Physicochemical and Bacteriological Studies of Selected Swimming Pool Water in Ilorin Metropolis, Kwara State, Nigeria

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Abstract: Ten swimming pools at different locations were selected for the analysis. Samples were collected three times each in an interval of 14 days and analyzed physio-chemically and bacteriologically using standard methods. Sixty-seven (67.0%) of the selected samples from six locations were within the pH range of 6.2 – 7.3 while the remaining 33.0% exceed the WHO standard limit. The dissolved oxygen (DO) in this study ranges from 0.2-15.1 mg/L with only 47.0% of the samples tested are within the permissible limit of WHO standards while the remaining 35.0% exceed the permissible standards limit. The Total Dissolved Solids (TDS) ranges from 11-855mg/L and 63.0% of the samples analyzed are within 11-453mg/L while the remaining 37.0% exceed the WHO standard limit (500 mg/L). The turbidity of the samples ranges from 75 and above which do not meet the WHO standard (1NTU). Thirty-seven (37.0%) of the samples analyzed for electrical conductivity are not within the range of WHO standard (1000µs). Total heterotrophic count, *E. coli* count, *Salmonella* and *Shigella* count of the samples ranges from 1.0 x 10^3 - 8.9 x 10^3Cfu/mL, 0.0 x 10^3 - 1.1 x 10^3Cfu/mL and 0.0 x 10^3 - 2.0 x 10^3Cfu/mL respectively. Only 23.0% of the samples analyzed were satisfactory, 37.0% were suspicious while the remaining 40.0% were unsatisfactory in accordance with WHO standard for coliform organisms. The results suggest that the swimming pools do not meet the WHO standards for recreational water. It indicates either deficiencies in treatment of the swimming pool or inadequate protection of untreated water sources. However, proper hygiene and management of the swimming pool facilities is recommended.

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1. Introduction

The increase of water borne disease outbreak and illness related to public swimming facilities in the past few decades suggest a need to analyze the bacteriological composition of swimming pool facilities to better protect public health safety. The preservation of swimming pool water quality is a universal necessity that demands attention on the part of sanitation authorities and agencies, particularly with regard to water source and for human consumption in as much as their contamination by human and animal can become a vehicle for transmission of infectious and parasitic disease.

According to the World Health Organization, 80% of diseases that occur in the developing world are caused by contaminated water. Water remains the major source of transmission of enteric pathogen in developing countries. The contaminated water can lead to a variety of diseases including diarrhea, skin, ear and upper respiratory infections particularly if swimmer's head is submerged or water swallowed. Children may spend long period in recreational water and are more likely than adults to intentionally or accidentally swallow water (Babaniyi, 2000).

Public swimming facilities are continually contaminated with harmful bacteria from urinary and faecal accidents, various orifice, washings and other forms of bacterial contamination. Public swimming facilities can be compared to dilute sewage if not properly maintained, filtered and disinfected (Koren and Bisesi, 2003; CDC, 2008). Reports indicate that between 1978 and 2004, a steady increase had occurred in recreational water illness resulting in more than 30,000 illness and over 170 outbreaks (CDC, 2008). In many cases, the risk of illness or infection has been limited to faecal contamination of the water.

Swimming pools may be private, semipublic or public, and may be supervised or unsupervised (WHO, 2006). There are also temporary or portable pools, diving pools and pools with special features like hot tubs and plunged pools. Swimming pool water may become contaminated by pathogenic microorganisms entering the pool directly or indirectly through contaminated air, soil, dust, rain water, sewage, human or animal excrement (such as droppings from birds) and individual bathers (Cruickshank *et al*., 1975 and Podewils *et al*., 2007).

Unless water is adequately treated, contamination may lead to outbreak of diseases such as skin ulcers, gastroenteritis, conjunctivitis, trachoma, ear infection such as otitis media, cholera, dysentery, eczema and skin rashes (Cairncross *et al*., 1980 and UNDP, 1989). Vomit, mucus, saliva or skin of infected users can directly contaminate pool water. The surfaces of object or material at a facility with pathogens which may lead to skin infection in users who come in contact with the contaminated water or surfaces. Opportunistic pathogens can also be shed from users and transmitted via surfaces and contaminated water.

