EVALUATION OF WATER QUALITY HEALTH INDICATORS OF SWIMMING POOLS IN SOUTHWEST IRAN: 2023

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Abstract

Introduction: Water pollution of swimming pools can cause the transmission of various diseases to humans. Therefore, the purpose of this study is to evaluate health indicators of water quality in swimming pools in Khuzestan province.

Materials and methods: This cross-sectional research was conducted in the form of a census of all indoor and active swimming pools in the cities of Khuzestan province, 14 were selected as a census in 2023, and the physical parameters included pH, temperature, and turbidity, and the chemical parameters included the amount of residual free chlorine, alkalinity, Hardness and microbial parameters including the population of heterotrophic bacteria, Staphylococcus aureus, Pseudomonas aeruginosa, Streptococcus, faecal coliform and total coliform were investigated. Sampling was done every week for 6 months and the samples were tested according to standard methods. Data were analyzed using descriptive statistics.

Findings: Investigations showed that the remaining free chlorine in 67%, turbidity in 89.9%, pH in 83.8%, temperature in 76.2% were favorable. coliforms, faecal streptococcus and staphylococcus aureus did not exceed the standard in any of the pools. The populations of heterotrophic bacteria, Staphylococcus aureus, and Pseudomonas aeruginosa were favorable in 69.96%, 98.8%, and 85.1% of cases, respectively. The statistical analysis of the data showed that there was a significant and inverse relationship between the bacteria population and direct water turbidity, and between the remaining free chlorine and the investigated organisms ($p<0.005$, $r=-0.595$).

Conclusion: Based on the results, the full compliance of the water quality of the swimming pools with the standards was relatively poor, and the continuous monitoring of the remaining free chlorine along with the pH adjustment is an important factor in maintaining the desired quality of the swimming pool water.

Keywords: swimming pool water, microbial quality, physical quality, chemical quality, Khuzestan province.

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Introduction

Swimming pools are among the public places that provide suitable conditions for the transmission of some skin and infectious diseases (1). The health importance of swimming pool water is related to the microbial and chemical quality of water (2). The water of swimming pools that are used by swimmers becomes contaminated due to the addition of substances from the swimmers' bodies such as hair, fat, microbes from the respiratory, digestive, reproductive system and other harmful bacteria and waste materials on the skin of the swimmers, and because the amount This pollution is increasing due to the use of different people from the pool regularly, it provides a very suitable place for many people who use the pool water to get contaminated (3). Therefore, swimming pools are always associated with health issues and risks

(4). These risks can be divided into three categories: physical, chemical and microbial risks. Normally, the most important risk is microbial risk and diseases caused by it (5).

The cause of illness in swimming pools includes contact with water and swallowing unhealthy water. Among these diseases are gastrointestinal diseases (cholera, typhoid, bacillary diarrhea, infectious hepatitis), eye diseases (trachoma, conjunctivitis), ear, throat and nose (sore throat) and skin diseases (types of ringworm, infection Fungus between the toes and infections caused by Mycobacterium marinum) pointed out (6-7) these diseases in the case of continuous discharge of mucus from the nose, eyes, ears, unwanted urination and skin contamination of swimmers with lack of pH control and accurate injection. Disinfectants and non-observance of health tips are accelerated (8).

Studies conducted in Egypt and Greece also isolated bacteria including heterotrophs, Staphylococcus aureus, Pseudomonas aeruginosa and fungi such as Firmigatospenicillium and Trichophyton from swimming pool water (9-10). In a study conducted in Greece, the results showed that in 32.9% of the samples, the microbial indices of Pseudomonas alkaligenes, Staphylococcus aureus exceeded the maximum allowed and in 35% of the samples, microbial resistant species were identified (11). In a research that was conducted on the cause of itchy feet of swimmers. The results showed that about 60% of yeasts and 40% of dermatophytes were important factors in causing this disease, which were mainly transmitted through swimming in polluted waters (12). In a study conducted by Barben et al. in Switzerland, 7% of samples from public pools and 4% from private pools contained Pseudomonas aeruginosa (13). The presence of these bacterial agents depends on the quality of the pool water, the type of pool, the personal health status of the swimmers, and the way the pool water is disinfected (14-15). Investigations have shown that swimming pool water may be an important source of transmission of bacterial and fungal diseases if there is no proper and continuous control and disinfection (16).

