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Study of Fungal Contamination of Indoor Public Swimming Pools

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Abstract

Fungi are found in different environments with variable distribution patterns depending on various factors. The aim of this study was determination of fungal contaminants in public swimming pools in Uromia, Iran. The fungal contaminations of four indoor swimming pools were studied by using membrane filtration and swab sampling method. Samples were collected by a manual plastic pump, in a 200 ml sterilized bottle. All samples were collected within 2 hours and then transferred to the laboratory. A total of 384 samples including water and environmental surfaces were collected and tested for the presence of fungi in different seasons within one year. In addition to the above information, some physical and chemical parameters such as temperature, residual chlorine, pH, turbidity of water and the number of swimmers were studied. Findings indicated that, the average temperature, pH, residual chlorine and turbidity of water in the swimming pools within one year were: 29.9°C, 8.1, 0.6 ppm and 0.8 NTU respectively. The most common fungi recovered were as follows: *Asepergillus* Spp. 56.25%, *Candida* spp. 22.9%, *Rhizopus* spp. 4.16 %, other filamentous fungi 16.6% and other yeast species 2.8%. The fungi such as *Alternaria*, *Cladosporium*, *Philophora* and *Trichophyton mentagrophyti*s were isolated from dressing room, bathing room and other places out of pools. According to these results and previous studies on pools, it has been indicated that contamination by fungi in the pools is not significant in water and environment. Presence of dermatophytic fungus from dressing room is probably due to human contact.

Keywords: *Fungi, Fungal contamination, Uromia, Iran*

Introduction

The water in swimming pools cannot be a good carrier for transmission of fungal diseases but can be a source of fungi, so environmental surfaces may be contaminated by many species of fungi, and transmit them to swimmers.

Public indoor swimming pools are one of the recreation centers which many people use every day, so, they can be contaminated by infectious agents, saprophytic fungi and other micro organisms(1). Fungi are found in different environments with variable distribution patterns depending on various factors. The most important of which is human association (2, 3). In order to control this endemic problem, adequate preventive measures must be taken. It has been proven that swimming pools may contribute to the spread of fungi and to be a source of fungal infections according to these results. Fungal infections related to pools may bedermatophytosis, otomycosis, and etc (1, 4, 5). People using swimming pools, due to wet conditions of external ear, among fingers and inguinal tract, are susceptible to fungal infection.

In this case, the fungi such as *Aspergillus*, *Candida*, *Penicillium*, *Rhizopus* and dermatophytes have pathogenicity for otomycosis and wrinkle skin respectively (6).

Several authors have reported on the occurrence of dermatophytes, as well as other fungi, from swimming pools (1, 7, 8, 9).

The main objective of the present research was to determine fungal contamination of four indoor public swimming pools for the first time in Uromia, in order to promote the knowledge of swimmers and people to observe health

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regulations to control and prevent the fungal disease.

Materials and Methods

In this research a descriptive-cross sectional method was used. Samples from water of four indoor public swimming pools including: (Shahrdary =1, Janbazan = 2, Haft- Tir = 3 and University = 4) of Uromia city were taken in four seasons during one year, in 2001. A plastic manual pump was used to take sample from swimming pools. From total 348 samples, 248 samples were collected from disinfected swimming pools in compliance with American Public Health Association (APHA) standard methods (10). A sufficient amount of sodium thiosulfate was present in the sampling bottles to neutralize the chlorine residual in the samples. All samples were processed immediately upon arrival. For each swimming pool sampling was carried out two times per month, first and fifteenth. Samples were filtrated through millipore filters with 0.45 micrometer size. Filters were transferred to three different culture media including Saboroud dextrose agar, Saboroud + chloramphenicole + cyclohexamide and Malt extract agar 2%. The plates were incubated at 25°C for 3 weeks and examined at frequent intervals. Other samples (n=100) were collected from environmental places of swimming pools such as: foot washing sink, bathrooms, dried sauna rooms, walls and floor around the pools. Sampling was carried by carpet (a piece of sterilized carpet in the size of 4×6 cm^2). Sampling from dried surfaces and swab sampling for wet samples that were rubbed against the surfaces and then wrapped, again in sterile aluminum foil and transferred to the laboratory. All carpet pieces were shaken over the culture media and the swabs were rubbed inoculating to agar under a biologic hood. The plates were incubated for 3 weeks at 25ºC and tested at frequent intervals and fungal growth was determined by the routine laboratory methods, especially slide culture (5, 11).

Results

Findings of this research regarding to the physical and chemical parameters indicated that the average temperature, pH, residual chlorine and turbidity of water were: 29ºC, 8.1, 0.6, mg/l and 0.8 NTU respectively. Moreover, the average daily number of swimmers during summer season were more than others (Mean = 385).