Contaminated swimming pools water can lead to variety of disease including skin ulcer, diarrhea, conjunctivitis, trachoma, ear infection, eczema, skin rashes, pharyngo-conjuctival fever which is an infection of the eyelid or throat. Report indicates that between 1977 and 2004, a steady increase has occurred in recreational water illness resulting in more than 30,000 illnesses and over 170 outbreaks (Alice, 1977; CDC, 2008). This increase in disease outbreak and illness suggest a need to analyze the bacteriological composition of swimming pool water for better protection of public health and safety.

The aim of the present study is to assess the sanitary condition of swimming pool water samples in Ilorin metropolis, Kwara State, Nigeria through physicochemical analysis, examine it bacteriologically using standard methods and compare all parameters to the WHO standard for recreational water standards.

2. Materials and Methods

2.1. Sample collection

A total of 30 samples comprising of three each of ten swimming pools were obtained from different sites within Ilorin metropolis. The sample bottles were labeled A – J based on the site of collection and period of collection. The samples were aseptically collected in an interval of two weeks period and were immediately taken in cold packs under aseptic condition to the laboratory for analysis. The sample, sample site and the code is presented in Table 1.

In this study, thirty (30) samples of pools water collected from different sites in Ilorin metropolis, Kwara State, Nigeria were tested for physicochemical parameter and the presence of bacteria using standard methods.

Table 1: Sample Code and Their Location

S/n	Location	Sample	Code
1	Irewolede	Bovina Hotel	A
2	G.R.A	Kwara Hotel	B
3	G.R.A	Kingstone Hotel	C
4	Tanke	Bekadims Hotel	D
5	Taiwo	Stadium	E
6	Offa Garage	Royal shekina Hotel	F
7	G.R.A	Success Hotel	G
8	Offa Garage	Stella Obasonjo	H
9	Pipeline	Princess Luxury Hotel	I
10	G.R.A.	Private Home Pool	J

2.2. Physicochemical Analysis

The swimming pool water samples were examined in terms of physicochemical parameters using the standard procedures of the American Public Health Association, (APHA, 1992) and American Water Works Association (AWWA, 1993). The parameters measured include the following: pH, Dissolved Oxygen, Total Dissolved Solid**,** Turbidity and Electrical Conductivity (EC).

2.3. Bacteriological Analysis

The standard pour plate method was used. Ten-fold serial dilution of each sample was prepared aseptically in sterile physiological saline up to 10^{-3} dilution factor and 0.1mL aliquot of each dilution was seeded onto duplicates sterile agar plates of Nutrient Agar (oxoid), Eosin Methylene Blue Agar (oxoid), MacConkey Agar, MacConkey Broth, *Salmonella/Shigella* Agar. The plates were properly swirled and incubated at 37^{o}C in an inverted position for 24 -48 hours under aerobic conditions. Different cultere plates were examined for microbial growth after incubation time. Colonies were counted using the colony counter (Gallenkamp, England). The number of colony forming units per ml (cfu/mL) was calculated by multiplying the number of colonies by the dilution factor. The counts were used to estimate total heterotrophic count, total *E. coli* count, total Salmonella/Shigella count and total feacal coliforms which was incubated at 44^{o}C.

2.4. Data analysis

The values obtained for total heterotrophic count, total *E. coli* count, *Salmonella/Shigella* count and feacal coliform count were subjected to analysis of variance.

3. Results

3.1. Physico-chemical Analysis

The results of the physicochemical analysis of water as shown in Table 2 reveals the various parameters of each pool for the triplicate data collected. About 67.0% of the selected samples from six locations were within the pH range of 6.2 – 7.3 while the remaining 33.0% were below the WHO standard limit. The swimming pool water samples from Bovina Hotel, Stadium, Royal Shekina Hotel and Success Hotel have the pH range from 4.2 - 6.5 which did not conform to the WHO standards (Table 2).

The dissolved oxygen (DO) in this study ranges from 0.2 - 15.1 mg/L with only 47.0% of the samples tested are within the permissible limit of WHO standards while the remaining 53.0% exceed the permissible standards limit. Only the swimming pool water samples from Bovina Hotel, Kwara Hotel, and Princess Luxury Hotel have the DO range from 0.2 - 15.1 mg/L, in line with the WHO standards while only the third samples from Stadium and Royal Shekina Hotel were within the permissible limits. The Total Dissolved Solids (TDS) ranges from 11-855mg/L. Sixty-three percent (63.0%) of the samples analyzed are within 11-453mg/L while the remaining 37.0% (Kingstone Hotel, Bekadims Hotel, Stella Obasonjo and Private Home Pool) exceed the WHO standard limit (500mg/L) as shown in Table 2.