The above studies show that the development of health standards in order to prevent common diseases transmitted from contaminated water is one of the most important factors that has a direct effect on the health of swimming pools and the health of swimmers (17). Therefore, in the investigation of swimming pool water quality, physical and microbial factors are among the quality health indicators of swimming pool water, and the compliance of each of them has a major role in preventing the occurrence of diseases (18). In new indicators, physical factors such as turbidity, floating substances, oil, pH and microbial factors including total coliform, Escherichia coli, salmonella, Streptococcus faecalis, Pseudomonas aeruginosa have been measured (19). Heterotrophic bacteria plate count (HPC) is considered as the most important indicator of water disinfection efficiency, faecal coliforms and streptococci as indicators of faecal pollution, and Staphylococcus aureus and Pseudomonas aeruginosa are considered as water health risk indicators (20-21)

There are 14 public indoor swimming pools in Khuzestan. The vastness and diversity of the user groups and as a result the difference in their health conditions and immune systems, as well as the lack of clarity about the microbial contamination of these pools, as well as the physical and chemical factors affecting them, have encouraged the researchers of this article to conduct the present study. This study was carried out with the aim of identifying the physical, chemical and microbial conditions of water in swimming pools in Khuzestan province.

materials and methods

This study is a cross-sectional type and in this study, 14 microbial and chemical sampling pools were censused. The selected pools were from the cities of Ahvaz, Abadan, Dezful and Behbahan. This study was conducted in the summer and autumn seasons of 2023 and for 6 months. All the pools were circulating or closed circuit based on the type of water supply and purification system. All the studied pools are covered and have a water purification system with a rotating flow and retention time of 6 to 8 hours. From the set of pools examined in this study, the source of water supply in 12 of them was the urban water supply system, and in only 2 cases, the source of water supply was a private well pool. Also, all swimming pools had filtration systems, garbage collectors, diatom filters and disinfection. Samples were collected at weekly intervals from a depth of 30 cm from the water surface and near the outlet of the pool and sent to the laboratory as soon as possible. Therefore, 4 samples were taken from each pool every month and 24 samples were taken from each pool in 6 months, and the total samples taken from all pools are 336 samples. At the designated place of the pool for sampling, open it and turn it upright until the water enters the bottle and reaches the mark line. The samples were collected in such a way that there was an empty space at the top of the bottle so that the mixing process was easily possible before performing the test.

The collected samples were taken in 200 ml glass bottles with screw caps to measure physical and chemical parameters. The parameters of residual free chlorine, pH (Karizab model chlorinometer device made in Iran) and pool water temperature (Jeohai thermometer) were measured in the pool. Also, turbidity was measured by a turbidity meter (HANNA model, made in Italy). Oxidation-reduction potential was measured using an ORP meter (HACH model, Germany). Titration method was used to measure alkalinity and hardness. To measure alkalinity, phenolphthalein and methyl orange solution was used, and to measure hardness, Eriochrome Blacketti solution was used (4).

In order to measure the microbial quality, the samples were collected in 300 ml sterile wide-mouth bottles containing 10 drops of sodium thiosulfate solution (to neutralize the remaining free chlorine in the water) and transferred to the laboratory in a cool box. The considered variables were total coliform, faecal coliform, Pseudomonas aeruginosa, Staphylococcus aureus and faecal streptococcus, and their measurements were performed respectively based on the tests of the 21st edition of the Standard Methods of Water and Wastewater Testing (22). Based on this, the total coliform by multi-tube fermentation method with lauryl tryptose broth culture media (presumptive stage) and brilliant green lactose bile broth (confirmation stage) for 24 hours at 35 degrees Celsius and faecal coliform also by multi-tube fermentation method. It was detected with EC broth medium.

To detect Pseudomonas aeruginosa, the samples in the tubes containing lactose broth were cultured on citrimite agar medium, and the formation of a green colony after incubating the medium for 24 hours at 44 degrees Celsius indicated the presence of Pseudomonas aeruginosa, which was also confirmed by the oxidase test (23).

