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Comparison of Chemical, Biological and Physical Quality Assessment of Indoor Swimming Pools in Maragheh City, Iran in 2015

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ABSTRACT

Swimming pools being some of the popular sport centers are able to potentially receive some pollutants such as nasal secretions, saliva and urine and endanger the health of swimmers. The aim of this study was to determine the chemical, biological and physical quality of swimming pools in Maragheh city. This research was a cross-sectional study. Totally, 120 water samples were collected from five public swimming pools in Maragheh, Iran. Microbial and physicochemical conditions were examined according to the standard method. The average of residual chlorine and pH in pools was 0.93±0.51 mg/L and 7.3±0.69, respec tively. The maximum and minimum of pH were 8.1 and 6.95 and for residual chlorine were 2.06 and 0.24 mg/L respectively. Out of 120 water samples examined, 90 (75%) conformed to the microbiological standards specified, and 30 (25%) exceeded at least one of the indicated limits. The positive samples contained at least one or several types of bacteria. Results indicated that S. aureus had the highest percentage frequencies while the least was exhibited by E. coli. It is recommended that health authorities should pay more attention to cleaning and disinfecting, to prevent infectious disease transfer as a result of contact with contaminated swimming pool.

Keywords: Maragheh, public swimming pools, water quality

INTRODUCTION

Water occupies about 70% of the earth surface and is considered the largest natural resource around us[1]. The importance of water includes drinking, washing, cooking, swimming, and also cooling the ecosystem[2]. Therefore, its importance to humans cannot be overlooked. But in spite of the awareness to safeguard our waters, the resource is still contaminated by pathogenic microorganisms[3]. Swimming is an active and healthy way to spend free time and is one of the popular activities in Iran[4]. It is also interesting and all friendly as a public sport and recreation[5]. cause various illness in public pools and expose bathers to diseases[6]. Nowadays, swimming in public pools has been recognized as one of the most important illness or infection transmission channel in the world[7]. The risk of various diseases related to swimming in pools has been associated with contaminated water due to body shedding of bathers includes body fluids such as urine, blood, saliva or vomit, hair, release of respiratory, digestive, and genital bacteria, and other harmful bacteria from skin[8-10]. A variety of microorganisms can be found in swimming pools, which may be introduced in the pool water in a number of ways[11, 12]. In many cases, the risk of illness or infection has been linked to faecal contamination of the water, due to faeces released by

bathers or a contaminated source water or, in outdoor pools, may be the result of direct animal contamination[13, 14]. Microorganisms detectable in swimming pools water usually originate from the skin, mucous membranes, clothing and faeces released by swimmers[15]. Contamination can also come from pets especially dogs that occasionally wander around these swimming pools as well as from debris already around the properties[16]. In this study, we determined the microbial and physiochemical water quality of five public and private swimming pools in the maragheh city-iran and compared the parameters to the World Health Organization standards for recreational waters.

MATERIALS AND METHODS

A cross-sectional study was conducted in five indoor swimming pools of maragheh city in northwest of Iran. This study was conducted between January to March, 2015. Before sampling a pre tested data collection were done through the direct observation of the environment of the selected swimming pools, interview with swimming pool operators to get information on the average number of swimmers, swimming bathing loads and average age group of pool users. The operators of the swimming pools were also interviewed for information about recycling of the swimming pool water, treatment methods of swimming pool water and disinfection and type of chlorine used.

Researchers decided to take 24 samples from each swimming pool and 120 samples in total. 120 specimen were collected in the morning and the evening in the 2015 from top, shallow and deep level for testing microbial by sterilized bottles and were immediately transferred to the lab. There were also 120 samples for testing chemical and physical water quality such as temperature , PH, chlorine residual, color, turbidity, dissolved oxygen, hardness. All samples were placed in cold storage (4 ℃) immediately after sampling.

Temperature, PH, chlorine residual, turbidity, dissolved oxygen were measured in situ. Alkalinity was determined by titration with sulfuric acid to a pH of 4.5. Hardness was determined by titration with a chelating agent, ethylenediaminetetraa- cetic acid (EDTA) and Eriochrome Black T as indicator.

