

## Prevalence and Risk Factors of Tinea Unguium and Tinea Pedis in the General Population in Spain

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**This study prospectively evaluated the prevalence and risk factors of tinea unguium and tinea pedis in the general adult population in Madrid, Spain. One thousand subjects were clinically examined, and samples of nails and scales from the interdigital spaces of the feet were taken from those patients presenting with signs or symptoms of onychomycosis and/or tinea pedis, respectively. In addition, a sample from the fourth interdigital space of both feet was collected from all individuals with a piece of sterilized wool carpet. Tinea unguium was defined as a positive direct examination with potassium hydroxide and culture of the etiological agent from subjects with clinically abnormal nails. Patients with positive dermatophyte cultures of foot specimens were considered to have tinea pedis. The prevalence of tinea unguium was 2.8% (4.0% for men and 1.7% for women), and the prevalence of tinea pedis was 2.9% (4.2% for men and 1.7% for women). The etiological agents of tinea unguium were identified as *Trichopyton rubrum* (82.1%), followed by *Trichopyton mentagrophytes* var. *interdigitale* (14.3%) and *Trichopyton tonsurans* (3.5%). *Trichophyton rubrum* (44.8%) and *Trichophyton mentagrophytes* (44.8%), followed by *Epidermophyton floccosum* (7%) and *T. tonsurans* (3.4%), were the organisms isolated from patients with tinea pedis. The percentage of subjects who suffered simultaneously from both diseases was 1.1% (1.7% for men and 0.6% for women). In a multivariate logistic regression analysis, age (relative risk [RR], 1.03) and gender (RR, 2.50) were independent risk factors for tinea unguium, while only gender (RR, 2.65) was predictive for the occurrence of tinea pedis. In both analyses, the presence of one of the two conditions was associated with a higher risk for the appearance of the other disease (RR, >25).**

Onychomycosis, defined as fungal infection of the nail, represents up to 20% of all nail disorders. The most frequent etiologic agents are dermatophytes (tinea unguium) (80 to 90%), mainly *Trichophyton rubrum* and *Trichophyton mentagrophytes* var. *interdigitale*, followed by yeasts (5 to 17%) and nondermatophyte filamentous fungi such as *Scopulariopsis* spp., *Scytalidium* spp., *Acremonium* spp., *Fusarium* spp., and *Aspergillus* spp. (3 to 5%) (1, 3, 5, 6, 12, 21, 24, 25). Tinea pedis, which is fungal infection of the interdigital toe web space as well as the skin of the feet, is caused solely by dermatophyte fungi, with *Trichophyton* spp. (*T. rubrum* and *T. mentagrophytes*) and *Epidermophyton floccosum* being the most frequent agents identified (4, 26). Interaction with bacteria is also possible in the toe cleft spaces. This mixed dermatophyte and bacterial infection is clinically more severe and has a polymicrobial etiology (complex infection) (16).

Several studies have assessed the prevalence of onychomycosis in the general population in different countries. These studies differ greatly in several methodological aspects such as the population studied (healthy general population versus dermatological patients), number of subjects analyzed, type of clinical assessment (medical examination versus patient self-diagnosis on the basis of mailed questionnaires and photographs), microbiological studies (identification of the responsible pathogen versus no microbiological examination), and, finally, the criteria used to define onychomycosis. The prevalence of onychomycosis obtained in these studies is very heterogeneous, with rates ranging from 2.1 to 9.1%, limiting the

applicability and generalization of these data (4, 7, 10, 11, 22, 23; Editorial, *J. Investig. Dermatol.* 73:395–401, 1979). With regard to the prevalence of tinea pedis, the majority of the studies have been conducted with selected populations with high risk factors for the development of tinea pedis. Prevalence rates in these groups ranged from 3.8 to 61% (2, 9, 13, 16, 18; Editorial, *J. Investig. Dermatol.*). The results obtained in these studies cannot consequently be extrapolated to the general population. Neither of these types of studies has simultaneously determined the prevalence of tinea unguium and tinea pedis in healthy individuals, nor have they evaluated the potential risk factors for the development of both diseases.

