the prevalence of tinea pedis was 15.1%, with 35.6% prevalence of tinea pedis-associated symptoms, while the prevalence of tinea unguium was 12.8%, and 19.3% experienced changes in their toenails. Moreover, 12.9% and 11% reported having a family history of tinea pedis and tinea unguium respectively. Different results were reported by Khalifa et al., showing a lower prevalence of tinea pedis and tinea unguium in Hail, Saudi Arabia. However, the latter study included fewer diabetic patients [11]. On the other hand, the incidence of tinea pedis was assessed in another study by Legge et al. in patients with asymptomatic pedal interdigital macerations; they reported a very high prevalence of 42.5% in diabetic patients. However, the prevalence was comparable to the non-diabetic population (37.5%) with no statistically significant difference [16]. In diabetic patients with clinical features suggestive of onychomycosis, the prevalence of onychomycosis and tinea pedis was 40.6% and 10.9%, respectively [17]. The awareness level was low for both tinea pedis and tinea unguium. Only 39.4% have heard of tinea pedis (athlete's foot), and 32.7% heard

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Table 1: Characteristics of the studied sample (n = 2952).

Sex	
Female	1537 (52.1%)
Male	1415 (47.9%)
Age	
18 – 30	1218 (41.3%)
31 – 50	1072 (36.3%)
>50	662 (22.4%)
Marital status	
Single	1228 (41.6%)
Married	1431 (48.5%)
Divorced	169 (5.7%)
Widow	124 (4.2%)
Educational level	
Secondary or below	1231 (41.7%)
University or higher	1721 (58.3%)
BMI Category	
Underweight (< 18.5)	232 (7.9%)
Normal (18.5-25)	1137 (38.5%)
Overweight (25-30)	845 (28.6%)
Obese (30 – 40)	606 (20.5%)
Extreme obesity (> 40)	132 (4.5%)
Type of diabetes	
Type 1 diabetes	1665 (56.4%)
Type 2 diabetes	1287 (43.6%)
Time of diagnosis of diabetes	
Less than one year	907 (30.7%)
1 – 5 years	1012 (34.3%)
6 – 10 years	498 (16.9%)
> 10 years	535 (18.1%)
Last HbA1C	
≤ 6.5%	870 (29.5%)
6.6 – 7.5%	950 (32.2%)
7.6 – 8.5%	679 (23%)
≥ 8.6%	453 (15.4%)
Is your daily sugar level reading usually within normal range?	
5 – 6 days/week	1069 (36.2%)
3 – 4 days/week	1027 (34.8%)
2 days or less/week	417 (14.1%)
I don't check the glucose level	439 (14.9%)
Do you adhere to your medications and regular follow-ups	
Yes	2272 (77%)
No	680 (23%)
Do you get your feet checked when you visit your physician?	
Yes	1540 (52.1%)
No	1412 (47.9%)
Do you use any medications that suppress your immune system?	
No	2301 (78%)

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Corticosteroid	386 (13.1%)
Biologic therapy	142 (4.8%)
Chemotherapy	123 (4.2%)
Have you been diagnosed with peripheral artery disease?	
Yes	563 (19.1%)
No	2389 (80.9%)
Do you own a pet?	
Yes	736 (24.9%)
No	2216 (75.1%)
Do you exercise regularly?	
Yes, running/walking/jogging	1213 (41.1%)
Yes, football	576 (19.5%)
Yes, swimming	438 (14.8%)
Yes, basketball	275 (9.3%)
Yes, another type of sport.	497 (16.8%)
I don't exercise regularly	970 (32.9%)

BMI: Body Mass Index. HbA1C: Hemoglobin A1c.

