Environmental Health Engineering and Management Journal 2015, 2(3), 123–128

http ehemj.com

Environmental Health Engineering and Management Journal

Original Article

Environmental Health Engineering and Management

Open Access Publish Free

Survey of bacterial contamination of environment of swimming pools in Yazd city, in 2013

Hossein Jafari Mansoorian[1], Salman Zarei[2*], Narges Khanjani[3]

[1]Lecturer, Environmental Health Engineering Research Center, Department of Environmental Health, Kerman University of Medical Sciences, Kerman, Iran.
[2]MSc of Environmental Health Engineering, Chief of Environmental Protection, Ilam Gas Company, Ilam, Iran
[3]Department of Environmental Health Engineering, School of Public Health, Kerman University of Medical Sciences, Kerman, Iran

Abstract

Background: Infections are readily transmitted as a result of bacterial contamination of swimming pools. Therefore, hygiene and preventing the contamination of swimming pools is of particular importance. The objective of this study was to determine the amount of bacterial contamination in indoor pools of Yazd in 2013.

Methods: In this descriptive and analytical study, all indoor swimming pools of Yazd (12 pools) were evaluated during the spring and summer of 2013, in terms of bacterial contamination. In order to determine contamination, a sterile cotton swab was used for sampling. On average, 45 samples were taken from different surfaces in each pool (shower, dressing room, sitting places in sauna, platforms and around the pool). In total, about 540 samples from all pools were tested for bacterial contamination.

Results: The results show that from 540 samples, bacterial contamination was observed in about 93 samples (17.22%); and was seen more in showers, edges of the pool and jacuzzis, and the slippers used in swimming pools. The most important isolated bacteria types were *E. coli, Actinobacteria, Pseudomonas alcaligenes, Pseudomonas aeruginosa* and *Klebsiella pneumoni*a.

Conclusion: The results indicate the presence of bacterial contamination on the surface of these places. It is recommended that health authorities should pay more attention to cleaning and disinfecting surfaces around the pool, showers, dressing rooms etc, to prevent infectious disease transfer as a result of contact with contaminated swimming pool surfaces.

Keywords: Bacterial contamination, Health indices, Swimming pools, Yazd

Citation: Jafari Mansoorian H, Zarei S, Khanjani N. Survey of bacterial contamination of environment of swimming pools in Yazd city, in 2013. Environmental Health Engineering and Management Journal 2015; 2(3): 123–128.

Article History:
Received: 23 June 2015
Accepted: 14 August 2015
ePublished: 7 September 2015

***Correspondence to:**
Salman Zarei
Email: : ab.salmanzarei@gmail.com

Introduction

Swimming is a sport that all ages enjoy. Swimming pools attract a lot of people, especially during warm seasons. However, due to mismanagement of these swimming pools and the poor quality of swimming pool water, the transmission of water borne diseases has become a serious problem worldwide (1). People who swim in these pools are in danger of acquiring various gastrointestinal, dermatologic, ear and upper respiratory tract infections. Also, eye complications can occur in people who use contact lenses (2-6). Studies show that in addition to water, some free living bacteria and amoebas, can live in swimming pool facilities (including warming systems, ventilation and air conditioning) or other humid surfaces and some of them may lead to various respiratory, dermatologic or neurologic diseases (7). Research shows that different infections are transmitted by direct or indirect contact with surfaces and facilities (8).

In swimming pools, there is a possibility of direct or indirect transmission of infections from one swimmer to another by eye, ear, upper airway or skin contact (9-11). Also, the dirty surfaces, toilet, wardrobe and personal devices of swimmers are capable of transmitting diseases (12). Generally, infections are transmitted by inanimate objects such as door handles, showers, toilet seats, cupboards and chairs. When these objects are in continuous contact with humans, they are the main source of transmitting infectious diseases and pathogenic organisms (13).