The aims of the present study were to determine the prevalence of onychomycosis caused by dermatophytes (tinea unguium) and tinea pedis in the adult population of Spain as well as the percentage of individuals who presented with both disorders simultaneously. In addition, this study analyzed the potential risk factors for the acquisition of tinea unguium and tinea pedis.

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### MATERIALS AND METHODS

**Study population.** One thousand healthy volunteers were prospectively studied from April 1997 to December 1997 in Madrid, Spain. The population surveyed was stratified according to age into eight groups, spanning 10 years each. Age ranged from 20 to more than 90 years. The participants were recruited from a local college (youngest age segment), residents of a nursing home (oldest age segment), and visitors of patients admitted to the Department of Internal Medicine, Hospital Universitario 12 de Octubre, Madrid (middle age segment). The subjects recruited from community-living facilities lived in individual rooms and did not share showers.

**Clinical assessment.** The assessment of the participants was conducted entirely by the authors and consisted of an interview, clinical examination, and collection of specimens for microbiological studies. All subjects completed a

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TABLE 1. Distribution of subjects according to results of clinical examination of fingernails and toenails

Age group (yr)	No. of men/no. of women (total no.) with:			
	No symptoms of onychomycosis	Clinically suspected onychomycosis in toenails	Clinically suspected onychomycosis in fingernails	Clinically suspected onychomycosis in fingernails and toenails
20-30	87/102	1/1	0/0	0/0
31-40	101/107	5/5	0/0	0/0
41-50	37/49	4/4	0/0	0/0
51-60	30/66	2/11	0/0	0/0
61-70	48/76 <sup>a</sup>	9/18	0/1	1/1
71-80	46 <sup>b</sup> /46	14/10 <sup>c</sup>	0/0	0/0
81-90	27/48 <sup>c</sup>	9/13	0/0	0/0
>91	5/8	2/4	1/0	0/0
Total	381/503 (884)	46/66 (112)	1/1 (2)	1/1 (2)

<sup>a</sup> One woman had had tinea unguium in her fingernails in the past.

<sup>b</sup> One man had had tinea unguium in his fingernails and toenails in the past.

<sup>c</sup> One woman had had tinea unguium in her toenails in the past.

questionnaire that contained demographic data, patient history, and specific data related to risk factors for onychomycosis and tinea pedis (age; gender; physical activities; occupation [student, housewife, blue-collar and white-collar worker, retired]; predisposing diseases [in the case of onychomycosis] such as diabetes, cardiovascular disease, and psoriasis; use of common facilities; and previous tinea pedis and/or tinea unguium). The clinical examination consisted of a detailed inspection of the fingernails, toenails, and toe web spaces, with a search for any sign or symptom of onychomycosis and/or tinea pedis. The fingernails and the toenails were classified as normal or abnormal. The type of onychomycosis (distal and lateral subungual [DLSO], proximal subungual, superficial white, and total dystrophic) and the percentage of the nail affected, along with the clinical evaluation of the nail and the surrounding skin affected, were documented. Similarly, feet were classified as normal or abnormal. The locations of the lesions were determined, and the type of tinea pedis (interdigital, moccasin, bullous) and clinical evaluation of the severity of the lesion were performed for those feet classified as abnormal.

**Specimen collection.** The specimens were collected for microbiological analysis on the basis of the results of the clinical evaluation. Samples from clinically abnormal nails were collected by vigorously scraping the distal portion of the nail, the underside area, as well as the nail bed (14, 15). For subjects in whom tinea pedis was suspected, a sample from the toe web or the surrounding skin was collected by scraping with a sterile scalpel. For all individuals (with or without symptoms of tinea pedis) a sample from the fourth toe clefts of both feet was taken by previously described techniques (2, 17). This technique consists of rubbing the cutaneous surface firmly with a piece (6 by 6 cm) of previously sterilized wool carpet.

