Original paper

Awareness of people using municipal swimming pools about the prevention, symptoms, and treatment of athlete's foot and onychomycosis before COVID-19

Hanna Cisoń[1], Paulina Kostrzewska[2], Natalia Łątka[1], Piotr K. Krajewski[1], Jacek Szepietowski[1], Alina Konsur-Jankowska[1], Rafał Białynicki-Birula[1], Adam Reich[3]

[1]Department of Dermatology, Venereology, and Allergology, Wroclaw Medical University, Wroclaw, Poland
[2]Team of the Departments of Internal Diseases, Endocrinology, and Diabetology, Masovian Bródnowski Hospital, Warsaw, Poland
[3]Department of Dermatology, Institute of Medical Sciences, Medical College of Rzeszow University, Rzeszow, Poland

Adv Dermatol Allergol 2024; XLI (2): 226–231
DOI: https://doi.org/10.5114/ada.2024.136083

Abstract

Introduction: Superficial mycosis is one of the most common diseases worldwide; however, its epidemiology is changing over time.

Aim: To present the awareness of people using swimming pools about athlete's foot and onychomycosis.

Material and methods: A total of 690 participants were subjected to an extensive survey administered via Google Documents. The questionnaire consisted of 30 online polling items and aimed to evaluate respondents' knowledge pertaining to fungal infections, encompassing aspects such as prevention strategies, disease trajectory, and therapeutic modalities. The survey sample specifically encompassed students and sports enthusiasts associated with 33 Internet groups, and data collection transpired during the period spanning 12 January to 15 March, 2018, predating the advent of the COVID-19 pandemic.

Results: In the study, 85.2% of participants regularly inspected their feet, with 4.8% seeking podiatric services. While 75.2% demonstrated hygienic behaviour by changing towels after each pool visit, 41.4% acknowledged sharing nail tools. Notably, 75.7% preferred professional assistance for symptoms, with 24.3% opting for home remedies. Gender disparities were evident, with women showing significantly better hygiene practices and pool usage than men ($p < 0.001$). Women also exhibited a stronger tendency to disinfect grooming tools and prioritise sterility during beautician services ($p < 0.001$). These findings emphasise the importance of gender-specific health behaviour analysis in promoting preventive measures.

Conclusions: The study highlights onychomycosis as a significant societal concern. Pre-COVID-19, awareness among municipal swimming pool users regarding prevention, symptoms, and treatment of athlete's foot and onychomycosis was insufficient.

Key words: onychomycosis, tinea, dermatomycoses, health care surveys.

Introduction

According to the international study Project Achilles, Poland ranks fourth in Europe in occurrence of tinea pedis. Among the 40,000 surveyed Poles, 42% were diagnosed with athlete's foot and 21% with onychomycosis [1]. Almost half of the Poles tested in the project had tinea pedis, and every fifth onychomycosis. The number of fungal nail infections is increasing worldwide and accounts for about half of all nail diseases. Onychomycosis is a serious social and epidemiological problem, due to therapeutic difficulties and high rate of recurrence. Tinea pedis is principally associated with the etiological agent *Trichophyton rubrum* (70% of documented tinea pedis cases). Additionally, *Trichophyton interdigitale* and *Epidermophyton floccosum* are significant contributors to this condition [2].

Onychomycosis typically manifests as nail discoloration, commonly appearing as white or yellow-brown in nature, or in less frequent instances, observations include violaceous, green, or black nail discolorations [3]. Clinical presentations extend to subungual hyperkeratosis, onycholysis (separation of the nail from the

Address for correspondence: Hanna Cisoń, Department of Dermatology, Venereology, and Allergology, Wroclaw Medical University, Wroclaw, Poland, phone: +48 502 667 553, e-mail: hanna.cison@student.umw.edu.pl
Received: 23.12.2023, **accepted:** 14.02.2024, **online publication:** 7.03.2024.

nail bed), and onychauxis (thickening of the nail plate) [4, 5]. A distinctive and diagnostically specific feature of onychomycosis is the presence of dermatophytoma, characterised by linear, single, or multiple bands on the nail plate, which may vary in colour from white, yellow, orange, to brown [4].

Aim

The aim of the study was to assess the knowledge of the swimming pool users concerning the prevention, course, and ways to treat tinea before COVID-19.