In order to prevent the transmission of bacteria, swimming pool operators should keep the inner surface of swimming pools and their surroundings clean. These surfaces increase the probability of transmission and also facilitate human contact with pathogens (14). In many circumstances, swimmers use the platform and chairs around the swimming pool for changing their clothes, and small particles may remain on the surface of their clothes and

the bacteria in these particles are easily transferred when these devices are used (15). Also, studies have shown that 35% of people do not take a shower before jumping into the pool and this can increase the probability of infectious disease transfer by several folds (16).

If recreational equipment inside and around pools are not properly cleaned, they can transmit microbes through unwashed hands (15). In these pools, dermal infections and rushes due to *Pseudomonas aeruginosa* have been reported (11). Certain microbes are capable of producing a slimy thin layer or biofilm, to protect them from disinfectants (15). When the biofilm is cleaned from the surface, the microorganisms are scattered in water.

Increase in the prevalence of water borne diseases and diseases related to public swimming facilities in the past decades, has shown that bacterial analysis of local swimming facilities is necessary for the health and safety of people (17). Therefore, to safeguard the health of swimming pool staff and swimmers, it is necessary to manage the health risks surrounding swimming pools (18). Yazd has a warm and dry climate. The swimming pools of this city can become a suitable place for the growth of fungi and bacteria. Therefore, this study was conducted to evaluate the bacterial contamination of surfaces in the swimming pools of Yazd, during the spring and summer of 2013. By determining the contamination rate of swimming pools in this city and using the results, appropriate action can be taken to promote health.

Methods

In this analytic and descriptive cross sectional study, all the active indoor swimming pools of Yazd, including 7 public (governmental) and 5 private pools, were evaluated through the spring and summer of 2013 in regard to bacterial contamination. The swimming pools studied were all indoor pools used by both men and women in different hours. Pools owned by specific organizations and those in residential complexes were excluded.

In order to determine bacterial contamination, sampling was done using a sterile cotton swap. All swimming pools were visited and different surfaces of the pool (including shower, changing rooms, chairs, sitting places in saunas, baths, platforms and around the swimming pools) were sampled and cultured. Sampling was done monthly and in two rounds in the morning and afternoon. Researchers decided to take 8 samples from each swimming pool and 576 samples in total. However, because parts of some swimming pools like the sauna and jacuzzi were closed due to repairs, in average 45 samples were randomly taken from different surfaces and totally, 540 samples from all swimming pools were examined for the presence of harmful bacteria. Researchers also attempted to find out the time of pool disinfection and conducted sampling at a time that is in compliance with sampling standards (19). This time was when the pool was crowded and the duration between disinfection time and washing of pool surfaces. Therefore, the sampling time was the same for all swimming pools.

Sampling was done using a sterile cotton swap from different surfaces of swimming pools. In order to do this, the swap was rubbed on surfaces with 20×20 cm area (19,20) and was then cultured separately on Blood Agar and Eosin Methylene Blue, manufactured by the Micromedia Company in Germany.

The media were then transferred to the microbiology laboratory at the Medical School and kept in the incubator for 48 hours at 37°C. Colonies were determined based on their appearance, gram color, differential tests such as coagulase, DNAse, sensitivity to novobiocin MR-VP, mannitol fermentation test, motivity and hemolysis test and culture on specific media, based on techniques mentioned in the book for standard techniques of water and wastewater experiment (19). Data analysis was done using frequency tables, descriptive statistics, proportions (percents) and also graphs from Excel 2013. Statistical analysis was done using SPSS version 16 and chi-square test.

Results

In this study, bacterial contamination of surfaces in indoor swimming pools of Yazd was evaluated and the relation between contamination and type of swimming pool (private or public), years of operation, location and site of sampling were recorded. From the 540 samples collected during spring and summer, 93 cases (17.22%) were contaminated and 447 (82.78%) were negative or without bacterial contamination. Figure 1 shows the contamination of swimming pools in different months. The positive samples contained at least one or several types of bacteria. The most important isolated types were *E. coli*, *Actinobacteria*, *Pseudomonas alcaligenes*, *Pseudomonas aeruginosa* and *Klebsiella pneumonia* (93 samples).

