ISSN 0975 -8542

Journal of Global Pharma Technology

Available Online at www.jgpt.co.in

RESEARCH ARTICLE

Studying the Status of Biological and Physico-Chemical Indicators of Swimming Pools of the City Kermanshah (Iran) in 2016

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Abstract

Swimming pools are the most attractive and popular of sports centers. Swimming has constructive effects on human physical and mental health care and lack of proper sanitation and disinfection Regulations of water in swimming pools is led to health problems and infectious disease transmission among swimmers. The aim of this study was to evaluate and compare the results of swimming pools in Kermanshah with the national standards. This study was descriptive-sectional and carried out in 2016 in 24 active pools in Kermanshah city by collecting statistics. In the survey in addition of the characterization of Public Pools Through interviews, heterotrophic bacteria, fecal coliforms, Pseudomonas aeruginosa, Staphylococcus aureus and physicochemical parameters such as residual chlorine, turbidity were assessed in the sampling sites and were recorded in the relevant forms. All calculations were performed with SPSS software (version 16) and statistical significance was considered 0.05. The results showed that from 99 samples in 15.2% of Pseudomonas aeruginosa has exceeded the standard level. In addition, 17.2% Staphylococcus aureus, 15.2% and the amount of fecal coliform, 17.2% bacteria heterotroph and 17.2% of residual chlorine levels were out of the standard limit. According on the results, residua chlorine, Staphylococcus aureus, Pseudomonas aeruginosa, fecal coliform, heterotroph bacteria indicators had the minimum compliance with standard levels which indicates the need for continuous monitoring of physical, chemical and biological indicators of water as well as filtration and disinfection of water. It also recommended alternative antibiotics.

Keywords: *biological, physical, chemical, swimming pool, Kermanshah, Iran.*

Introduction

Aesthetic and recreational use of water is one of the uses of water in each community (1-5). The uses of natural or synthetic aqueous chambers have long been considered by mankind. So that, nowadays swimming is considered as a physically and psychologically recreational activity and exercise (6). In our country, such places especially from the private sector are increasing day by day. Regarding health issues and aspects of swimming pools for the health and well-being of swimmers is very important. The health of the water quality is important in this context (7).

So that the source of water must have an appropriate physical, chemical and biological Features and the characteristics are maintained at an optimal level over the years. In swimming pools, the human body will be directly in contact with water (8). Also The water immersion may cause water entering the mouth, nose, ear and eye (9).

Therefore, chemical and biological contamination, disease transmission will happen (10). On the water coliform bacteria, thermophilic, heterotrophic, Pseudomonas and Staphylococcus, pH, turbidity and chlorimetry tests is done (11). Studies show that formulating health measures to prevent water-borne diseases is an important factor which has a direct impact in purifying contaminated water in swimming pools and swimmers health.

Therefore, in the water quality study of swimming pools, physical and microbial factors are quality of health indicators of swimming pools standards that regulates each of them has a major role in the prevention of diseases (12).

New Indicators of physical factors such as turbidity, total coliform bacterial agents and substances, pH, E. coli, Pseudomonas aeruginosa and Staphylococcus aureus and methicillin-resistant bacterial resistance to chlorine has been evaluated. HPC heterotrophic bacteria plate count as the most important indicator of water disinfection performance, coliforms as an indicator of fecal contamination and Staphylococcus aureus and Pseudomonas aeruginosa as indicators of water health hazard are considered (14). In a descriptive study, Ghaneian and his colleagues the quality of the physical, chemical and biological swimming pools in Yazd was conducted in 2011 (15).

According to the results the population of heterotrophic bacteria indicators, as well as alkalinity and temperature had the minimum compliance with standard, which suggests the need for continuous monitoring of physical, chemical and microbial indicators as well as control of biological filtration and disinfection of water (16).