Fecal streptococci was diagnosed using azide dextrose broth and kanamycin squaline azide agar media. The formation of black metallic colonies confirmed the presence of this indicator. To measure Staphylococcus aureus, M-SB culture medium was used for the presumptive stage and LSAM or lipothelin mannitol salt agar culture medium was used for the confirmation stage. The formation of yellow colonies confirms this indicator. R2A agar culture medium was used to measure heterotrophic bacteria. In this method, the sample is incubated at a temperature of 37 degrees Celsius for 48 to 72 hours (24).

In case of delay in the test, the samples were kept in the refrigerator (4 degrees Celsius) (25). The results of all microbial tests, except for heterotrophic bacteria, which are counted in /ml, are reported in 100 ml and then recorded in the relevant tables. The obtained results were checked with the existing standards (25-26).

To maintain the privacy of the information, the results were reported as a pool code and without names. In order to check the health and safety points, the parameters related to each of them were extracted from the swimming pool health regulation form and examined for each pool (27). Then, with the same importance, the obtained answers were converted into percentages. The collected data were analyzed by SPSS version 22 statistical software. The results were reported as descriptive statistics including number, percentage, mean and standard deviation. One-way analysis of variance, Pearson correlation coefficient (for data with normal distribution) and Spearman (for data with non-normal distribution) were used to investigate the relationship between variables. Normality of data distribution was determined by Kolmogdov-Smirov test. The level of significance in the tests was considered 0.05.

Findings

Table 1 shows that among the pools, 5 pools are managed by the government and 9 are privately managed. Private swimming pools have better safety conditions than public swimming pools. The state of compliance with safety precautions by the operators was 90% on average and compliance with swimmers' health precautions was 80% on average. The results of other parameters are also presented in Table 1.

Table 1- Characteristics and percentage of compliance with safety and health points in swimming pools in Khuzestan province in 2023

Compliance with health tips (%)	observance of safety points(%)	Time of each group (hours)	Activity time (hours)	Number of drinking fountains	Number of toilets	Number of showers	ownership	parameter / Pool code
83/3	87/5	1/25	10	1	4	8	private	1
87/5	79/1	1/5	8	1	3	6	Governmental	2
83/3	91/6	1/5	9	2	5	8	private	3
79/1	75	1/25	10	1	7	10	private	4
95/8	83/3	1/5	12	1	6	9	private	5
87/5	70/8	1/5	9	1	5	12	Governmental	6
83/3	95/8	1/5	10	1	6	10	private	7
75	83/3	1/5	7/5	2	4	8	Governmental	8
87/5	91/6	1/5	12	1	3	9	private	9
70/8	95/8	1/5	12	3	6	13	private	10
83/3	70/8	1/5	9	2	5	11	Governmental	11
83/3	87/5	1/25	10	1	4	8	private	12
87/5	79/1	1/5	8	1	3	6	private	13
83/3	91/6	1/5	9	2	5	8	Governmental	14

The chemical and physical properties of swimming pool water are shown in Table 2.

In terms of residual free chlorine, out of 336 samples taken from the pools, 275 samples were within the standard range, which is equal to 67% of the samples taken, and 33% of the samples taken were either above the standard or below the standard. The average total residual free chlorine is equal to 0.84 ± 1.6 mg. In terms of hardness, the average of all the samples taken is equal to 222.7 ± 44.9 mg/liter, which is within the standard limit, but in total 73% of the samples taken are within the standard limit and 27% are outside the standard limit.

The highest hardness related to pool 2 is 298 mg/liter and the lowest hardness related to pools 3 and 5 is 130 mg/liter, which are outside the standard limit. The average alkalinity is also within the standard range and is equal to 106.5 ± 38.6 mg/liter of calcium carbonate. The lowest alkalinity is related to pools 3 and 5 and the highest alkalinity is related to pool 2 equal to 192 mg/liter. The average water turbidity of all pools is less than the standard unit and is equal to NTU 0.4±0.24, and the minimum and maximum turbidity is equal to NTU 0.08 and 1, respectively. The average water temperature of the pools was 28.2 ± 0.71 degrees Celsius and its standard deviation from the average is 1.5. 83% of the pH samples were in the range of 7/5 and almost 17% of the samples were beyond the standards required for swimming pools.

The microbial characteristics of swimming pools are listed in Table 3, and as can be seen, faecal coliform was not seen in the pools, and faecal streptococcus and staphylococcus did not exceed the standard limit in any sample. However, the amount of heterotrophic bacteria in 33 samples and Pseudomonas aeruginosa bacteria in 14.9% of samples and total coliform in 14.4% were more than the standard.