The positive samples were mainly from the changing cubicles, the edges of swimming pools and jacuzzis, diving platforms, cold and warm water tabs and slippers. The most contaminated samples were taken from 2 public and one private pool. Tables 1 and 2 show the frequency and type of bacterial contamination, according to type of

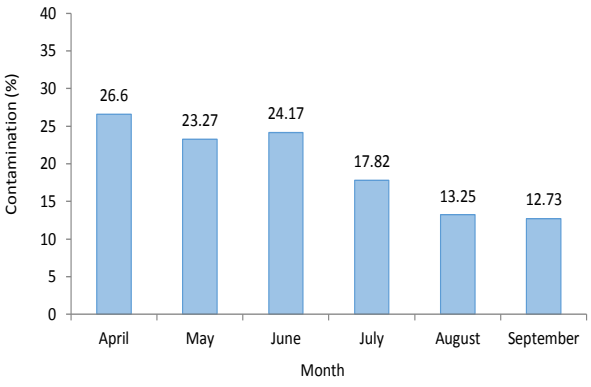

Figure 1. The distribution of bacterial contamination of the swimming pool surface by sampling month.

Table 1. The distribution of bacteria isolated from private and public (governmental) swimming pools

Swimming pools	Bacteria											
	E. coli		*Proteus*		*Pseudomonas*		*Actinobacteria*		*Klebsiella*		Total	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Private pools	24	25.8	1	1.07	5	5.38	0	0	3	3.23	33	35.48
Governmental pools	35	37.63	2	2.15	13	13.98	5	5.38	5	5.38	60	64.52

Table 2. The distribution of bacteria isolated from different parts of the swimming pools under study

Sampling site	Bacteria											
	E. coli		*Proteus*		*Pseudomonas*		*Acinetobacter*		*Klebsiella*		Total	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Changing rooms	5	5.38	0	0	0	0	0	0	0	0	5	5.38
Changing cubicles	5	5.38	0	0	2	2.15	0	0	1	1.07	8	8.6
Shower	13	13.98	0	0	4	4.3	1	1.07	2	2.15	20	21.5
Slippers	11	11.83	1	1.07	4	4.3	1	1.07	3	3.23	20	21.5
Platforms	1	1.07	1	1.07	1	1.07	0	0	1	1.07	4	4.3
Pool edges	8	8.6	0	0	1	1.07	0	0	0	0	9	9.68
Jacuzzi edges	6	6.45	1	1.07	2	2.15	2	2.15	1	1.07	12	12.9
Diving platforms	3	3.23	0	0	4	4.3	1	1.07	0	0	8	8.6
Sauna	3	3.23	0	0	0	0	0	0	0	0	3	3.23
Slide	1	1.07	0	0	0	0	0	0	0	0	1	1.07
Pool ladder	3	3.23	0	0	0	0	0	0	0	0	3	3.23
Total	59	63.44	3	3.23	18	19.35	5	5.38	8	8.6	93	100

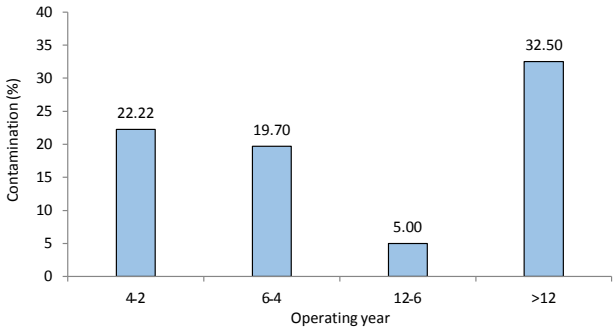

Figure 2. The distribution of bacterial contamination of the swimming pool surfaces by operating years.

pool and site of sampling. Also, in this study the rate of contamination was determined according to the operating years of the pool (Figure 2). The result of statistical analysis showed that there was a significant association between bacterial contamination and type of pool ($P<0.01$), operating years of pool ($P<0.01$) and site of sampling ($P<0.01$). But there was no relation between the rate of bacterial contamination and the sampling months ($P=0.067$).