In a study (2007) in Spain, the findings showed that the pollution of swimming pools which were fed from chlorinated sea water and fresh water was due to Staphylococcus aureus in the first place and secondly due to mycobacterium species (17). Mohammad Ali Zangi Abadi (2013) evaluated health indicators of water quality of Swimming Pools in Urmia. According to the results, full compliance with the standards of water quality was relatively weak and continuous monitoring of free residual chlorine and pH adjustment considered as an important factor in maintaining good water quality for swimming pools (18).

Material and Methods

The study was descriptive - analytical and 24 active swimming pool in Kermanshah, were studied in terms of microbiological status of the water. In this study, 99 samples were taken from swimming pools.

The all under studied pools were indoors with water treatment system and flow rotation and retention time was 6 to 8 hours. Of examined pools in this study, water supply of 19 was urban water supply system and in five cases, their water was supplied from specific wells. In order to assess the quality of the samples in 500 ml sterile, wide span bottles with 10 drops of sodium thiosulfate solution (to neutralize

the residual chlorine water) were selected and with ice were transported to the laboratory and tested immediately. Time range for swimming pools sampling was between 9 am to 10 pm. Samples were taken at a time that swimmers were present to show the real critical conditions. The Sampling point was draining water from the pools. For sampling, Bottle Caps in the depth of 30 to 40 cm below the surface was opened then; it was rotated to the vertical position till water entered into the bottle and reached the mark.

The sampling method was in a way that empty space at the top of the bottle stay up for easy mixing before the experiments were carried out. All samples were taken in the afternoon. Free residual chlorine and PH parameters by chlorine meter were measured (with Karyzab models made in Iran) at the pool sites. Also, the turbidity was measured by the turbidity meter (HANNA model made in Italy).

Microbial tests in accordance with the procedures outlined in Standard Methods of water and sewer were determined in the laboratory water of health and sanitation department. In terms of biological indicators, the number of fecal coliform was determined by multi tube fermentation technique and for estimating the density of Pseudomonas aeruginosa, Staphylococcus aureus membrane filter method was applied and for counting bacteria and heterotrophic, plate count method was used based on standard methods for water and wastewater instructions (edition 21).

On this basis, total coliforms were diagnosed by multi tube fermentation technique with Lactose broth medium (the probability stage) and fecal coliform using multi tube fermentation method with broth EC environment was studied. Also IMVIC test was used for fecal coliform type. In this manner, positive EC samples were transferred to EMB environment. After 24 hours of isolated colonies was transferred to the environment -SIM-MR-vp Simon citrate and finally after 24 hours, fecal coliform type was detected according to the obtained tests and the results. (19). finally, the results obtained were analyzed by SPSS software and standard method comparison (20).

Results and Discussion

Table 1: Mean and standard deviation of turbidity, chlorine and MPN

Variable	number	Minimum	maximum	average	STD
turbidity	99	0	8	1.24	0.878
Chlorine	99	0	3	1.10	0.896
MPN	99	0	1150	20.32	124.203

Table 2: The frequency and percentage of pool

Pool type	frequency	percentage
Shallow	25	25.3
Deep	24	24.2
Jacuzzi hot	22	22.2
Cold Jacuzzi	21	21.2
Children	7	7.1

Table 3: percentage of samples taken from each pool.

Number pool	Abundance	Percent
1	4	4
2	2	2
3	9	9.1
4	4	4
5	4	4
6	4	4
7	5	5.1
8	4	4
9	4	4
10	4	4
11	5	5.1
12	3	3
13	4	4
14	4	4
15	4	4
16	2	2
17	5	5.1
18	6	6.1
19	4	4
20	4	4
21	4	4
22	4	4
23	5	5.1
24	1	1

Table 4: Frequency of microorganisms in water

microorganisms	Test result	Abundance	Percent
Staphylococcus aureus	Positive	17	17.2
Pseudomonas	Negative	82	82.8
Coliforms	Positive	84	84.8

Staphylococcus aureus	Negative	15	15.2
Pseudomonas	Positive	84	84.8
	Negative	15	15.2

Table 5: Frequency of Antibiogram Test result

Variable	Test result	Frequency	Percent
Antibiogram	Resistant	17	17.2
	Non-resistant	82	82.8

Increasing usage of the swimming pools besides improper maintenance and monitoring them can cause serious risk to public health. In the present study about microbial water quality, data showed that microbial indicators examined in pools in some cases did not meet the standard of swimming pools (21-24). As data showed that Staphylococcus aureus causing of the skin, eye infections and inflammation of the external ear, urinary tract infection and impetigo and has detected in the nasal mucosa, skin, and human feces (22).