The correlation coefficient and statistical analysis are shown in Table 4. Pearson's correlation coefficient showed that there is an inverse and significant relationship between residual free chlorine and the studied organisms ($p<0.005$, $r=-0.595$). Also, there is a direct and significant relationship between turbidity and the studied organisms.

Table 2- Average values and standard deviation of physical-chemical parameters of water in swimming pools in Khuzestan province in 2023

residual free chlorine mg/L Mean ± standard deviation	Oxidation potential Mv Mean ± standard deviation	Activity time (hours) Mean ± standard deviation	temperature °C Mean ± standard deviation	animosity NTU Mean ± standard deviation	Alkalinity mg/L Mean ± standard deviation	Hardship mg/L Mean ± standard deviation	parameter / Pool code
1/8±0/94	697±134	7/4±0/25	30/1±0/17	0/25±0/17	112±34/1	235±45/6	1
1/6±1/05	710±210	7/3±0/17	30/4±0/81	0/34±0/21	141±51/3	252±46/7	2
1/1±0/75	704±145	7/6±0/56	29/7±0/45	0/28±0/34	75±47/6	195±64/4	3
1/2±0/71	645±87	7/4±0/95	30/2±0/37	0/41±0/19	102±45/1	212±35/1	4
1/2±0/45	665±95	7/8±0/12	30/1±0/52	0/47±0/24	71±48/4	189±58/3	5
1/4±0/76	657±107	7/7±0/22	29/7±1/49	0/34±0/14	104±39/8	215±52/1	6
1/6±0/95	695±121	7/9±0/31	30/4±0/51	0/54±0/24	109±31/1	224±64/3	7
2/1±0/82	641±44	7/9±0/45	29/1±0/38	0/39±0/28	115±12/4	236±41/2	8
2/2±1/17	652±93	7/6±0/28	29/4±0/45	0/47±0/33	108±42/2	217±39/5	9
1/5±1/05	710±114	7/3±0/26	28/8±1/62	0/52±0/41	99/5±38/8	209±71/4	10
1/2±0/65	644±65	7/7±0/21	29/2±1/19	0/44±0/14	103±47/7	214±29/7	11
0/75±0/4	721±185	7/4±0/19	30/1±0/29	0/51±0/19	111±48/3	227±34/6	12
1/8±0/75	645±114	7/6±0/22	29/9±0/74	0/38±0/24	118±24/7	241±27/9	13
1/9±1/4	654±79	7/5±0/16	28/6±0/95	0/38±0/24	123±29/3	252±17/8	14
1/6±0/846	674/2±113/7	7/57±0/31	28/2±0/71	0/4±0/24	106/5±38/6	222/7±44/9	Total mean and standard deviation
67	81/1	83/85	76/2	89/9	69/1	72/91	The percentage of favorable cases
33	18/9	17/15	23/8	10/1	31/9	27/1	Percentage of adverse events
1-3	650-700	7/2-8	28-30	NTU 0/5	80-120	180-250	standard (22-23)

Table 3- Average values and standard deviation of microbial water parameters of swimming pools in Khuzestan province in 2023

Faecal coliform 100 ml / qty Standard deviatio	All coliforms 100 ml / qty Standard deviation	streptococcus stool 100 ml / qty Standard deviation ±	Pseudomonas aeruginosa 100 ml / qty Standard deviation ±	Staphylococcus Oreos 100 ml / qty Standard deviation ±	Heterotrophic bacteria ml / quantity Standard deviation ± mean	type of bacteria / Pool code