All the sampling and analysis were carried out according to the standard water and wastewater experiments and the approved guidelines for microbial quality assessment of swimming pool water which have been published by Institute of Standards and Industrial Research of Iran. Thus, HPC bacteria, count of total coliform and E. coli, intestinal enterococci, and P. aeruginosa were found to be 5271, 3759, 3620, and 8869, respectively, using national standard methods(17-20). The parasitic quality and S. aurous were measured (microscope, Nikon model, and centrifuge Hettich model purchased from Japan) according to the methods approved by Institute of Standards and Industrial Research of Iran.

RESULTS

The total of 30 samples, all selected swimming pools in the maragheh were investigated. all of the selected swimming pools had a bathing load ≤200 per day. It was observed from the study that all the swimming pools operators claim to disinfect their pool water with chorine; but majority (20%) of the pool operators chlorinated their pools manually with powdered chlorine. All swimming pools were free from floating material during all visits and were clean during the sampling period.

The results of physico-chemical parameters in five indoor swimming pool water in maragheh city showed that the average of temperature was 28.02˚C and the minimum and maximum temperature were 25.2 and 31.85 ˚C, respectively. As depicted in Table 1, the average of residual chlorine and pH in pools was 0.93±0.51 mg/L and 7.3±0.69, respectively. The maximum and minimum of pH were 8.1 and 6.95 and for residual chlorine were 2.06 and 0.24 mg/L respectively.

Out of 120 water samples examined, 90 (75%) conformed to the microbiological standards specified in Table 1, and 30 (25%) exceeded at least one of the indicated limits. The positive samples contained at least one or several types of bacteria. The most important isolated types were E. coli, Clostridium perfringens, Staphylococcus aureus, Pseudomonas aeruginosa and Klebsiella pneumonia (30 samples). Figure 1 shows the percentage frequencies of isolates obtained in this study: Enterobacter aerogenes (40%), Clostridium perfringens (25%), Klebsiella pneumonia (30%), Escherichia coli (20%), Pseudomonas aeruginosa (65%), Staphylococcus aureus (80%) and Enterococcus

faecalis (40%). This indicated that S. aureus had the highest percentage frequencies while the least was exhibited by E. coli.

Table 1. Mean and standard deviations values of physico-chemical parameters of studied pools

parameters / Code	residual chlorine (mg/L)	pH	Temperature ℃	Turbidity NTU	Alkalinity mg/l ($Caco_3$)	hardness mg/l ($Caco_3$)
1	0.91±0.35	7.42±0.65	25.83±1.74	0.95±0.41	125±17.5	215±59.5
2	0.53±0.29	7.17±0.81	27.5±0.42	0.74±0.29	142±45.2	234±78.4
3	1.12±0.69	7.44±0.59	29.2±1.5	0.81±0.65	114.5±65.7	198.4±51.6
4	1.35±0.71	7.25±0.48	27.8±0.95	1.24±0.48	95.6±39.5	179.4±41.7
5	0.76±0.52	6.25±0.92	29.84±1.85	1.12±0.37	154.5±45.8	265.5±92.4
Total Average and SD	0.93±0.51	7.3±0.69	28.02±1.29	0.972±0.44	126.3±42.74	218.38±64.72