Distribution of Last HbA1c Levels

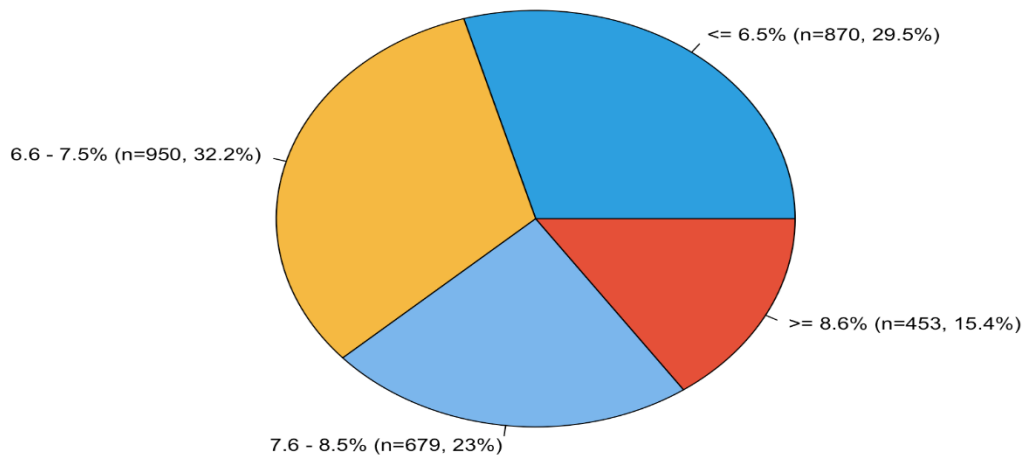


Figure 1: Distribution of last HbA1C levels among our sample.

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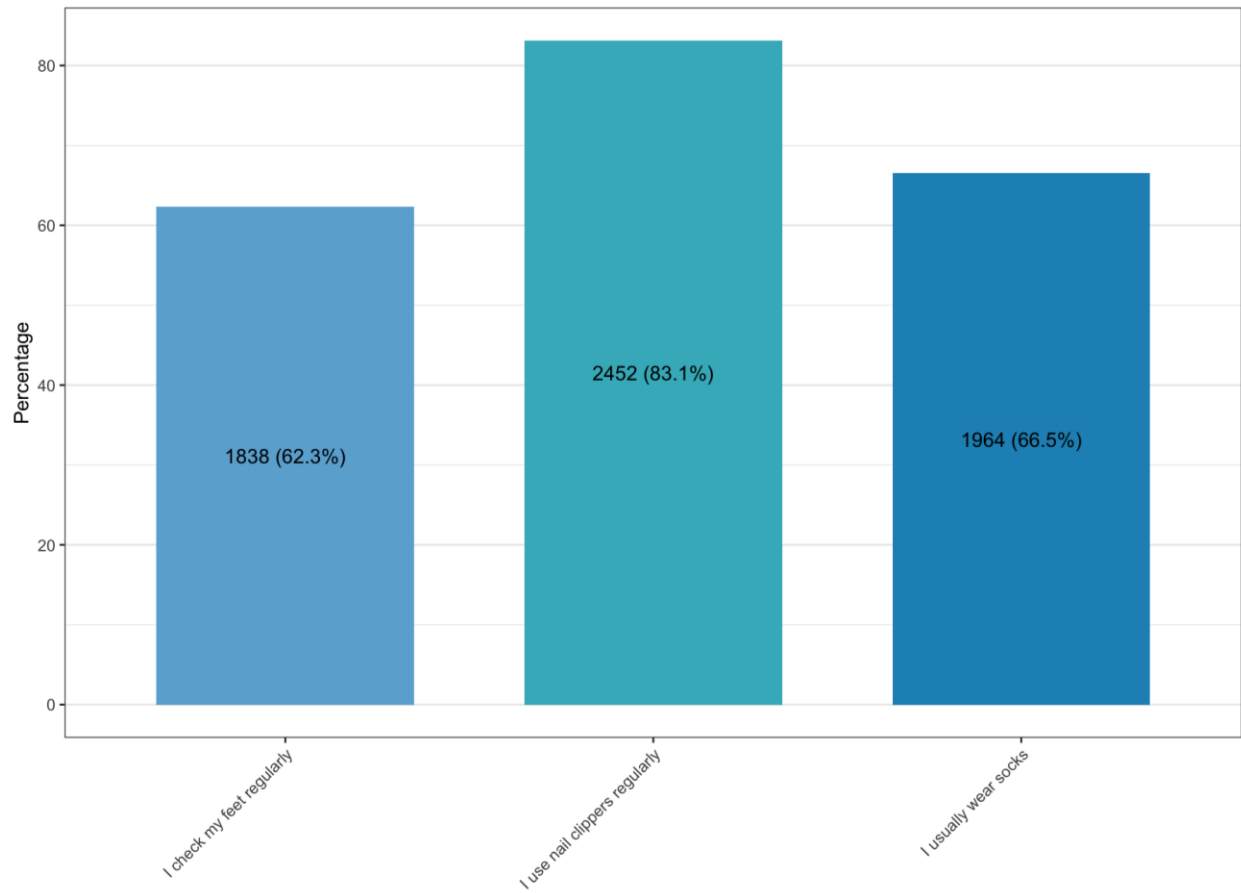