Discussion

Studies show that the incidence of infectious diseases has increased in recent years. This may be due to increase in the population of vulnerable people or those with immunodeficiency and also increased contact of people with contaminated environments (20). This problem has been highlighted by different studies performed in Iran (21-26) and other areas of the world (10,12,27,28) about bacterial contamination of pools. In the current study, 17.22% 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.

Garrido Mata et al (29) 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. In Hutcheson et al (30) study, in Atlanta, 42% of the samples contained *E. coli* and Pseudomonas.

In another 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 (7). Also, in a study conducted by Mansoorian et al (31) about health indices of water in Kerman swimming pools, showed that the total coliform, heterotrophic plate count (HPC), and *Pseudomonas aeruginosa* in 100%, 14.6% and 31.4% of the samples were more than standard, respectively. The results of this study are in line with the results of other studies; however, contamination of *S. aureus* was not observed in our study and the percentage of bacterial contamination (17.22%) was less than other studies. This result indicates better hygiene control in the swimming pools of Yazd.

Based on the results, the highest contamination was seen in April and it decreased in the other months. Generally, bacterial contamination in spring (24.9%) was more than summer (15.76%). This increase maybe due to increase in the number of people visiting swimming pools after February (the winter season) and the unpreparedness of swimming pools to accept this extra load of visitors. As the weather gets warmer, the number of hygiene inspectors performing surveillance on swimming pools increases, resulting in a decrease in contamination. In Sohrabi et al (32) study in Zahedan, the highest bacterial contamination was seen in summer and was 26.5%, which is different from what was recorded in this study. This difference maybe because of the increase in the number of visitors in summer in comparison to spring, in Sohrabi et al study.

Also, in this study, the relation between bacterial contamination with pool type (private or public) and operation years of the pool was evaluated. The results showed that bacterial contamination was higher in public pools (64.52%) than private pools (35.48%), this is in line with the studies of Papadopoulou et al (7) and Tesauro et al (33). The reason might be that nowadays, the cost of running swimming pools has increased due to increase in the cost of detergents and disinfectants, cost of water, electricity, gas etc. This leads to increases in customer fees and decrease in service quality. The low level of environmental hygiene, detergents, disinfectants, lighting etc are due to financial problems and is seen more obviously in public pools.

The results of this study show that the percent of bacterial contamination in pools up to 12 years old, decreased with increase in operating years. The reason for the decrease in pool contamination may be due to increased management experience. But increase after 12 years is probably due to aging of the building and facilities of the pools. The results showed the most bacterial contamination in the changing cubicles, edges of jacuzzis, showers and slippers. This can cause disease in vulnerable people or those with immunodeficiency. It is necessary to observe hygienic regulations and inform people about the consequences of not obeying hygienic regulations, by hanging posters at the entrance of swimming pools and changing rooms. This will make swimmers more responsible and prevent the transmission of diseases by showering before swimming.

Conclusion

The aim of this study was to determine the amount of bacterial contamination in indoor pools of Yazd, in 2013. The results show that from the 540 samples collected during spring and summer, 93 cases (17.22 %) were contaminated and 447 (82.78%) were negative or without bacterial contamination. The most important isolated types were *E. coli*, *Actinobacteria*, *P. alcaligenes*, *P. aeruginosa* and *K. pneumonia* (93 samples). Based on the result of this study, contamination is higher in old swimming pools and is related to the weariness of the building and facilities. Therefore it is necessary to do critical repairs in these swimming pools and replace old and worn out equipment with new and appropriate ones. Also, the walls and surface should be covered with tiles for better cleaning. Also, it is recommended that the swimming pool directors should observe hygienic regulations completely and in addition to disinfecting pool water, pay more attention to the cleanliness and disinfection of pool surfaces, showers, changing rooms etc, to prevent the spread of infections.

