Mycological assessment of selected swimming pools of recreational centers around the University of Port Harcourt, Nigeria.

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ABSTRACT

Aims: This study was carried out to determine the physicochemical properties and mycological safety of four swimming pools within and around the University of Port Harcourt, Rivers State, Nigeria.
Study design: Random sampling design was employed.
Place and Duration of Study: Department of Microbiology laboratory, University of Port Harcourt, between August and October, 2024.
Methodology:A total of 8 samples were collected before and after patronage by patrons from 4 swimming pool. Standard methods were employed for the physicochemical parameters such as pH, turbidity and residual chlorine as well as the enumeration for molds using potato dextrose agar.
Results: The pH values ranged from 4.50 to 10.00. The Nephelometric Turbidity Unit ranged from 0.45 to 0.90 NTU while the residual chlorine ranged from 0.36 to 355.00 mg/l. The fungal counts ranged from 1 to 9 cfu/ml, while the isolated species on the basis of cultural morphology and microscopic characteristics were identified as species of *Fusarium*, *Penicillium*, *Aspergillus*, *Histoplasma*, *Rhodotorula*,*Microsporium* and *Trichophyton*.
Conclusion: This study has revealed a potential health risk associated with the use of water of the examined recreational facilities due to none compliance with the WHO standard of < 1 cfu/100ml for fungal and the other parameters, suggesting a public health concern and need for effective interventions.

Keywords: Chlorine, molds, physicochemical properties, swimming pool, yeast

1. INTRODUCTION

Water is among the most important natural resources crucial for life processes in both plants and animals playing prominent roles in food production and processing, transportation, power generation, cooling industrial machines, irrigation, recreation amongst others [1, 2]. However, contaminated water, irrespective of the intended use poses serious threats by serving as a medium for disease transmission [3].

A swimming pool is an enclosed body of water of limited size contained in a holding structure, patronized by different classes of people for leisure activities such as sports or rehabilitative treatment [4]. Pools can be built into the ground (in-ground pools) or built above ground; as a freestanding construction or as part of a building or other larger structures, aboard ocean-liners and cruise ships. Pools in most hotels or other guest houses are exposed to contamination from body fat and human waste materials such as nasal secretions, saliva, sweat, faecal, urine and body lotions and creams [5].

Public pools can infect individuals based on the fact that public pools do not use environmentally sound disinfectant agents in the water, rather brominating agents are used, when these brominating agent gets mixed with carbon- friendly substances such as urine, hair, skin, cosmetics and sunscreen it becomes toxic [6]. Reported injuries from swimming pools include asthma [7, 8], skin and eye irritation, neurological disease conditions [9, 10, 11] and other skin infections, especially fungal foot disease or athlete's foot and genital infections resulting from bacterial, fungal, protozoan and viral agents [4, 11, 12, 13, 14, 15, 16, 17].

The fungal species previously isolated from the swimming pool samples included *Cephalosporium* spp., *Fusarium* spp., *Penicillium* spp., *Rhizopus* spp., *Aspergillus* spp., *Trichophyton mentagrophytes*, *Mucor* spp., *Candida albicans*, *Aspergillus niger*, *Alternaria* spp., *Absidia* spp. and *Trichophyton* spp.[18, 19, 20, 21].

The assessment of a variety of physical-chemical parameters at the time of collection, such as pH, turbidity, and free accessible chlorine, as well as the presence of fungi could also predict the quality of pool water which is the focus of this present study.

2. MATERIAL AND METHODS

2.1 Study area

The four swimming pools used for this study, were hotel swimming pools in communities around the University of Port Harcourt, Port Harcourt. The test samples were obtained directly from the swimming pools just before washing and refilling of the pool by the management.

2.2 Determination of Physicochemical parameters

The various physicochemical parameters analyzed were pH, turbidity and residual chlorine. These were all carried out according to the analytical methods described in Standard Methods for Water and Wastewater Analysis [22].