The turbidity of the samples ranges from 72.0 to 107.4 (NTU) which exceed the WHO standard (1NTU). About 37.0% of the samples analyzed for electrical conductivity are not within the range of WHO standard (1000µs). Water samples from Stella Obasonjo and Private Home Pool were not within the permissible limit while only one sample out of the three samples taken from Kingstone Hotel and Bekadims Hotel are within the recommended limit (Table 2).

Parameters/Units	Code	A	B	C	D	E	F	G	H	I	J	WHO STD
Disolved Oxygen (mg/L)	1	1.3	0.2	9.8	7.0	4.9	4.8	7.6	9.8	6.5	15.1	**7.5**
	2	3.5	0.4	8.2	9.6	6.7	6.7	7.7	9.7	7.4	14.5	
	3	3.4	0.2	10.2	9.4	7.6	7.6	9.5	11.5	6.0	14.8	
Ph	1	5.0	6.7	6.6	6.6	4.6	4.5	4.2	6.2	7.3	6.7	6.5-
	2	5.0	6.9	6.7	6.6	4.6	4.3	46.	6.5	7.3	6.7	8.5
	3	5.0	6.7	6.7	6.7	4.7	6.5	6.3	6.5	7.2	6.7	
Total Dissolved Solids(mg/L)	1	454	11	854	372	157	232	374	831	154	836	500
	2	438	11	453	853	272	262	358	782	211	853	
	3	337	11	855	826	228	442	844	850	213	834	
Electrical Conductivity (µs)	1	908	21	1716	748	313	471	750	1705	320	1708	1000
	2	879	23	908	1706	454	526	734	1564	422	1675	
	3	754	23	1676	1661	456	885	1670	1696	410	1698	
Turbidity (NTU)	1	99.4	107.4	100.1	97.2	98.8	99.3	99.6	99.4	97.8	99.8	1
	2	97.1	99.9	72.0	95.0	93.1	98.2	97.6	99.4	99.1	99.4	
	3	98.2	99.4	91.5	100.2	100	100.0	98.3	100.0	97.0	96.8	
Appearance	1	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear
	2	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	
	3	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	
Odour	1	INO	INO	INO	INO	INO	INO	INO	INO	INO	INO	INO
	2	INO	INO	INO	INO	INO	INO	INO	INO	INO	INO	
	3	INO	INO	INO	INO	INO	INO	INO	INO	INO	INO	

Table 2: Physiochemical Analysis of the Swimming Pool Water Studied

Key: ND= Not detected INO=Inoffensive

3.2. Bacteriological analysis

The results of the bacteriological analysis of water as presented in Table 3 reveals that the Total heterotrophic count, *E. coli* count, *Salmonella*/*Shigella* count and Feacal Coliform count for the samples ranges from 0.0 x 10^3 - 5.4 x 10^4Cfu/mL, 0.0 x 10^3 - 4.0 x 10^3Cfu/mL, 0.0 x 10^3 -

8.0 x 10^3Cfu/mL and 0.0 x 10^3 - 3.0 x 10^3Cfu/mL respectively (Table 3).