n ± mean	± mean	mean	mean	mean		
Zero	3/2± 4/5	Zero	6/25± 10/14	19± 8/5	1237± 844	1
Zero	6/4±17/25	12/4± 8/38	10/8± 14/64	22± 9/75	1045± 956	2
Zero	9/4± 7/7	17/8± 11/25	13/2± 16/38	34± 11/7	676± 1156	3
Zero	2/5± 1/6	Zero	Zero	11± 7/6	604± 475	4
Zero	Zero	Zero	Zero	Zero	257± 194	5
Zero	4/5± 6/17	Zero	Zero	14± 9/7	306± 245	6
Zero	14/8± 9/65	Zero	4/4± 9/15	26± 11/4	775± 944	7
Zero	Zero	Zero	Zero	Zero	324± 135	8
Zero	9/6± 8/7	Zero	Zero	9± 5/4	521± 394	9
Zero	9/7± 14/16	14/1± 9/6	18/25± 25/45	16± 11/6	244± 1021	10
Zero	Zero	Zero	Zero	Zero	176± 95	11
Zero	5/4± 8/11	35/4± 22/4	28/2± 34/25	18± 7	1272± 1217	12
Zero	Zero	Zero	Zero	Zero	317± 175	13
Zero	Zero	Zero	Zero	Zero	164± 211	14
Zero	4/67±5/56	5/7± 3/68	5/79±7/85	12± 14/7	565/5±572/5	Total mean and standard deviation
%100	85/6	%100	85/1	98/8	66/96	The percentage of favorable cases
Zero	14/4	Zero	14/9	1/2	33/04	Percentage of adverse events
Zero	Zero	Maximum 100 x 100 ml	Zero		Maximum 200 per ml	standard (22-23)

Table 4- Correlation matrix between the parameters in the water of swimming pools in Khuzestan province in 2023

Organisms studied	temperature	PH	Free residual chlorine	animosity	parameter
r=-0/345 p= 0/049	r=-0/017 p= 0/141	r=-0/124 p= 0/74	r=-0/564 p= 0/053	r=1	animosity

r=-0/595 p= 0/034	r=-0/186 p= 0/441	r=-0/329 p= 0/084	r=1	r=-0/421 p= 0/046	Free residual chlorine
r=0/147 p= 0/087	r=0/089 p= 0/114	r=1	r=0/045 p= 0/096	r=0/321 p= 0/179	PH
r=0/496 p= 0/056	r=1	r=0/045 p= 0/189	r=0/274 p= 0/206	r=0/165 p= 0/064	temperature
r=1	r=0/196 p= 0/205	r=0/421 p= 0/162	r=0/174 p= 0/051	r=0/351 p= 0/083	Organisms studied

Discuss

The increasing use of swimming pools and on the other hand their improper maintenance and monitoring can create many risks in terms of public health. In the present study, among the investigated chemical parameters, alkalinity was the least consistent with the existing standard criteria. Hardness and alkalinity are among the chemical factors that affect the corrosiveness or sedimentation of water and thus reduce the useful life of swimming pool facilities. Comparing the hardness and alkalinity data of Urmia city pools with similar studies in Kerman and Yazd shows that Urmia pools have a better condition in this respect (4-28).

One of the important parameters that play an important role in the evaluation of water disinfection is the determination of the remaining free chlorine. According to the recommended national standard, 7.2-8pH = residual free chlorine is between 1 and 3 mg/liter and at 7.5-7.6pH = 0.6 mg/liter residual free chlorine in order to prevent eye irritation. (29). It is important to mention that the remaining free chlorine concentration is not the only effective factor for chlorine disinfection, but pH adjustment is necessary to achieve the maximum efficiency of chlorine disinfection (4). The comparison of the average residual free chlorine in this research with the study conducted in Zahedan shows that the residual free chlorine in this research is higher, so that this parameter is mentioned as 0.9 mg/liter in Zahedan swimming pools (30). Also, in Hajjartabar's study on the pools of Tehran city, the average residual free chlorine is 1.3 mg/liter, which is lower than the present study (31). In the study conducted in Athens, only 27% of the samples met the standard of residual free chlorine (32). However, in a study conducted in the United States, only 22% of the samples had residual free chlorine less than 1 mg/liter, which indicates the better quality of the pools studied in the United States compared to this study (33).