2.3 Enumeration of Total Fungi

Samples of the swimming pool water samples were serially diluted in ten folds. Then the molten potato dextrose agar at 45^oC was supplemented with 1% lactic acid and poured into the Petri dishes containing 0.1 ml of the appropriate dilution for the isolation of the total fungi. They were swirled to mix and colony counts were taken after incubating the plates at room temperature ($29\pm2\ ^oC$) for 48 to 72 h. Colonies from primary plates were purified on freshly prepared Potato Dextrose agar supplemented with 1% lactic acid for identification

2.4 Characterization and Identification of Fungal Isolates

Fungal isolates were examined macroscopically and microscopically using the needle mounts technique. Their identification was performed according to the scheme of Barnett and Hunter and Larone [23, 24].

3. RESULTS AND DISCUSSION

The presence or absence of pathogenic molds and yeast in recreational water has a crucial role in determining the health risk connected with swimming, as it can spread infectious diseases such as skin, eye, and ear infections [25].

3.1 Physicochemical parameters

Recreational water does not provide drinkable water to humans anywhere in the world. Its quality needs to be on par with drinking water due to the high danger of microbial contamination from the environment and the fact that many swimmers inadvertently consume it while swimming. The results of the examined parameters are presented in Table 1. The turbidity, with the exception of a single pool water collected before patronage were within the WHO acceptable limit (0.5). The values obtained in this present study were within the range (0.22-12.61 NTU) reported by Ajadi et al. [21] in examined swimming pools in Osogbo metropolis, western Nigeria but are below the 38.00 to 90.00 NTU reported by Agomuo and Amadi [26] from swimming pools in Owerri, the Imo State capital.

The pH of some pools was either below or above the WHO acceptable limit (7.2 -7.8). Some of the values obtained in this study were comparable to the 5.6 to 6.7, 6.8 to 7.1 and 4.48 to 7.70 reported by Agomuo and Amadi [26], Eze et al. [20] and Ajadi et al. [21], respectively. The low pH of 4.50 to 5.00 in two pools, will make the water more acidic hence patrons may experience burning eyes, itchy skins and easily ripped swimming clothes.

The residual chlorine in this present study (0.36-355.00) with the exception of a sample were higher than the WHO limit <3.0. Similar higher values of 221±6.0 to 294±10.0 have been reported by Eze et al. [20]. Elevated chlorine levels could lead to higher operational expenses and an increased risk of corrosion and scaling.

Table 1. Physicochemical parameters of swimming pool water

Parameters	USC Pool		MBL Pool		MH Pool		HH Pool		WHO Limit
	BS	AS	BS	AS	BS	AS	BS	AS	
Residual Chlorine (mg/l)	355.00	0.36	21.30	7.10	177.50	35.5	14.20	7.10	<3.0
Turbidity (NTU)	0.45	0.45	0.45	0.45	0.90	0.45	0.45	0.45	0.5
pH	10.00	6.68	5.00	5.00	7.10	7.10	4.50	4.50	7.2-7.8

BS=Before swimming; AS=After swimming

Osei-Adjei et al. [27] have posited that chlorine's ability to react with foreign particles diminishes as pH rises and that only about 20% of the chlorine applied to the pool can be utilized at pH 8.0 because the chlorine reacts with carbonates to generate scale. The water in the pool turns murky and aggravates skin. Free (residual) chlorine levels should be maintained within limits set by national, local regulations or WHO recommendations as low free chlorine encourages the growth of microorganisms in pool water, while high amounts can cause irritation to skin, eyes, and upper respiratory tracts as well as the production of disinfection byproducts such trihalomethanes [28].