Material and methods

For the needs of the study, we generated a set of questions using Google Documents. The survey was created based on an interview with 15 pool users regarding their behaviours and habits related to use of the public swimming pool. The questionnaire, consisting of 30 questions in the form of online polling, was meant to estimate the knowledge of the respondents about fungal infection, its prevention, course, and methods of treatment. The survey was gathering students and sports amateurs associated with 33 Internet groups shown in Appendix and was available during the period from 12 January to 15 March, 2018, before the COVID-19 pandemic. Incomplete sheets were rejected. Received questionnaires were analysed.

Results

Preventive measures for athlete's foot

558 (85.2%) of the interviewers admitted to checking the condition of their feet regularly, whereas others (102; 14.8%) denied it. 33 (4.8%) of the respondents declared using the services of a podiatrist, while 657 (95.2%) did not.

519 (75.2%) respondents changed their towel after each visit to the pool. There was no statistically significant difference ($p = 0.412$) observed in the incidence of fungal infection between people who changed their towels after each visit to the swimming pool and those who used it more than once (27.2% vs. 23.9%).

648 (93.9%) of the surveyed never shared a towel with another person, while 42 did. There was no difference ($p = 0.1568$) in ever suffering from mycosis between respondents who shared their towel with another person (35.7%) and those who did not (25.8%). On the other hand, there appeared to be a statistically significant difference ($p = 0.002$) in suffering from recurrent mycosis between people who do not share towels (10.3%) and those who do (26.2%).

543 (78.7%) of the respondents used and 147 did not use generally available disinfectants. There was no difference ($p = 0.1751$) in having tinea more than once between respondents who always use disinfectants (8.2%) and those using them less frequently (12.2%). No difference ($p = 0.3270$) was noted also in relation to having mycosis more than once between people using footwear at the swimming pool (10.8%) and those who do not (19.4%). Moreover, there was no statistically significant difference ($p = 0.261$) in always using a disinfectant after using the swimming pool between women and men (22.5% vs. 18.7%).

286 (41.4%) shared nail tools. There was also a significant difference ($p = 0.034$) in having recurrent dermatomycosis between respondents who share nail clippers, scissors, and other tools (14.3%) and those who do not (9.2%).

522 (75.7%) responders declare seeking medical consultation in case of any disturbing symptoms, while 168 (24.3%) would prefer to use home remedies. In the case of onychomycosis, it was not observed that women visit a doctor more often than men (30.3% vs. 33.3%).

There was no statistically significant difference ($p = 0.978$) in the occurrence of mycosis between respondents who attend the swimming pool often (≥ 1 time a week, 26.5%) and those who attend it rarely (26.4%). There was also no difference between those groups ($p = 0.678$) in respect to suffering from mycosis more than once in their lifetime (10.3% vs. 11.5%) (Table 1).

In the realm of behavioural disparities related to swimming pool utilisation and personal hygiene practices, statistical significance ($p < 0.001$) emerged when comparing women to men in various aspects. Firstly, women (75%) displayed a notably greater inclination than men (61%) to engage in swimming pool usage one or more times, highlighting a significant difference. Secondly, women (81%) were notably more likely than men (62%) to consistently change their towels after each visit to the swimming pool, with a statistical significance of $p < 0.001$. Thirdly, a significant distinction ($p = 0.003$) was observed in the regularity of foot monitoring, as women (87%) exhibited a higher prevalence of this practice compared to men (81%).

Fourthly, women (57%) exhibited a marked proclivity to disinfect their personal grooming tools after each use, significantly surpassing the rate observed among men (29%), and this difference was statistically significant ($p < 0.001$).

Lastly, concerning diligence in ensuring the sterility of tools during beautician services, women (87%) exhibited a significantly higher level of vigilance in comparison to men (81%), with a p-value indicating statistical significance of less than 0.001 (Table 2).