High pH of water reduces the effectiveness of chlorine so that at pH above 8, only 20% of chlorine is in the form of hypochlorous acid, which is an effective disinfectant (34). Table 2 shows the fact that in 17.15% of cases the pH is higher or lower than the standard and this issue can be effective in clogging the floor and walls of the pool, water supply pipes and sand filtration systems. If the pH is lower than the standard level, it can cause corrosion of water supply pipes and purification systems, loss of chlorine, stains, eye irritation and skin irritation of swimmers in swimming pools. In the studies conducted by Mahdinejad in Gorgan city, the pH is 66.7% higher than the standard level, while in this study only 17% is outside the standard level. The difference between these two studies depends a lot on time, so that the study of Gorgan city was done ten years ago and the big difference was due to the improvement of health and safety of swimming pools during these ten years (35). High pH prevents the formation of hypochlorous acid (HClO) which is a strong bactericide. At pH greater than 5.8, the conversion of chlorine into hypochlorous acid is 10% and its conversion into hypochlorite ion (ClO) is 90%. Therefore, at high pH, more chlorine is needed to reach the required level, which results in more costs. A research conducted by Paul Roy in America showed that when the pH and free chlorine remaining in a pool are measured, it is possible to make a correct judgment about the level of microbial contamination of the pool with 95% confidence (36). In the study of Rakestraw and Ibarluzea and their colleagues, it was concluded that the only predictable variable that can indicate the reliability of water from a microbial point of view is the disinfectant concentration (33-37).

According to Pearson's correlation coefficient test, there is a significant inverse relationship between residual free chlorine and turbidity with $p<0.05$, which in fact increases turbidity is the main factor in reducing the amount of residual free chlorine and, of course, increases pH, and unfortunately, pool operators ignore this issue according to It is a regular habit to disinfect water and this action reduces the effect of chlorine on microbes due to the increase of hypochlorite ion in high pH, which ultimately, excessive chlorine can cause eye irritation, allergies, skin dermatitis, digestive and respiratory problems, and This has been emphasized in the studies conducted on the swimming pools of Kerman and Gorgan (2 and 3). The purpose of turbidity measurement is to determine the level of transparency in pool water, and one of the problems caused by high turbidity is preventing the improvement of the disinfection process and reducing the effect of the disinfectant (38).

The standard temperature for swimming pools is 29 degrees Celsius (4), which is favorable in 76% of the samples taken, and approximately 26% of the samples are unfavorable in terms of temperature. Celsius and 40% of the collected samples were outside the standard limit (1). In a study in Jordan, most of the swimming pools have an unfavorable condition in terms of temperature, and the temperature is above the standard conditions. In this study, the temperature of the pools is 31 degrees Celsius (38). The high temperature of water provides the basis for the growth of algae and microbes (20).

Oxidation-regeneration potential (ORP) is the activity or oxidation of an oxidizing agent in water, which is used as an effective indicator to detect the disinfection efficiency in swimming pools. Therefore, there is a correlation between this parameter and the bacteriological quality of water. The standard ORP level is 650-700 mv. The low oxidation and reduction potential in these samples indicates the low efficiency of the disinfection process and disinfectant, and this has been confirmed by a study conducted in Kerman city (4).

Measuring the microbial quality of swimming pool water is mainly done by using the indicator bacteria of fecal water pollution. According to the developed standard, faecal coliforms should be zero, and in the present research, this parameter has been fully observed and it is zero in all collected samples. Fecal streptococci have been proposed as another indicator organism for monitoring the microbial quality of pool water. These microorganisms usually live in human and warm-blooded animals' rivers and are used to trace water pollution. The maximum number of faecal streptococci in swimming pool water is 100 per 100 ml. According to the research carried out in water that contains 10 Streptococcus fecalis in 100 ml, swimmers face the risk of stomach and river disorders (35). Staphylococcus aureus is the cause of skin and eye infections, otitis externa, urinary tract infection and jaundice and is present in the nasal mucosa, skin and feces of humans (39). The maximum allowable number of this bacteria in swimming pool water is 50 per 100 ml, which is lower than the standard limit in the present study. Among the indicator bacteria, heterotrophic bacteria and total coliforms were more than the standard value in some samples. In a study conducted on swimming pools in Milan, Italy, the results show that the number of non-standard bacteriological samples is 36% (40). Also, in a study conducted in the city of Colorado, USA, on swimming pools, the results show that in about 11% of the pools, the bacteriological samples were more than the standard value. In this study, the main factor of pollution is the lack of adequate and correct operation of the pool purification systems (41). Pearson's correlation test showed an inverse relationship between free residual chlorine, which was confirmed in the study of Rakestraw et al. and Martins et al. (33,42,43, 44).

Conclusion

Considering the significant and inverse relationship between microbial parameters and turbidity with residual free chlorine, it can be concluded that residual free chlorine is an effective factor for reducing microbial factors and turbidity and should be constantly monitored in swimming pools. In addition, for better control of the disinfectant, pH control is also necessary.

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