Table 2. Identification of the fungal isolates

IC	Cultural characteristics/appearance on PDA	Microscopic features using low power magnification and lactophenol cotton blue	Tentative organism
MH (BT) a	Brown sporing/granular surface and light cracked reverse	Vesicles are hemispherical and phialides are produced from a primary row of metulae. Phialides produce globose to elliptical conidia arranged in chains.	*Aspergillus* spp.
MH (BT) b	White woolly surface and light reverse	Hyphae are small and septate and give rise to phialides that produce single-celled microconidia.	*Fusarium*spp.
MH (BT) c	Black sporing/granular surface and light cracked reverse	Septate hyphae with long conidiophores that support spherical vesicles that give rise to large metulae from which long chains of conidia are produced.	*Aspergillus* spp.
MH (BT) d	Dull white, coarse woolly surface and light reverse	Smooth club-shaped, thin-walled macroconidia with 3-8 septa.	*Trichophyton* spp.
MH (BT) e	Dull white woolly surface and light reverse	Smooth club-shaped, thin-walled macroconidia with 3-8 septa.	*Trichophyton*spp.
MH (AT) a	Flat, white with a dense suede-like to downy surface	Large spindle shape-shaped multisegmented macroconidia with curved ends	*Microsporium*spp.
UPSC (AT)a	Black sporing/granular surface and light cracked reverse	Septate hyphae with long conidiophores that support spherical vesicles that give rise to large metulae from which long chains of conidia are produced.	*Aspergillus* spp.
UPSC (BT) a	Dense woolly white surface and light reverse	Large, rounded, single-celled, 8-14 µm in diameter, tuberculate macroconidia formed on short, hyaline, undifferentiated conidiophores.	*Histoplasma* spp.
UPSC (BT) b	White woolly surface and light reverse	Hyphae are small and septate and give rise to phialides that produce single-celled microconidia.	*Fusarium*spp.
UPSC (BT) d	Dull white, coarse woolly surface and light reverse	Smooth club-shaped, thin-walled macroconidia with 3-8 septa.	*Trichophyton*spp.

MBLH (BT) a	Orange, 2mm, round, raised, smooth, shiny, white surface and light reverse	Oval shaped cells appearance single, budded, clustered.	*Rhodotorula*spp.
MBLH (BT) b	Dull white, coarse woolly surface and light reverse	Smooth club-shaped, thin-walled macroconidia with 3-8 septa.	*Trichophyton*spp.
MBLH (AT) a	Blue velvet surface and light reverse	Hyphae are hyaline and septate and produce brush-like conidiophores.	*Penicillium*spp.
MBLH (AT) b	Dull white, cottony surface and light reverse	Smooth club-shaped, thin-walled macroconidia with 3-8 septa.	*Trichophyton*spp.
MBLH (AT) c	White fluffy surface and light reverse	Hyphae are small and septate and give rise to phialides that produce single-celled microconidia.	*Fusarium*spp.

3.2 Mycological count and identity

The study revealed that the mycological quality of the examined swimming pool water (1 to 9 cfu/ml) generally exceeded WHO's limit (<1 cfu/100ml). The presumptive identities of the isolated molds are presented in Table 2. The predominant mold was *Trichophyton* spp. (33.33%), followed by *Aspergillus* spp. and *Fusarium* spp. (20.00% and the least occurring were jointly *Penicillium*, *Histoplasma*, *Microsporium* and *Rhodotorula* (6.67%). These molds and some yeasts have been reported in swimming pools by several researchers from different locations and countries [18, 19, 20, 21, 29]. Among these are *Aspergillus*, *Penicillium* and *Trichophyton* which have been implicated in human illness. According to Alice [30], *Aspergillus niger* isthe causative agent of aspergillosis, which is typically an external ear infection (otomycosis) that can cause tympanic membrane perforation and ear canal ulceration. Additionally, *Aspergillus* has been documented to serve as a gateway for the spread of diseases in people with weakened immune systems [31]. *Trichophyton mentagrophyte* is the etiologic agent of nails and feet infections. It is responsible for ringworm in the buttocks, groin, beard hair, and scalp. Prescott et al. [32] reported that *Fusarium* is known to cause eye infections in both humans and animals.

4. CONCLUSION

The results of this study revealed that the physicochemical parameters examined and mold counts from the pools exceeded the WHO's acceptable limits thereby, underscoring the necessity of heightened monitoring of swimming pool water quality. Maintaining ideal pH, and chlorine levels, as well as using flocculants to keep water clear, are all important aspects of proper water management that are essential to stopping the spread of fungal illnesses. Regular inspection and testing of the swimming pools will guarantee all year-round, low-maintenance and safe swimming pool.

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