Figure 2: Foot Care Practices among diabetic participants.

Table 2: Foot care practices and knowledge regarding tinea pedis and tinea unguium (n = 2952).

I check my feet regularly	
Yes	1838 (62.3%)
No	1114 (37.7%)
I use nail clippers regularly	
Yes	2452 (83.1%)
No	500 (16.9%)
I usually wear socks	
Yes	1964 (66.5%)
No	988 (33.5%)
How often do you wash your feet daily	
3 times or more/daily	2421 (82%)
Less than 3 times daily	531 (18%)
How long do you wear tight or closed shoes each day?	
I don't wear tight shoes	752 (25.8%)
Less than 2 hours/day	576 (19.5%)
2 – 4 hours/day	595 (20.2%)
4 – 8 hours/day	739 (25%)

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> 8 hours/day	290 (9.8%)
Have you heard of tinea pedis (athlete's foot)?	
No	1788 (60.6%)
Yes	1164 (39.4%)
Have you or any of your family member ever had athlete's foot?	
No	2126 (72%)
Yes (me)	445 (15.1%)
Yes (family member)	381 (12.9%)
Have you noticed any redness, itching, dryness, peeling or cracking between your toes?	
No	1901 (64.4%)
Yes	1051 (35.6%)
Have you noticed blisters between your toes?	
No	2287 (77.5%)
Yes	665 (22.5%)
Have you heard of tinea unguium?	
No	1988 (67.3%)
Yes	964 (32.7%)
Have you or any of your family member ever had tinea unguium?	
No	2251 (76.3%)
Yes (me)	377 (12.8%)
Yes (family member)	324 (11%)
Have you visited a beauty salon to get your nails done?	
No	1976 (66.9%)
Yes	976 (33.1%)
Have you noticed any bad odor or changes in the shape and color of your toenails?	
No	2382 (80.7%)
Yes	570 (19.3%)
Have you used any of the following topical creams or medications to treat fungal infections?	
No	2079 (70.4%)
Clotrimazole cream	276 (9.3%)
Terbinafine cream	242 (8.3%)
Terbinafine spray	236 (8%)
Miconazole cream	231 (7.8%)
Ketoconazole cream	226 (7.7%)
Amorolfine nail lacquer	162 (5.5%)
Have you used any oral antifungal medications?	
No	2307 (78.2%)
Yes (for tinea pedis)	312 (10.6%)
Yes (for tinea unguium)	204 (6.9%)
Yes (for tinea pedis and tinea unguium)	129 (4.4%)

Table 3: Significant variables associated with the presence of tinea pedis or tinea unguium (n = 2952).