**Microscopy and culture.** All specimens collected were analyzed by direct microscopy and culture. The biological materials were placed in petri dishes and were transported to the laboratory. Microscopic examination of the nail and the skin from the toe cleft material was carried out in potassium hydroxide solution (20%) with dimethyl sulfoxide (4%) (20). Nail specimens were cultured on Mycobiotic agar medium (Difco, Detroit, Mich.) and Sabouraud dextrose agar with chloramphenicol (5%; Becton Dickinson, Cockeysville, Md.). Scales from the interdigital spaces were cultured only on Mycobiotic agar. The specimens on

wool carpet were contact smeared onto Mycobiotic agar plates. All cultures were kept at room temperature for at least 3 weeks. The interpretation of the results obtained by direct examination was performed according to the criteria of English (8) and Migdley et al. (19). The dermatophytes were identified by the methodology of Rebell and Taplin (21).

Tinea unguium was defined as a positive direct examination and positive culture for a dermatophyte. Data for subjects for whom the direct examination was positive but culture was negative were not included in the calculation of prevalence. For subjects for whom the direct examination was consistent with the presence of a dermatophyte but cultures were negative, up to three additional specimens were collected in an attempt to confirm the presumptive diagnosis of tinea unguium. In the calculation of the prevalence of tinea pedis, subjects for whom a dermatophyte culture was positive, regardless of the presence of clinical symptoms, were considered positive.

**Statistical analysis.** The global sample size, age distribution, and gender of the participants were estimated based on previously published studies (7, 10, 11, 22, 23; Editorial, J. Invest. Dermatol.). The prevalences of tinea unguium and tinea pedis were calculated by dividing the number of subjects with the disorder by the total number of subjects. To estimate the prevalence of tinea unguium and tinea pedis in the general population, the results obtained in this study were extrapolated to the general population of Spain by using the 1991 electoral census (Instituto Nacional de Estadística, Madrid, Spain). The relevance of potential risk factors was analyzed by univariate (chi-square and Fisher exact tests) and multivariate logistic regression analyses.

## RESULTS

A total of 1,000 subjects were examined in the survey (age group distribution, 20 to 30 years, 191 [19.1%]; 31 to 40 years, 218 [21.8%]; 41 to 50 years, 94 [9.4%]; 51 to 60 years, 109 [10.9%]; 61 to 70 years, 154 [15.4%]; 71 to 80 years, 116 [11.6%]; 81 to 90 years, 98 [9.8%]; and >91 years, 20 [2.0%];

TABLE 2. Results of microscopic examination in KOH and culture of abnormal toenails and fingernails

Age group (yr)	No. of men/no. of women (total no.) with:					
	Results of microscopic examination in KOH		Positive culture results	Etiologic agents		
	Negative	Positive		<i>T. rubrum</i>	<i>T. mentagrophytes</i>	<i>T. tonsurans</i>
20-30	0/1	1/0	0/0 (0)	0/0	0/0	0/0
31-40	3/3	2/2	3/2 (5)	3/2	0/0	0/0
41-50	2/4	2/0	1/0 (1)	0/0	1/0	0/0
51-60	2/8	0/3	0/1 (1)	0/1	0/0	0/0
61-70	5/14	5/6 <sup>a</sup>	5/5 (10)	5 <sup>a</sup> /4 <sup>a</sup>	0/1	0/0
71-80	5/10	9/0	7/0 (7)	6/0	1/0	0/0
81-90	5/12	4/1	2/1 (3)	1/0	0/1	1/0
>91	2/3	1 <sup>a</sup> /1	1/0 (1)	1 <sup>a</sup> /0	0/0	0/0
Total	24/55 (79)	24/13 (37)	19/9 (28)	16/7 (23)	2/2 (4)	1/0 (1)

<sup>a</sup> One participant in each group presented with fingernail and toenail tinea unguium.