Education

There was a statistically significant difference ($p = 0.003$) in the incidence of dermatomycosis between people who used a swimming pool at which there was no information on the prevention of mycosis, compared to

Table 1. Collective analysis of the study group

Parameter	*N (%)*
Total	690 (100)
Gender:	
Male	214 (31.0)
Female	476 (69.0)
Age [years]:	
18–24	584 (84.6)
25–39	79 (11.4)
40–60	19 (2.8)
> 60	8 (1.2)
Educational status:	
Basic	33 (4.8)
Secondary	400 (58.0)
Vocational	8 (1.1)
Higher	249 (36.1)
Place of living:	
Rural	123 (17.8)
Urban	567 (82.2)
Frequency of using swimming pool:	
> 1 time per week	136 (19.7)
< 1 time per week	554 (80.3)
Knowledge regarding symptoms of fungal infection:	
Yes	639 (92.6)
No	51 (7.4)
History of onychomycosis and athlete's foot:	
No	182 (26.4)
Yes	508 (73.6)
History of recurrent fungal infection:	
or 0	612 (8.7)
> 1	78 (11.3)

people using a pool at which leaflets were available about mycosis (27.4% vs. 3.3%). There was no statistically significant difference (p = 0.954) regarding the importance of information campaigns on the prevention of mycoses between people who graduated university and people with primary education.

We asked whether the information campaigns about mycosis are necessary and effective. This question was answered favourably by 598 (86.7%), while 92 (13.3%) of the surveyed answered disapprovingly.

There was no statistically significant difference (p = 0.954) regarding the importance of information campaigns on the prevention of mycoses between people who graduated university and people with primary education.

Discussion

Superficial mycosis has been estimated to affect about 20–25% of the World's population [6, 7], which is in agreement with the results of this study: 26.4% of respondents admitted to suffering from dermatomycosis in their lifetime.

Athletes, especially swimmers, are a high-risk group for mycosis. Gudnadóttir *et al.* [8] stated that onychomycosis of the toenails is at least 3 times more prevalent in swimmers than in the rest of the population. Daggett *et al.* [9] examined professional athletes in fields such as soccer, handball, swimming, and wrestling, and found that fungal infections were more frequently seen in swimmers and soccer players. Fungal infections were found significantly more commonly in athletes in comparison to people leading a sedentary lifestyle. Furthermore, Auger *et al.* [10] showed that 22% of marathon runners had fungal athlete's feet. Another study carried by Kamihama *et al.* [11], who examined 282 athletes, 137 non-athletes, and 140 students enrolled in swimming lessons at the University of Tsukuba, provides information that there was a significantly higher risk of dermatophytosis in both athletes and non-athletes using the swimming pool. This study also showed that 63.6% of the swimming class students had interdigital tinea pedis. However, our study did not show a statistically significant difference in the incidence of athlete's foot between frequent and occasional swimming pool users.

Prevention plays an important role. Gupta *et al.* [12] recommend preventive strategies such as using footwear in public showers, keeping feet dry, and using absorbent socks. Daggett *et al.* [9] advise keeping short nails, proper washing, and well-ventilated mesh shoes. In an Italian study, almost all (93.9%) respondents declared they always use footwear at the swimming pool [13]. In our study 86.1%. people admitted to always wearing footwear. Pasquarella *et al.* [13] observed that treating in the family can prevent the possible spread of onychomycosis. The results of this study do not support this claim, as there was no statistically significant difference in suffering from mycosis between the group using such footwear and the one who do not. This may be caused by small research groups or rarely going to the swimming pool by our respondents.

It has been shown in an Egyptian study conducted by school children that a higher rate of dermatophyte infections was associated with towel sharing [14]. Similar results have been shown in our study; however, such a relationship was noted only with recurrent mycosis.

According to our data, towel sharing could increase the likelihood of reinfection, rather than getting the disease for the first time. A similar conclusion can be made in relation to sharing nail clippers, scissors, and other tools used for foot hygiene. Sharing these tools showed a higher likelihood of getting recurrent dermatomycosis in our study.