The fungi isolated from water of swimming pools included saprophytic filamentous fungi and species of yeasts. The fungi isolated from environmental surfaces were: saprophytic filamentous, "yeast and dermatophytic fungus, *Mentagrophytics* isolated from dressing room. Table 1, shows the frequency and percentage of above fungi in each swimming pool with related environmental surfaces. Findings indicated that no dermatophytes were recovered from water samples, indeed the fungi isolated from water samples were common saprophytic flora and their presence in pools water was not significant. Frequency and percentage of the fungi isolated from the different environmental places of swimming pools are shown in Table 2. According to the results, fungi species such as *Aspergillus*, *Penicillium*, *Cladosporium*, and *Candida* were in high frequency that was isolated from environmental surfaces. Moreover dermatophytic fungus, "*Mentagrophytis"* was the most important fungus isolated from dressing room. The most frequent fungi isolated from environmental surfaces were: *Aspergillus* 53%, *Penicillium* 51%, *Cladosporium* 45%, *Candida* 23% and low frequent cases were *Exophila*, *Crysosporium*, and *Phoma*.

Results also showed that from total 284 samples of water pools, 48 cases (18.6%) of fungal contaminations were observed and the most common ones were: *Aspergillus* 56.25%, *Rhizopus* 4.16%, *Candida* 29.9% and 16.6% others (Fig1).

Table1: Frequency and percentage of fungal groups in water and environmental surfaces

Cases pool	Place of sample	Dermatophyte N	Dermatophyte %	Yeast N	Yeast %	Filamentous N	Filamentous %
1	water	0	0	2	18.2	17	45.9
	places	1	100	10	35.8	74	37.3
2	Water	0	0	3	27.3	12	32.4
	places	0	0	5	17.8	43	21.8
3	water	0	0	5	45.5	5	13.5
	places	0	0	12	42.8	61	30.7
4	water	0	0	1	9	20	8.2
	places	0	0	1	3.6	20	10.2
total	water	0	0	11	100	37	100
	places	1	100	28	100	198	100

Table2: Types of fungi in different places of four swimming pools

Pool fungi	1		2		3		4		Total	
	N	%	N	%	N	%	N	%	N	%
Ulocladium	2	100	0	0	0	0	0	0	2	100
Aspergillus	21	39.6	8	15	16	30.1	8	15	53	100
Alternaria	1	14.2	1	14.2	5	71.4	0	0	7	100
Fusorium	2	40	1	20	2	40	0	0	5	100
Rhizopus	5	41.6	3	25	4	33.3	0	0	12	100
Penicillium	21	41.1	13	25.6	17	33.3	0	0	51	100
Acremonium	3	60	1	20	1	20	0	0	5	100
Cladosporium	16	41.1	10	22.2	11	24.4	8	17.7	45	100
Arthriniumq	0	0	2	100	0	0	0	0	2	100
Rhodotorub	3	60	1	20	1	20	0	0	5	100
Candida	7	30.4	4	17.39	11	47.8	1	4.34	23	100
Phialophrera	4	57.1	1	14.2	1	14.2	1	14.2	7	100
Exophiala	0	0	1	100	0	0	0	0	1	100
Crysosporium	0	0	1	100	0	0	0	0	1	100
Phomo	0	0	1	33.3	2	66.6	0	0	3	100
Trichophyton	0	0	0	0	0	0	1	100	1	100
Mucorr	0	0	0	0	2	40	3	60	5	100

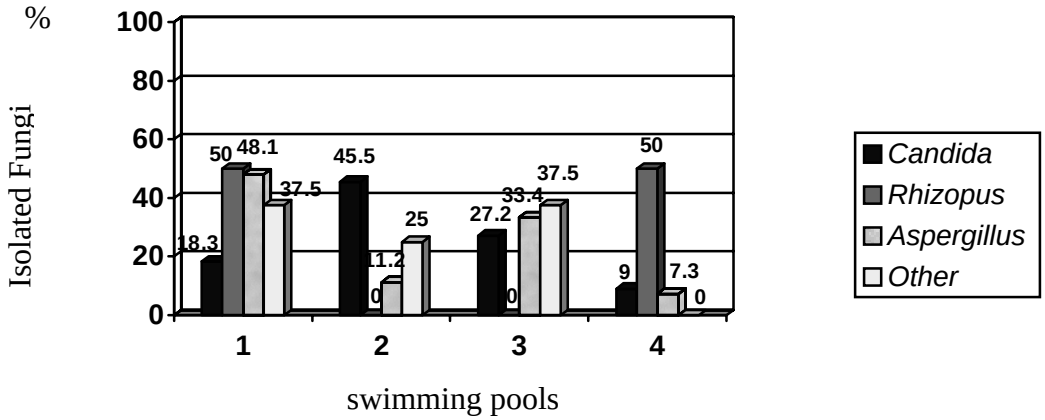

Fig. 1: Types of isolated fungi from swimming pools

Discussion

Many studies have indicated that the sanitary quality of indoor public swimming pools is a concern for swimmers due to swallowing and contact with water. Furthermore, it has been shown that swimming pools contribute to the spread of fungi and other organisms (1, 12) because of their common usage.