TABLE 3. Prevalences of tinea unguium and tinea pedis

Age group (yr)	Total no. of subjects (no. of men/no. of women)	Individuals with tinea unguium		Individuals with tinea pedis	
		No. of men/ no. of women	Total no. (%; 95% CI)	No. of men/ no. of women	Total no. (%; 95% CI)
20–30	191 (88/103)	0/0	0	6/0	6 (3.1; 1.2–6.7)
31–40	218 (106/112)	3/2	5 (2.3; 0.7–5.2)	3/3	6 (2.7; 1–5.8)
41–50	94 (41/53)	1/0	1 (1.1; 0.03–5.7)	1/1	2 (2.1; 0.2–7.4)
51–60	109 (77/32)	0/1	1 (0.9; 0.01–5)	1/0	1 (0.9; 0.1–5)
61–70	154 (58/96)	5/5	10 (6.5; 3.1–11.6)	1/2	3 (1.9; 0.4–5.5)
71–80	116 (60/56)	7/0	7 (6; 2.4–12)	5/1	6 (5.1; 1.9–10.9)
81–90	98 (36/62)	2/1	3 (3; 0.6–8)	2/1	3 (3; 0.6–8)
>91	20 (8/12)	1/0	1 (5; 1–24)	1/1	2 (10; 1.2–3.1)
Total	1,000 (474/526)	19/9	28 (2.8; 1.9–4.0)	20/9	29 (2.9; 1.9–4.1)

gender distribution, 474 [47.4%] men and 526 [52.6%] women). The number of clinically suspected cases of onychomycosis and the results of microscopy and nail specimen cultures are depicted in Tables 1 and 2, respectively. A total of 116 participants presented with toenail and/or fingernail abnormalities. The direct examination and culture were positive for dermatophytes for a total of 28 individuals, resulting in a global prevalence of tinea unguium of 2.8% (95% confidence interval [CI], 1.9 to 4.0) (Table 3). The prevalence was higher in men (4.0%; 95% CI, 2.4 to 6.2) than in women (1.7%; 95% CI, 0.7 to 3.2). The etiological agents of tinea unguium were *T. rubrum* ( $n = 23$ ; 82.1%), *T. mentagrophytes* var. *interdigitale* ( $n = 4$ ; 14.3%), and *Trichophyton tonsurans* ( $n = 1$ ; 3.5%) (Table 2). The clinical features of the nails affected by tinea unguium were onycholysis, hyperkeratosis, and decoloration of different grades of severity. The nail most commonly affected was the first toenail, and the nails least commonly affected were the fingernails. Three subjects presented with toenail and fingernail tinea unguium simultaneously. Fifteen subjects presented with DLSO (in 13 subjects 25% of the nail was affected, and in 2 subjects 50% of the nail was affected), 13 presented with total dystrophic onychomycosis, and none presented with superficial white onychomycosis or proximal subungueal onychomycosis. The fungi most commonly associated with DLSO were *T. rubrum* and *T. mentagrophytes* var. *interdigitale*. DLSO was present in all the subjects with fingernail tinea unguium. By considering the different values of prevalence in the different age groups and extrapolating to the Spanish population, the estimated global prevalence of tinea unguium was 2.4%.

The number of subjects with suspected tinea pedis is shown in Table 4. The results of the culture of specimens from the fourth toe cleft of both feet are displayed in Table 5. Tinea pedis was detected in 29 subjects, resulting in a global prevalence of tinea pedis of 2.9% (95% CI, 1.9 to 4.1). The prevalence was higher in men (4.2%; 95% CI, 2.5 to 6.4) than in women (1.7%; 95% CI, 0.7 to 3.2) (Table 5). The etiological agents of tinea pedis were as follows: *T. rubrum* ( $n = 13$ ), *T. mentagrophytes* var. *interdigitale* ( $n = 7$ ), *T. mentagrophytes* var. *granulosum* ( $n = 5$ ), *E. floccosum* ( $n = 2$ ), *T. mentagrophytes* var. *interdigitale* and *T. mentagrophytes* var. *granulosum* ( $n = 1$ ), and *T. tonsurans* ( $n = 1$ ). Sixteen (55%) of these individuals did not have any symptoms of tinea pedis (occult tinea pedis), and 13 (45%) presented with interdigital ( $n = 9$ ) and moccasin-type ( $n = 4$ ) tinea pedis. By considering the different values of the prevalence for the different age groups and extrapolating the data to the Spanish population, the estimated global prevalence of tinea pedis was 2.6%.