Table 3: Bacteriological Characteristics of the Swimming Pool Water Studied

S/N	CODE	Total Heterotrophic Count (cfu/mL)	*E. coli* Count (cfu/mL)	*Salmonella* and *Shigella* Count (cfu/mL)	Feacal Coliform at 44°C (cfu/mL)	Remarks
1	A_1	2.0 x 10^3	0.0 x 10^3	0.0 x 10^3	1.0 x 10^3	Satisfactory
2	A_2	3.0 x 10^3	0.0 x 10^3	0.0 x 10^3	1.0 x 10^3	Suspicious
3	A_3	2.8 x 10^4	0.0 x 10^3	8.0 x 10^3	1.0 x 10^3	Unsatisfactory
4	B_1	2.0 x 10^3	0.0 x 10^3	0.0 x 10^3	1.0 x 10^3	Satisfactory
5	B_2	5.0 x 10^3	0.0 x 10^3	0.0 x 10^3	1.0 x 10^3	Unsatisfactory
6	B_3	1.0 x 10^3	0.0 x 10^3	0.0 x 10^3	1.0 x 10^3	Unsatisfactory
7	C_1	3.0 x 10^3	0.0 x 10^3	0.0 x 10^3	1.0 x 10^3	Satisfactory
8	C_2	2.7 x 10^4	0.0 x 10^3	2.0 x 10^3	3.0 x 10^3	Suspicious
9	C_3	1.5 x 10^4	0.0 x 10^3	0.0 x 10^3	1.0 x 10^3	Unsatisfactory
10	D_1	1.0 x 10^3	0.0 x 10^3	0.0 x 10^3	2.0 x 10^3	Unsatisfactory
11	D_2	4.7 x 10^4	0.0 x 10^3	0.0 x 10^3	3.0 x 10^3	Unsatisfactory
12	D_3	1.0 x 10^3	0.0 x 10^3	0.0 x 10^3	1.0 x 10^3	Unsatisfactory
13	E_1	7.0 x 10^3	1.0 x 10^3	0.0 x 10^3	1.0 x 10^3	Suspicious
14	E_2	0.0 x 10^3	2.0 x 10^3	0.0 x 10^3	1.0 x 10^3	Suspicious
15	E_3	4.0 x 10^3	4.0 x 10^3	0.0 x 10^3	2.0 x 10^3	Unsatisfactory
16	F_1	1.0 x 10^3	1.1 x 10^3	0.0 x 10^3	1.0 x 10^3	Unsatisfactory
17	F_2	1.5 x 10^4	0.0 x 10^3	0.0 x 10^3	1.0 x 10^3	Suspicious
18	F_3	1.2 x 10^3	0.0 x 10^3	2.0 x 10^3	1.0 x 10^3	Suspicious
19	G_1	1.0 x 10^3	0.0 x 10^3	0.0 x 10^3	0.0 x 10^3	Suspicious
20	G_2	2.0 x 10^3	0.0 x 10^3	0.0 x 10^3	0.0 x 10^3	Satisfactory
21	G_3	5.3 x 10^4	0.0 x 10^3	1.0 x 10^3	0.0 x 10^3	Suspicious
22	H_1	1.0 x 10^3	3.0 x 10^3	2.0 x 10^3	2.0 x 10^3	Unsatisfactory
23	H_2	3.0 x 10^4	0.0 x 10^3	0.0 x 10^3	1.0 x 10^3	Suspicious
24	H_3	1.1 x 10^4	0.0 x 10^3	1.0 x 10^3	1.0 x 10^3	Satisfactory
25	I_1	0.0 x 10^3	0.0 x 10^3	0.0 x 10^3	1.0 x 10^3	Unsatisfactory
26	I_2	2.0 x 10^3	0.0 x 10^3	0.0 x 10^3	1.0 x 10^3	Suspicious
27	I_3	4.0 x 10^3	0.0 x 10^3	1.0 x 10^3	0.0 x 10^3	Satisfactory
28	J_1	2.2 x 10^4	0.0 x 10^3	0.0 x 10^3	2.0 x 10^3	Unsatisfactory
29	J_2	8.9 x 10^3	0.0 x 10^3	0.0 x 10^3	1.0 x 10^3	Suspicious
30	J_3	1.0 x 10^3	0.0 x 10^3	1.0 x 10^3	0.0 x 10^3	Satisfactory

Note: Satisfactory = 7 Suspicious = 11 Unsatisfactory = 12

3.3. Most Probable Number (MPN) for Selected Swimming Pool Water Samples in Ilorin Metropolis

The MPN results presented in Table 4 were interpreted using the standard MPN table of American Public Health Association (APHA, 1998). Out of the three samples obtained from each location, only the first sample from Bovina Hotel, Kwara Hotel and Kingstone Hotel; the second sample from Success Hotel; and the third sample from Stella Obasonjo, Princess Luxury Hotel and Private Home Pool were within the satisfactory range for bacteriological analyses (Table 4). Only 23.0% of the samples analyzed were satisfactory, 37.0% were suspicious while the remaining 40% were unsatisfactory in accordance with WHO standard for coliform organisms. The results suggest that these swimming pools do not meet the WHO required standards for recreational water. It indicates either deficiencies in treatment of the swimming pools or inadequate protection of untreated water sources (Table 4).