Table 2. Analysis of the study group

Variable	Female (1) 476	Male (2) 214	*P*-value
How frequently do you use the swimming pool?			
≥ 1 time per week	75 (16%)	61 (28%)	< 0.001
< 1 time per week	401 (84%)	153 (72%)	
Are you familiar with symptoms of fungal skin infection?			
Yes, I am	29 (6%)	22 (10%)	NS
No, I am not	447 (94%)	192 (90%)	
Do you have a history of onychomycosis and athlete's foot?			
Yes, I have	340 (71%)	168 (78%)	
No, I have not	136 (29%)	46 (22%)	NS
Did you disinfect socks and shoes after treating the onychomycosis?			
Yes, I did	55 (11%)	29 (14%)	
No, I did not	421 (89%)	185 (86%)	NS
Do you use disinfectants after using the pool or sauna each time?			
Yes, I do	369 (78%)	174 (81%)	
No, I do not	107 (22%)	40 (19%)	NS
Do you use flip-flops when you are at the swimming pool?			
Yes, I do	62 (13%)	34 (16%)	
No, I do not	414 (87%)	180 (84%)	NS
Do you always wipe your feet dry?			
Yes, I do	87 (18%)	40 (19%)	
No, I do not	389 (82%)	174 (81%)	NS
Do you change the towel after each visit to swimming pool?			
Yes, I do	386 (81%)	133 (62%)	
No, I do not	90 (19%)	81 (38%)	< 0.001
Do you use a shared towel with other people?			
Yes, I do	446 (94%)	202 (94%)	
No, I do not	30 (6%)	12 (6%)	NS
Are disinfectants available at the swimming pool you use?			
Yes, they are.	370 (78%)	162 (76%)	
No, they are not	106 (22%)	52 (24%)	NS
Are leaflets about tinea prevention available at the swimming pool you use?			
Yes, they are	460 (97%)	200 (93%)	
No, they are not	16 (3%)	14 (7%)	NS
Do you change socks daily			
Yes, I do	21 (4%)	16 (7%)	
No, I do not	456 (96%)	198 (93%)	NS
Do you regularly monitor your feet?			
Yes, I do	415 (87%)	173 (81%)	
No, I do not	61 (23%)	41 (19%)	0.030
Do you wash your feet every day?			
Yes, I do	32 (7%)	22 (10%)	
No, I do not	444 (93%)	19 (90%)	NS

Table 2. Cont.

Variable	Female (1) 476	Male (2) 214	*P*-value
Do you share your personal grooming tools like nail clippers or scissors with others?			
Yes, I do	202 (42%)	84 (40%)	
No, I do not	274 (48%)	130 (60%)	NS
Do you disinfect your personal grooming tool after every using?			
Yes, I do	272 (57%)	62 (29%)	
No, do not	204 (43%)	152 (71%)	< 0.001
Do you pay attention to the sterility of used tools during beautician service?			
Yes, I do	278 (58%)	37 (17%)	
No, I do not	198 (42%)	177 (83%)	< 0.001
Do you visit a podiatrist?			
Yes, I do	453 (95%)	204 (95%)	
No, I do not	23 (5%)	10 (5%)	NS
Do you wash your bedding and towels in a temperature > 60°C?			
Yes, I do	138 (29%)	62 (29%)	
No, I do not	338 (71%)	152 (71%)	NS
Are you aware that foot and nail fungus is a significant problem in society?			
Yes, I am	343 (72%)	109 (51%)	
No, I am not	133 (28%)	105 (49%)	< 0.001
Do you believe that informational campaigns about fungal infection prevention are necessary and effective?			
Yes, I do	428 (90%)	170 (80%)	
No, I do not	48 (10%)	44 (20%)	< 0.001

In the literature, it is mentioned that the prophylactic use of antifungal medications can help in prevention of the mycosis recurrence [15]. So far, no guidelines for mycosis prophylaxis have been developed for people at risk of mycosis, and the data are limited.

More attention is paid to educating the public on the principle that prevention is better than cure. Tinea pedis can lead to onychomycosis (59% of patients with onychomycosis also develop tinea pedis) [15]; therefore, treatment of tinea pedis should also be considered as a measure to prevent the development of onychomycosis.

There was a significantly higher incidence of dermatophyte infections among persons who attend a swimming pool at which there was no information on the prevention of mycosis, compared to those using a pool where you can find leaflets about mycosis. This exposes how important raising awareness is in relation to preventing this disease.

In literature we found 2 previous studies reporting on patients' self-recognition of onychomycosis [16, 17]. Patients were more likely to self-diagnose when experiencing complications such as paronychia, itching, pain or aesthetic changes. Women and young patients were more likely to be aware of their onychomycosis [17].

Conclusions

The results of any questionnaire study are largely impacted by the characteristics of the respondents - their age, sex, and socioeconomic status. This questionnaire study was primarily based on the responses from students, few of whom attend the swimming pools regularly. Perhaps this could be the reason why some of the results were different from other research, which often focused on professional swimmers or school children. Only 136 (19.7%) of the respondents attended the swimming pool regularly, so most of them were rarely exposed to mycotic infections from such an environment. This makes it difficult to properly assess the risk factors and potential prophylactic measures for dermatophyte infections. More reliable results could come from recruiting more respondents and by analysing only regular swimming pool visitors.

Funding sources

None.