Acknowledgements

The authors wish to thank the managers of the swimming pools of Yazd and also the members of staff of the microbiology labs, who cooperated with this study.

Ethical issues

We certify that all data collected during the study is presented in this manuscript and no data from the study has been or will be published separately.

Competing interests

The authors declare that they have no competing interests.

Authors' contributions

SZ designed the study. HJM performed the literature search and wrote the manuscript. NK carried out statistical analyses and significant improvement in English. All authors participated in data acquisition, analysis and interpretation. Also, all authors critically reviewed, refined and approved the manuscript.

References

1. Amburgey JE, Bowen JD, Fielding RR, Lu P, Arrowood MJ. Cryptosporidium reduction and outbreak risk: intelligently balancing filtration, disinfection, and recirculation subsystem efficiencies. Fifth International Conference Swimming Pool & Spa; Italy: Istituto Superiore di Sanità; 2013.
2. Rasti S, Assadi M, Iranshahi L, Saffari M, Gilasi H, Pourbabaee M. Assessment of microbial

contamination and physicochemical condition of public swimming pools in Kashan, Iran. Jundishapur Journal of Microbiology 2012; 5(3): 450-5.
3. Wu YT, Tran J, Truong M, Harmis N, Zhu H, Stapleton F. Do swimming goggles limit microbial contamination of contact lenses? Optom Vis Sci 2011; 88(4): 456-60.
4. Rabi A, Khader Y, Alkafajei A, Aqoulah AA. Sanitary conditions of public swimming pools in Amman, Jordan. Int J Environ Res Public Health 2007; 4(4): 301-6.
5. Sule IO, Oyeyiola GP. Bacteriological assessment of some swimming pools within Ilorin Metropolis, Kwara, Nigeria. Bioresearch Bulletin 2010; 1: 13-7.
6. Barna Z, Kádár M. The risk of contracting infectious diseases in public swimming pools: a review. Ann Ist Super Sanita 2012; 48(4): 374-86.
7. Papadopoulou C, Economou V, Sakkas H, Gousia P, Giannakopoulos X, Dontorou C, et al. Microbiological quality of indoor and outdoor swimming pools in Greece: investigation of the antibiotic resistance of the bacterial isolates. Intl J Hygiene Environ Health 2008; 211(3-4): 385-97.
8. Ayan S. The hidden danger for the users of playgrounds and sport complexes. Life Sci J 2013; 10(1): 78-84.
9. Casanovas-Massana A, Blanch AR. Characterization of microbial populations associated with natural swimming pools. Intl J Hygiene Environ Health 2013; 216(2): 132-7.
10. Thorolfsdottir BO, Marteinsson VT. Microbiological analysis in three diverse natural geothermal bathing pools in Iceland. Int J Environ Res Public Health 2013; 10(3): 1085-99.
11. Salvato JA, Nemerow NL, Agardy FJ. Environmental Engineering. John Wiley & Sons Inc; 2003. p. 1196.
12. Lika M, Dako A, Meçe O. The microbial pollution in pools and diseases conected with them. Natura Montenegrina, Podgorica 2010; 9(3): 859-66.
13. Nworie A, Ayeni J, Eze U, Azi S. Bacterial contamination of door handles/knobs in selected public conveniences in abuja metropolis, nigeria: a public health threat. C J Med Res 2012; 6(1): 7-11.
14. World Health Organization (WHO). International Health Regulations Guide to Ship Sanitation Third Edition. Geneva: WHO; 2007. p. 39-60.
15. Lutz J K, Lee J. Prevalence and antimicrobial-resistance of pseudomonas aeruginosa in swimming pools and hot tubs. Int J Environ Res Public Health 2011; 8(2): 554-64.
16. Agbagwa O, Young–Harry W. Health Implications of some Public Swimming Pools located in Port Harcourt, Nigeria. Public Health Research 2012; 2(6): 190-6.