Table 4: Most Probable Number for Selected Swimming Pool Water Samples in Ilorin Metropolis.

S/N	Sample Code	Double Strength 10mL	Single Strength 1.0mL	Single Strength 0.1mL	MPN/100mL	Remark
1	A_1	0	0	0	0	Satisfactory
2	A_2	1	3	3	29	Suspicious
3	A_3	3	3	3	1100+	Unsatisfactory
4	B_1	0	0	0	0	Satisfactory
5	B_2	3	3	3	1100+	Unsatisfactory
6	B_3	3	3	3	1100+	Unsatisfactory
7	C_1	0	0	0	0	Satisfactory
8	C_2	0	3	3	19	Suspicious
9	C_3	3	3	3	1100+	Unsatisfactory
10	D_1	3	3	2	1100	Unsatisfactory
11	D_2	3	3	3	1100+	Unsatisfactory
12	D_3	3	3	3	1100+	Unsatisfactory
13	E_1	1	0	0	4	Suspicious
14	E_2	0	3	3	19	Suspicious
15	E_3	3	3	3	1100+	Unsatisfactory
16	F_1	3	3	0	240	Unsatisfactory
17	F_2	0	3	2	16	Suspicious
18	F_3	2	0	0	9	Suspicious
19	G_1	0	2	2	12	Suspicious
20	G_2	0	0	0	0	Satisfactory
21	G_3	1	3	0	16	Suspicious
22	H_1	3	3	3	1100+	Unsatisfactory
23	H_2	1	2	2	20	Suspicious
24	H_3	0	0	0	0	Satisfactory
25	I_1	3	3	3	1100+	Unsatisfactory
26	I_2	0	2	2	12	Suspicious
27	I_3	0	0	0	0	Satisfactory
28	J_1	3	3	3	1100+	Unsatisfactory
29	J_2	0	2	2	12	Suspicious
30	J_3	0	0	0	0	Satisfactory

Note: Satisfactory = 7 Suspicious = 11 Unsatisfactory = 12

4. Discussion

The physicochemical analysis of pool water samples taken from different residential areas in Ilorin metropolis are presented in Table 2. These pools were sampled three times each in an interval of 14days. Parameters like Dissolved Oxygen (DO mg/L), Total Dissolved Solids (TDS mg/L), Acidity or Alkalinity (pH), Turbidity (NTU) and Electrical Conductivity (μs), were examined and compared with World Health Organization standards for recreational water.

The dissolved oxygen (DO) reflects the physical and biological processes prevailing in the water. The dissolves oxygen ranges from 0.2 to 15.1 mg/L. These range showed that some pools values were within the permissible limit of WHO standards while some like (Kingstone Hotel, Stella Obasonjo hotel and the Private pool) were above the permissible standards limit of 7.5 mg/mL.

The present study shows that 67.0% of the selected water samples were within the pH range of 6.2 – 7.3 while the remaining 33.0% were below the standard limit of 6.5 – 8.5 stipulated (WHO, 2004). Those with the low pH might be due to the high level of free CO_2 which may consequently affect the bacterial counts (Edema *et al*., 2001). Water samples from Bekadims Hotel, Kwara Hotel, Kingstone Hotel, Princess luxury Hotel, Private Home Pool and Stella Obasonjo were within the pH range approved by WHO as the standard for drinking water which ranges from 6.5 to 8.5 (WHO, 2004), while the likes of Bovina Hotel, Stadium, Royal Shekina Hotel and Success Hotel were not. Moreover, Sule and Oyeyiola (2010) reported similar work on Kwara Hotel, Bekadims, Kingstone, and Success swimming

pools with a little different result from this research finding. (The pH of Kwara hotel, Bekadims, Kingstone and success as was reported in 2010 was 5.2, 6.2, 7.0, 6.9 while they showed 6.9, 6.6, 6.7 and 4.6 in the present study). The difference may be due to the time, maintenance culture, and the quality of pools users. The pH of the swimming pools water prior to use after disinfection and after used ranged from 4.8 to 6.9 and 6.4 to 7.6 respectively.