Conflict of interest

The authors declare no conflict of interest.

References

1. Burzykowski T, Molenberghs G, Abeck D, et al. High prevalence of foot diseases in Europe: results of the Achilles Project. Mycoses 2003; 46: 496-505.
2. Nigam PK, Saleh D. Tinea Pedis. In: StatPearls. Treasure Island (FL): StatPearls Publishing; July 3, 2022.
3. Leung AKC, Lam JM, Leong KF, et al. Onychomycosis: an updated review. Recent Pat Inflamm Allergy Drug Discov 2020; 14: 32-45.
4. Gupta AK, Mays RR, Versteeg SG, et al. Global perspectives for the management of onychomycosis. Int J Dermatol 2019; 58: 1118-29.
5. Lipner SR, Scher RK. Onychomycosis: clinical overview and diagnosis. J Am Acad Dermatol 2019; 80: 835-51.
6. Gawdzik A, Nowogrodzka K, Hryncewicz-Gwóźdź A, et al. Epidemiology of dermatomycoses in southwest Poland, years 2011-2016. Adv Dermatol Allergol 2019; 36: 604-8.
7. Zhan P, Liu W. The changing face of dermatophytic infections worldwide. Mycopathologia 2017; 182: 77-86.
8. Gudnadóttir G, Hilmarsdóttir I, Sigurgeirsson B. Onychomycosis in Icelandic swimmers. Acta Derm Venereol 1999; 79: 376-7.
9. Daggett C, Brodell RT, Daniel CR, Jackson J. Onychomycosis in athletes. Am J Clin Dermatol 2019; 20: 691-8.
10. Auger P, Marquis G, Joly J, Attye A. Epidemiology of tinea pedis in marathon runners: prevalence of occult athlete's foot. Mycoses 1993; 36: 35-41.
11. Kamihama T, Kimura T, Hosokawa JI, et al. Tinea pedis outbreak in swimming pools in Japan. Public Health 1997; 111: 249-53.
12. Gupta AK, Elewski BE, Rosen T, et al. Onychomycosis: strategies to minimize recurrence. J Drugs Dermatol 2016; 15: 279-82.
13. Pasquarella C, Veronesi L, Napoli C, et al. Swimming pools and health-related behaviours: results of an Italian multicentre study on showering habits among pool users. Public Health 2013; 127: 614-9.
14. Farag AGA, Hammam MA, Ibrahem RA, et al. Epidemiology of dermatophyte infections among school children in Menoufia Governorate, Egypt. Mycoses 2018; 61: 321-5.
15. Ogasawara Y, Hiruma M, Muto M, Ogawa H. Clinical and mycological study of occult tinea pedis and tinea unguium in dermatological patients from Tokyo. Mycoses 2003; 46: 114-9.
16. Bunyaratavej S, Pattanaprichakul P, Leeyaphan C, et al. Onychomycosis: a study of self-recognition by patients and quality of life. Indian J Dermatol Venereol Leprol 2015; 81: 270-4.
17. Arenas R, Bonifaz A, Padilla MC, et al. Onychomycosis. A Mexican survey. Eur J Dermatol 2010; 20: 611-4.

Appendix

Nursing in Wroclaw, Peer Support 2013-2014 IFMSA Wroclaw, Peer Support 2014-2015 IFMSA Wroclaw, Peer support 2015-2016 IFMSA Wroclaw, Peer support 2016-2017 IFMSA Wroclaw, Peer support 2017-2018 IFMSA Wroclaw, Two Leks, Pharmacy students announcements, Nature University students Lublin, Students of Wroclaw Nature University, Peer Support Poznan Nature University, Catholic University of Lublin 2012-2017, SWSP students, physiotherapy students AWF Wroclaw 2013-2018, Peer Support 2013-2014 IFMSA Poznan, Peer support 2014-2015 IFMSA Poznan, Stomatology students Poznan, Architect students infos Poznan, Peer Support IFMSA 2013-2014 Warsaw, Peer Support 2015-2016 IFMSA Warsaw, Peer support 2016-2017 IFMSA Warsaw, CMUJ medical students, UMCS students infos, Building students announcements, Medical Students Gdansk, Lodz Medicine, Peer Support 2013-2014 IFMSA Lodz, Actors Bytom, CUL students, AGH students, 2013-2018, Peer Support 2015-2021 CMUJ, Triathlon Wroclaw.