The prevalence of tinea unguium and tinea pedis simulta-

neously in this study was 1.1% (1.7% for men and 0.6% for women). Of the 31 subjects who presented with onychomycosis, 11 (35.5%) also presented with tinea pedis (asymptomatic tinea pedis in 6 [54.5%] subjects). The species of the dermatophytes isolated were *T. rubrum* ( $n = 6$ ; 54.5%), *T. mentagrophytes* var. *interdigitale* ( $n = 4$ ; 36.4%), and *T. tonsurans* ( $n = 1$ ; 9.1%). By considering the different values of the prevalence for the different age groups and extrapolating to the Spanish population, the estimated global prevalence of concomitant tinea unguium and tinea pedis was 0.9%.

In the univariate statistical analysis, age and gender (men versus women) appeared to be associated with a higher risk of the development of tinea unguium. In the multivariate analysis, both variables remained independent risk factors for tinea unguium. With regard to tinea pedis, gender and occupation (white-collar workers versus workers in the other categories) appeared to be associated with a higher risk of infection in the univariate analysis. However, in the multivariate analysis, only gender remained an independent risk factor for tinea pedis. In the multivariate analysis, the presence of one of the two conditions was associated with a higher risk for the appearance of the other disease (Table 6).

## DISCUSSION

Tinea unguium and tinea pedis are two cutaneous fungal infections highly prevalent in the general population. Although these disorders are not serious in terms of mortality or physical and/or psychological sequelae, they have significant clinical

TABLE 4. Distribution of population interviewed according to clinical examination of their feet

Age group (yr)	No. of men/no. of women (total no.) with:	
	No symptoms of tinea pedis	Clinically suspected tinea pedis
20–30	84/101	4/2
31–40	105 <sup>a</sup> /110	1/2
41–50	41/51	0/2
51–60	29/77	3/0
61–70	56/96	2/0
71–80	57 <sup>b</sup> /56	3/0
81–90	36/62	0/0
>91	7/11	1/1
Total	415/564 (979)	14/7 (21)

<sup>a</sup> Two men had had tinea pedis in the past.

<sup>b</sup> One man had had tinea pedis in the past.

TABLE 5. Culture results for specimens from the fourth toe cleft of both feet of all subjects interviewed

Culture result	No. of men/no. of women (total no.)			Total
	No symptoms of tinea pedis	Symptoms of tinea pedis	No symptoms of tinea pedis; had history of tinea pedis	
Negative	395/546	5/3	2/0	402/549 (951)
Dermatophyte				
Few (<5) colonies	6/4	2/0	0/0	8/4 (17)
Many (<5) colonies	4/2	7/3	1/0	12/5 (17)
Contaminant mould <sup>a</sup>	7/9	0/0	0/0	7/9 (16)
Yeast <sup>b</sup>	0/3	0/1	0/0	0/4 (4)
Total	357/564 (976)	14/7 (21)	3/0 (3)	429/571 (1,000)

<sup>a</sup> *Aspergillus versicolor*, *Chrysosporium* spp., *Aspergillus niger*.

<sup>b</sup> Three *Candida albicans* isolates and one *Geotrichum candidum* isolate.

consequences given their infectious nature, esthetic consequences, chronicity, and therapeutic difficulties. The prospective study described here evaluated the prevalence and risk factors of tinea unguium and tinea pedis in 1,000 healthy individuals representing different strata of the healthy population in Madrid, Spain, in an attempt to define the epidemiology of these disorders in the general population. The major results from this study indicate that the prevalences of tinea unguium and tinea pedis in the population studied were 2.8 and 2.9%, respectively. In addition, 1.1% of the study population presented with both disorders simultaneously. Univariate risk factor analysis showed that the prevalence of tinea unguium was higher in men than in women and increased with age. The risk of tinea pedis was also higher in men, being independent of age. Interestingly, the presence of one of the two conditions substantially increased the risk of having the other.

The prevalence of onychomycosis has been assessed in several prior studies, with values ranging from 2.6 to 9.1% (3, 7, 10, 11, 22, 23; Editorial, J. Investig. Dermatol.). These studies differ greatly in various relevant methodological aspects such as sample size, source of participants (healthy, nonselected population versus dermatological patients), type of evaluation (clinical versus mailed questionnaires), and definition of onychomycosis, which can explain the disparity in the observed results. The prevalence of tinea unguium obtained in this prospective study, in which only members of the healthy general population was enrolled, more closely resembles those from

previous studies obtained from questionnaires than those based on mycological cultures (23). Although the reasons for this discrepancy are unknown, the fact that this study required isolation of the etiologic agent in culture, whereas in the other studies microscopic observation of the fungi was enough to consider a nail affected, could have resulted in a more conservative estimation.