The Total Dissolved Solids has been associated with natural source, sewage industrial wastewater, urban run-offs and chemical used in water treatment process (EPA, 2002). Most of the pools values were within the WHO standards limits (500 mg/L) while few of them like Kingstone hotel, Stella Obasonjo and Private pool were not. The pools value ranges from 11 to 855 mg/L.

Electrical Conductivity is known to be a proxy indicator of total dissolved solids (WHO/UNICEF, 2010). Kingstone hotel, Bekadims hotel, Stella Obasonjo and private pool water samples electrical conductivities did not conform to the limit stipulated by the WHO standard. The WHO standard is 1000µs and the values of the pools ranges from 21 to 1716µs. Those above the WHO standard may be due to too much of ions present in the water.

Though little direct health risk associated with conductivity was documented, but high values are associated with poor taste, consumers dissatisfaction and complaints (Howard et al., 2003; WHO, 2004). The conductivity of water varies considerably by geological region, owing to differences in the mineral and chemical properties of the water body. However, changes in conductivity over time, and high conductivity values, indicate the water is contaminated, which makes the water unsafe for recreational purposes.

Turbidity presents an important aspect in water quality. The low values of turbidity in these samples can be attributed to the fact that the total suspended solids in the water samples were very low while high turbidity as detected in this work could be associated with high level of diseases causing microorganisms such as bacteria and other parasites (Shittu *et al.,* 2008).

Out of all the pool water samples analysed, 23.0% had a satisfactory result, 37.0% had unsatisfactory while 40.0% were suspicious. First sampling from Bovina hotel, Kwara hotel, Kingstone, Success and second sampling from Stella Obasonjo, Princess and Private pool were satisfactory; Royal Shekina and Stadium were suspicious while most of the second and third sampling of all the pools was unsatisfactory. The satisfactory rate for the WHO Standard (2008) ranges from 0-3 Cfu/mL, the suspicious rate ranges from 4-6 Cfu/mL and while the unsatisfactory rate range from 6 Cfu/mL and above.

The heterotrophic count of the pools ranges from 0.0 x10^3 - 5.3 x 10^4, the *E. coli* count ranges from 0.0 x 10^3 - 4.0 x 10^3 while the *Salmonella/Shigella* count ranges from 0.0 x 10^3 - 8.0 x 10^3. Kingstone hotel, Success hotel and Stella Obasonjo exhibited the highest heterotrophic plate count. Third sampling of water in Stadium has the highest *E. coli* count of 4.0 x 10^3. Also, the third sampling of Bovina hotel has the highest *Salmonella/Shigella* count of 8.0 x 10^3.

Also, the total bacterial count of the pools water carried out by Sule and Oyeyiola (2010) prior to use and after used ranged from 2 to 2800 Cfu/mL and 140 to 3000 Cfu/mL respectively. The total coliform count ranged from zero to 200 Cfu/mL and 4 to 300 Cfu/mL before and after used while their corresponding values of faecal coliform were zero to 4 Cfu/mL and zero to 6 Cfu/mL.

Based on the universally accepted WHO standard (2008), the high incidence of coliform obtained from the swimming pools in this study is not in-line with the recommended criteria of swimming pool safety. This is because according to WHO (2003), no sample from a pool should contain any coliform organism above 3 Cfu per 100mL of water. The presence of significant members of any coliform in swimming pool indicates either deficiencies in treatment of the swimming pool or inadequate protection of the source of untreated water (Borchardt and Walton, 1971).

5. Conclusion

This study has shown that few of the swimming pools in Ilorin Metropolis met the WHO standard bacteriologically, which could constitute a serious threat to the public health. Though, few of the physicochemical standards were in concordant except for the turbidity, dissolved oxygen, and total dissolved solids, it therefore become necessary that efforts should be made towards proper sanitation and regular monitoring of swimming pools in order to minimize public health hazard. It is also recommended that the pool operators should be sensitized about the maximum bathing load and should ensure that it is not exceeded during the operation of pool. Breastfeeding mothers and Menstruating women should not be allowed into the swimming pool because of the chances of breast milk and menstrual discharge dropping in the pool water. Children pool should be separated from adults. Bathers should be educated on various hygiene and precautions to be taken such as encouraging swimmers to bathe before and after swimming.

Footbaths should be provided to minimize soil contamination.

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