The maximum acceptable level of bacteria in swimming pool water is 50 per 100 ml which in this study, the average population of the bacterium was the 17.2% in 100 ml. Pseudomonas aeruginosa is another indicator bacterium which is found in water, vegetation and soil and transfer to the swimming pool from infected humans and the environment (24). Such bacteria should not be present in swimming pool water, but in this study the number of 15.2% was detected in 100 ml. Staphylococcus aureus and Pseudomonas aeruginosa are considered as indicators of water health hazard.

In a study by Papadopoulou and colleagues in 2008 in northwestern Greece was performed to evaluate of swimming pools, 67% of samples comply with microbiological standards, and 32.9% of the samples were above the standard level which shows better results than the present study. In a study, Martins and colleagues assessed water quality of swimming pools in Sao Paulo, Brazil; the most positive results were related to HPC (70.4%), total coliforms (13.3%), Staphylococcus aureus (9.1%) fecal streptococci (7.7%) fecal coliform (5.6%) and Pseudomonas (2%), respectively (25).

In a study Yousefi (2009) assessed the situation of swimming pools in Sari , the results showed that there has been a of Staphylococcus aureus on 91.3% of samples. which showed better conditions than present study. Also his research revealed that there's an adverse relationship between chlorine and the presence of Staphylococci (26). which in consistent with the present. Results of water samples show the presence of Pseudomonas aeruginosa.

This bacterium is not considered as indicator of water quality for swimming pools. But because it can cause ear infections, throat, eyes, urinary tract and dermatitis are of special importance (25).

According to information obtained from the study of 15.2% of cases, Pseudomonas values is greater than zero, indicating that water has been polluted to the bacterium. Given that the standard level of Pseudomonas is zero in 100 ml, results indicate similar situation with other researches on swimming pools.

Such bacteria and E. coli are sensitive to the presence of chlorine in the pool water which is a strong evidence for incomplete disinfection of pools in Gorgan during the research. It says that is the residual chlorine is desirable and using appropriate filtration systems and chlorination and lack of environmental pollutants entering into the pool water can eliminate this bacterium and other important bacteria and thereby ensured the health of swimmers.

Measuring water quality in swimming pools is mainly using fecal contamination indicator bacteria. According to standards, fecal coliforms must be zero which in the present study, this parameter contamination showed 15.2%. Among the indicator bacteria in some samples, heterotrophic bacteria and total coliform were more than the standard value; which the present study confirms the 15.2% pollution; Statistical results show the direct dependence between residual chlorine and pollution targets. In a study conducted on swimming pools in Milan, Italy the number of non-standard bacteriological samples was 36% (27).

Also, in a study conducted on swimming pools in Colorado, USA, Results show that

about 11% of pools Bacteriological samples were more than the standard amount. In this study, the main cause of pollution was lack of adequate and proper utilization of the pool filtration systems (28). Pearson correlation test showed an inverse relationship between free residual chlorine and bacteria, the study also confirmed by Rakestraw and colleagues as well as the Martins et al. (25, 29, 30). Also in the research on isolates Staphylococcus aureus, coagulase test and antibiotic sensitivity test were conducted.

Conclusion

The aim of this study was to evaluate and compare the results of swimming pools in Kermanshah with the national standards. This study was descriptive-sectional and carried out in 2016 in 24 active pools in Kermanshah city by collecting statistics. the results, residua chlorine, Staphylococcus aureus, Pseudomonas aeruginosa, fecal coliform, heterotroph bacteria indicators had the minimum compliance with standard levels which indicates the need for continuous monitoring of physical, chemical and biological indicators of water as well as filtration and disinfection of water. It also recommended alternative antibiotics.

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