Thus, the environmental sanitation of swimming pools is very important. Testing of some factors such as: pH, temperature, and residual chlorine are critical for swimming pools. A study carried out in the United States showed that, assessing the above factors with 95% confidence level can justify the contamination of swimming pools (13). In the present study, we examined these factors during one year (4 seasons) for swimming pools; water and environments, and then compared them with standard levels. The average of free residual chlorine in swimming pools water was 0.6 ppm, less than the standard level, i.e. 1-2 ppm (10, 14). Moreover, 85% of swimming pools had free residual chlorine less than the standard level. Fisher stated that normal concentration of chlorine does not inhibit the growth of fungi (7). The mean temperature of water was 30.1ºC, more than the standard level, i.e. 24.5°C-25.5ºC (15).

Increasing these factors more than the standard level may create growing of biological agents in the swimming pools. Anderson illustrated that the optimum temperature for the growth of fungi is between 20° C and 30° C, while the temperature higher than 45° C caused to stop growing of fungi (16). Feuerman showed that in swimming pools which had been disinfected with chlorine, no dermatophytes were isolated (17). Some authors have done studies concerning the presence of dermatophytes in water and different places of swimming pool areas (1, 7, 12).A study was carried out in 40 swimming pools in Tehran and 4(10%) dematophytes were isolated (18). Shadzi has investigated 4 indoor swimming pools in Isfahan and concluded that dematophytes were only isolated from dressing rooms and bathrooms. Morover, the occurance of dematophytes and some fungal species which are known to be opportunistic pathogens might be related to the low concentration of disinfectants, daily average of swimmers and attendance of bathers with fungal infections in public swimming pools(19).Vissent in France isolated *T.mentagrophytes*, *T.rubrum* and *Epidermphhytone flacosum* from swimming pools water (20). In Australia some fungi were isolated from the floor of swimming pools and dressing rooms through carpet sampling method (21).

In our study a strain of dermatophytic fungus, *T.Mentagrophytis* was isolated from dressing room for only once. Presence of this dermatophyte, could be related to contact of swimmers with Tinea pedis or the other type of dermatophytosis to floor or walls of the room.

Some authors (22, 23, 24) indicated that, swimmers with Tinea pedis could spread debris containing dermatophytes on the floor of pools. Bolanos (22) in 1991 studied on Tinea pedis among students enrolled in swimming courses at university pool. Tinea pedis was determined on twelve of swimming pools.

The most common agent of Tinea pedis in a study was *Trichophyton rubrum* (82%), whereas infections by *Trichophyton mentagrophytis* (9%) and *Epidermophyton floccosum* (9%) were less common. Results also showed that, no dermatophytes were recovered from any of 30 floor samples taken from the bathroom and pool facilities. In another study the following dermatophytes were isolated from students' feet: *T. mentagropgtis* (70%), *T. rubrum* (17.6%) and *Candida* albicans (11.8%). On this occasion *T.mentagrophytis* was recovered from 5 out of 30 floor samples. Another study was carried out regarding Athlete's foot (23). Results showed a significant incidence of occult athletes' foot in swimmers. Maghzay (8) isolated *T.terrestre*, *T.mentagrophytis* and *Microsporum gypseum* from water of two swimming pools in Egypt. The authors stated

that, isolation of above dermatophytes might be a continuous contamination of the swimming pool water by fungi through air, soil and human bodies. In our study, no dermatophytes were isolated from water; the reason may be related to the different techniques used for research or residual chlorine in water. Zaror isolated *T.mentagrophytis* from the bath rooms (3) which support our findings.

Our findings showed a relationship between the numbers of swimmers and the number of isolated fungal cases. The higher number of isolated fungal cases may be related to the higher number of swimmers (average daily 385) and lowest amount of residual chlorine (0.06mg/l) where as, swimming pool No. 4 with lower number of swimmers (150 daily) and high amount of residual chlorine (1.5mg/l) had the lowest number of isolated fungi (Fig 1).

Through this study we can conclude that the occurrence of dermatophytes and some pathogenic fungi in swimming pools are rarely related to high control of hygiene of pools, efficiency of residual chlorine for inhibiting growth of these fungi. However, it is recommended that the managers of swimming pools must pay more attention to the residual chlorine based on standard level and environmental sanitation of swimming pools because of high frequency isolation of saprophytic filamentous fungi and yeasts from water of swimming pools.

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