Variables	Tinea pedis			Tinea unguium		
	X ²	df	P value	X ²	df	P value
Age	39.1	2	< 0.001	50.2	2	< 0.001

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Marital status	53.2	3	<0.001	53.2	3	<0.001
Regular exercise	107.5	1	<0.001	85.9	1	<0.001
BMI class	38	4	<0.001	33.6	4	<0.001
Owning a pet	34	1	<0.001	24.1	1	<0.001
Type of diabetes	19	1	<0.001	9.6	1	0.002
Time of diagnosis of DM	8.7	2	0.033	19.6	3	<0.001
Daily sugar level readings	32.2	3	<0.001	29.3	3	<0.001
Immune suppressive medications	116.4	3	<0.001	131.7	3	<0.001
Diagnosed with peripheral arterial disease	407	1	<0.001	389.5	1	<0.001
Association between foot care practices and the presence of tinea pedis						
Variables	Tinea pedis					
	X ²	df	P value			
Checking feet regularly	47.48	1	<0.001			
Use nail clippers regularly	28.06	1	<0.001			
Wear socks regularly	8.62	1	0.003			
Washing feet daily	2.56	1	0.109			

Table 4: Significant variables associated with the presence of tinea pedis and tinea unguium in multivariate analysis* (n = 2952).

Variables	Tinea pedis		
	OR	95% CI	P value
Exercise			
Football	2.02	1.53 – 2.66	<0.001
Swimming	1.04	0.78 – 1.38	0.805
Basketball	1.79	1.30 – 2.45	<0.001
Running/jogging	0.60	0.46 – 0.78	<0.001
Daily sugar reading within normal range			
5 – 6 days/week	Ref	Ref	Ref
2 days or less/week	1.27	0.91 – 1.77	0.158
Immune suppressive medications			
None	Ref	Ref	Ref
Corticosteroid	1.74	1.29 – 2.35	<0.001
Diagnosed with peripheral artery disease	4.85	3.78 – 6.24	<0.001
	Tinea unguium		
	OR	95% CI	P value
Daily sugar reading within normal range			
5 – 6 days/week	Ref	Ref	Ref
2 days or less/week	1.47	1.03 – 2.10	0.032
Immune suppressive medications			
None	Ref	Ref	Ref
Corticosteroid	2.13	1.57 – 2.90	<0.001

*Adjusted for age, marital status, BMI class, owning a pet, type of diabetes and time of diagnosis.

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of tinea unguium. A slightly lower awareness level was previously reported by AlKaabi et al., showing 28.3% tinea pedis awareness [18]. Foot care is an important practice for diabetic patients to prevent the occurrence of diabetic foot infections. Moreover, proper foot hygiene and frequent foot washing reduce fungal foot infections and foot drying [19]. Our results showed that the regular use of nail clippers was associated with a lower risk of tinea pedis development. However, wearing socks consistently was significantly associated with increased tinea pedis incidence. Regular foot inspection was significantly associated with higher rates of tinea pedis, likely because the regular foot inspection increases the chance of detection and diagnosis. Superficial mycosis is common among athletes, and the fungal contamination mostly spreads in changing rooms, bathrooms, showers, or places with barefoot practice [20]. Our results showed that the rates of tinea pedis infection are significantly higher among participants who played football and basketball. A previous study by Pickup et al. reported similar results [21]. Corticosteroid administration and peripheral arterial disease increased the likelihood of developing tinea pedis. Poor glucose monitoring was associated with increased rates of tinea unguium infection. This study provides an overview of the prevalence, awareness, and factors associated with tinea pedis and tinea unguium among diabetic patients in Saudi Arabia. However, there were some limitations, including recall bias due to self-reported data, and the inability to establish causality due to the study design.

Conclusion

The prevalence of tinea pedis and tinea unguium was 15.1% and 12.8%, respectively, with generally low awareness levels. Football, basketball, peripheral arterial disease, corticosteroid use, and the presence of peripheral arterial disease significantly increase the risk of tinea pedis development. Moreover, poor glucose monitoring was associated with increased rates of tinea unguium infection.

Conflict of Interest

None

Funding

None

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