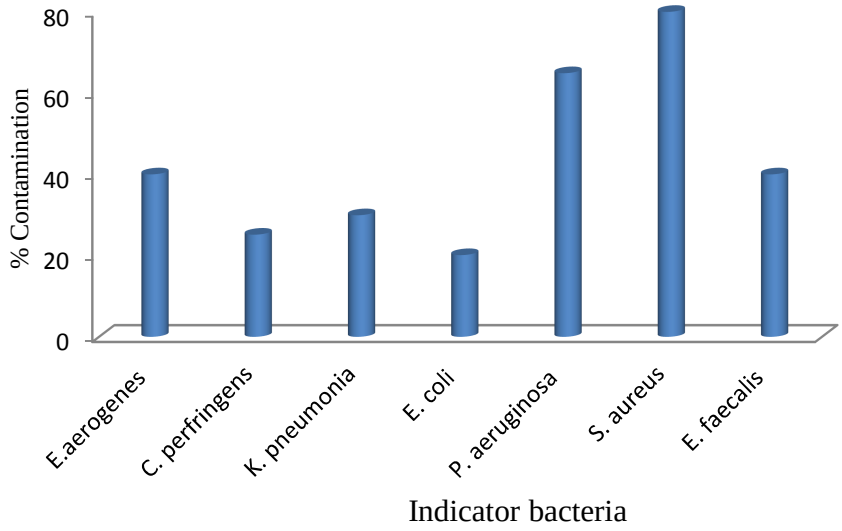

Fig. 1: Percentage (%) bacterial contamination of the surveyed swimming pools

DISCUSSION

In this study, physico-chemical parameters were lower or higher than standard levels, so it is necessary to pay more attention to the physico-hemical parameters. The pool water pH was at range of 6.95 to 8.1 and the average pH over the sampling period was 7.3 ± 0.69. Although, the gap between minimum and maximum values was high but also standard deviation is 0.69 units. According to guidelines, the recommended pH for swimming pool water is 7.2 to 8 ranges(21). Low pH of water can resulted in corrosive nature of water, skin and eye irritation, loss of chlorine, and skin stains in swimmers(22). In order to prevent eye irritation, the national standards recommended that in the water pH range from 7.2 to 8, free residual chlorine should be 0.5 to 2 mg/L and at range of pH 7.5 to 7.6, the amount of free residual chlorine should be 0.6 mg/L(21). In present study, the mean of free residual chlorine concentration was 0.93 ± 0.51 mg/L, hence it was lower than the national standard value. In our study, the main reason of low free chlorine residual were chlorination defect, presence ammonia nitrogen and organic matter. About 1 mg/l free chlorine residue is sufficient to reduce Escherichia coli, Legionella pneumophila, Pseudomonas aeruginosa, Staphylococcus aureus, and Candida(23). So, there was a positive relationship between the levels of microbial parameters and physicochemical conditions(24). It was shown that the swimming pools with particular desirability of physicochemical parameters (especially, free chlorine level) had a sufficient condition in terms of microbial quality(25).

In the current study, 35% of the samples were positive for bacteria, and different types of bacteria including E. coli, Proteus, Acinetobacter, P. alcaligenes, P. aeruginosa and K. pneumonia were isolated. In study in Greece, 32.9% of

the samples were contaminated and resistant bacteria such as P. alcaligenes, Staphylococcus aureus, P. aeruginosa and K. pneumonia were isolated (9).

Garrido Mata et al (26) in 2013 in Portugal, sampled different areas (such as surfaces, showers, etc.) as well as the pool and Jacuzzi water of a hotel, and observed Coliform bacteria such as E. coli, Pseudomonas and Staphylococcus in their samples. Also, in a study conducted by Balarak et al (27). about health indices of water in Urmia swimming pools, showed that the total coliform, heterotrophic plate count (HPC), and Pseudomonas aeruginosa in 40%, 11.6% and 21.1% of the samples were more than standard, respectively. In Hutcheson et al (28) study in Georgia, 42% of the samples contained E. coli and Pseudomonas. The results of this study are in line with the results of other studies; however, the percentage of bacterial contamination (25%) was less than other studies. This result indicates better hygiene control in the swimming pools of Maragheh.

CONCLUSION

According to the results presence of bacterial contamination may be related to hygiene level of pools, as well as physico-chemical parameters especially residual chlorine. In this study, physico-chemical parameters were lower or higher than standard levels, so it is necessary to pay more attention to the physico-chemical parameters, especially residual chlorine, by the managers of swimming pools. In general, monitoring of physico-chemical parameters in swimming pools can play an important role in control of pathogens.

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