17. Cappello MA. Assessing bacteriological contamination in public swimming facilities within a Colorado metropolitan community. J Environ Health 2011; 73(7): 19-25.
18. Guthrie B. Conference report: health and hygiene in pools: a snapshot of a conference by the Royal Society for Public Health. Perspect Public Health 2013; 133: 84.
19. American Public Health Association, American Water Works Association, Water Environment Federation. Standard methods for the examination of water and wastewater, part 9000 microbiological examination: 9213B. Swimming Pools. 21th ed. Washington: APHA; 2005. p. 133-9.
20. Leoni E, Legnani P, Mucci M, Pirani R. Prevalence of mycobacteria in a swimming pool environment. J Appl Microbiol 1999; 87(5): 683-8.
21. Shahriari A, Nafez AH, Norouzi S, Heidari M. Investigation of common microbial indicators in swimming pool of gorgan city. Journal Safety & Health of Ardabil 2011; 2(2): 17-26. [In Persion].
22. Neghab M, Gorgi H, Baghapour M, Rajaeefard A, Moemenbellah-Fard M. Bacterial contamination of the swimming pools in Shiraz, Iran; relationship to residual chlorine and other determinants. Pak J Biol Sci 2006; 9(13): 2473-7.
23. Dindarlu K, SoleimaniAhmadi M, Zare S, Abdi H, Heidari M. Hygiene condition of bandar abbas swimming pools, 2003. Medical Journal of Hormozgan 2005; 9(1): 41-6. [In Persian].
24. Nikaeen M, Hatamzadeh M, Vahid Dastjerdi M, Hassanzadeh A, Mosavi Z, Rafiei M. An investigation on physical, chemical and microbial quality of Isfahan swimming pool waters on standard indicators. Journal of Isfahan Medical School 2010; 28(108): 346-56. [In Persian].
25. Yousefi Z. Study of the contamination condition of water swimming pools in Sari city for the Staphylococcus Aureus. Iran J Health Environ 2009; 2(3): 178-87.
26. Nikaeen M, Hatamzadeh M, Vahid DM, Hassanzadeh A. Predictive indicators of the safety of swimming pool waters. Water Sci Technol 2009; 60(12): 3101-7.
27. Abd El-Salam MM. Assessment of water quality of some swimming pools: a case study in Alexandria, Egypt. Environ Monit Assess 2012; 184(12): 7395-406.
28. Agbabiaka TO, Oyeyiola G. Microbial and physicochemical assessment of Foma river, Ita-nmo, Ilorin, Nigeria: an important source of domestic water in Ilorin metropolis. International Journal of Plant, Animal and Environmental Sciences 2012; 2(1): 209-16.
29. Garrido Mata MS, Rocha Nogueira JM, Heitor AM. Identification and characterization of microbiologic critical points in swimming-pool surfaces. Fifth

International Conference Swimming Pool & Spa; 2013 April 9-12; Roam, Italy. Istituto Superiore di Sanità; 2013.
30. Hutcheson C, Cira R, Gaines SL, Jones KR, Howard W, Hornsby D, et al. Microbes in pool filter backwash as evidence of the need for improved swimmer Hygiene-Metro-Atlanta, Georgia, 2012. Morbidity and Mortality Weekly Report (MMWR) 2013; 62(19): 385-8.
31. Mansoorian HJ, Rajabizadeh A, Jafari Modrek M, Doulatshahi S, Hatami B. Water health indices in Kerman swimming pools, in 2011. J Health Dev 2013; 2(2): 128-37. [In Persian].
32. Sohrabi A, Qureshi MI, Dehdar M, Rakhsh Khorshid A. Study of fungal and bacterial contamination of Sheltered swimming pools of Zahedan, in 2002. 6th National Conference on Environmental Health; 2003.
33. Tesauro M, Bianchi A, Consonni M, Bollani M, Cesaria M, Trolli F, et al. Hygienic profile of the water in Milan swimming pools: a three-year comparative study. Ann Ig 2010; 22(4): 345-55. [In Italian]