The prevalence of tinea pedis has been assessed less frequently in prior studies, and therefore, it is more difficult to compare our results with the findings of other studies (2, 9, 13, 16, 18; Editorial, J. Investig. Dermatol.). The observed prevalence of tinea pedis in this study was 2.9%, which is slightly less than that in the only previous study conducted with subjects in the general population (3.9%) (Editorial, J. Investig. Dermatol.). Interestingly, more than half (55.1%) of the individuals who presented with tinea pedis were asymptomatic (occult tinea pedis). As reported previously (Editorial, J. Investig. Dermatol.), the most common etiologic agent in those subjects with symptomatology of tinea pedis, in whom the most common agent was *T. rubrum*. Furthermore, 33% of the individuals who had had symptoms of tinea pedis in the past were colonized with dermatophytes at the time of this evaluation. These results demonstrate the high prevalence of asymptomatic colonization and should be considered when designing strategies for the prevention of these disorders in the community.

One of the objectives of the present study was to assess the

TABLE 6. Analysis of risk factors for tinea unguium and tinea pedis

Analysis and variables	Tinea unguium			Tinea pedis		
	<i>P</i>	Relative risk	95% CI	<i>P</i>	Relative risk	95% CI
Univariate analysis						
Age	<i>0.00271<sup>a</sup></i>			0.3		
Gender (men vs women)	<i>0.00680</i>	1.6	1.2338–2.0975	0.00400	1.6	1.2687–2.1130
Occupation	0.08			0.02		
Physical activities	0.3			0.6		
Predisposing diseases	0.09			NA <sup>b</sup>		
Use of common facilities at work	0.6			0.07		
Multivariate analysis						
Age	<i>0.014</i>	1.0342	1.0184–1.0501	0.07		
Gender (men vs women)	<i>0.0383</i>	2.5083	1.3121–4.7949	<i>0.0235</i>	2.6554	1.4149–4.9836
Tinea pedis/tinea unguium	<i>0.0001</i>	28.7978	14.0820–58.8917	<i>0.0001</i>	26.5182	13.4489–52.2845

<sup>a</sup> Italic numbers indicate statistical significance.

<sup>b</sup> NA, not applicable.

risk factors for tinea unguium and tinea pedis. The risk of tinea unguium and tinea pedis was higher in men than in women and also increased with age in the case of tinea unguium. The increased prevalence of tinea unguium and tinea pedis in men compared to that in women could be the result of more traumas in the nails and the more common use of occlusive footwear, which favors the appearance of both diseases. The increased prevalence of tinea unguium in the elderly members of the population could be explained as a consequence of nail trauma and slow nail growth. The present study did not find a significant relationship between factors such as concomitant diseases (diabetes, psoriasis, and vascular diseases) and the frequency of tinea unguium and the practice of sports or the use of common showers and the risk of tinea pedis. However, the small number of subjects represented in each of these categories reduces the strength of this statement. In addition, this study evaluated whether the presence of one of the disorders increases the risk of having the other. We found that the relative risk that a subject would present with either tinea unguium or tinea pedis for subjects affected by one or the other disorder was  $>25$ . This finding has important clinical consequences. First, it indicates that patients with onychomycosis should be screened for the presence of tinea pedis. Second, screening and appropriate treatments for tinea pedis may likely reduce the incidence of tinea unguium, whose treatment is more cumbersome and difficult.

In conclusion, this study shows that the prevalences of tinea unguium and tinea pedis in the general adult population in Madrid were 2.8 and 2.9%, respectively. The frequencies of both disorders were higher in men and increased with age in the case of onychomycosis. More than half of the subjects with tinea pedis were asymptomatic at the time of evaluation. Importantly, the relative risk of having either of the two conditions increased substantially in patients who presented with the other disorder. The prevalence of onychomycosis and tinea pedis simultaneously was 1.1%. The data contain herein add to the knowledge of these diseases and may be useful in the design of preventive and educational strategies.

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