Caspian Journal of Health Research
School of Health, Guilan University of Medical Sciences

CJHR
Caspian Journal of Health Research
journals homepage: cjhr.gums.ac.ir

The Bacteriological Quality of Drinking Water of Water Coolers Located in Some hospitals in Rasht

Dariush Naghipour[1], Fatemeh Dodangeh[2], Fardin Mehrabian[3], Elahe Ebrahim-Nezhad[2], Esmaeel Rouhbakhsh*[,4]

ARTICLE INFO

History
Received: 2015/07/26
Accepted: 2016/01/05

Type
Original Article

1. (Ph.D.) Department of Environmental Health Engineering, School of Health, Guilan University of Medical Sciences, Iran

2. B.Sc. Student, School of Health, Guilan University of Medical Sciences, Iran

3. (Ph.D.) Department of Health Service Management, School of Health, Guilan University of Medical Sciences, Iran

4. (Corresponding Author)* (Ph.D. Candidate) School of Health, Guilan University of Medical Sciences, Iran

E-mail: esmaeil5115@yahoo.com

ABSTRACT

Objectives: Research background and objective: Having access to safe drinking water has an essential role in ensuring public health. Ignoring damages caused by failures in water distribution system leads to water contamination. This study intended to investigate the bacteriological quality of drinking water of water coolers in four hospitals of Razi, Heshmat, Al-Zahra and Aria in Rasht Township.

Methods: In order to meet the objective of the study, 13 water coolers located in these hospitals were randomly selected. The values of total coliforms, heterotrophic bacteria, residual chlorine, pH, and turbidity were measured. The data were analyzed using Excel and SPSS.

Results: The findings showed a strong relationship existed between pH values of input and output water (R=0.55), but that for turbidity was insignificant (R=0.13) (p=0.42). In two cases, coliform bacteria were observed, too. The value of HPC in tested samples was less than 15 cfu/ml before entering and after leaving water coolers.

Conclusion The results indicated absence of coliform bacteria. The reduction of residual chlorine after the water filtration system in water coolers indicated low-level of contamination in water coolers. Therefore, regular servicing and monitoring water coolers and their connections would ensure health of staff members, patients and all who enter hospitals.

Keywords: Heterotrophic bacteria, Water cooler, Pollution, Drinking water

Please cite this article as: Naghipour D., et al., The Bacteriological Quality of Drinking Water of Water Coolers Located in Some hospitals in Rasht, Caspian Journal of Health Research 2016; 2(1): 18-29

Introduction

Conditions of each area require the exact identification of Safe and sufficient drinking water supply is one of the essential environmental health objectives related to water issues [1]. Drinking water should be in good chemical and bacteriological condition and its most important physical characteristics including turbidity, temperature, suspended particles; along with physiochemical characteristics such as pH, electrical conductivity and total hardness, are taken into consideration [1, 3, 4].

Due to the high risk of microbial contamination, the presence of indicator microorganisms is taken more seriously than chemicals [2]. Presence of free residual chlorine in pipelines confirms no microbial contamination of water with a high degree of certainty [5].

Though in many cases, secondary uncontrolled water pollution occurs in reservoirs such as water cooler tanks as a results of water being transferred from one source of supply to another, water distribution and storage in treated water network, and pipe breaks in water distribution network [6].

Water coolers are mostly used during spring and summer and there is the possibility of biofilm growth and expansion due to water stagnation [7]. Biofilm formation in household drinking water filtration and purification equipment is one of the major problems in providing safe drinking water thus bacteria such as E.coli, Pseudomonas aeruginosa are of significant importance [9].

Since the quality of water distributed by water coolers depends on the material of water tank, environmental conditions and lifetime of the equipment, the results of the present investigation cannot be generalized to other water coolers [1]. For instance, a research studying water coolers in educational units of Shahid-Beheshti University in 2013 showed that water coolers did not have significant impact on the bacteriological quality of water and they did not increase the levels of fecal coliforms [8].

Rasht is one of the major cities with rainy wet climate due to its geographical location thus during warm seasons of the year, the demand for drinking water, especially from water coolers, increases. In order to provide safe drinking water for patients, staffs and all who are present in hospitals and to prevent outbreak and transmission of any water-borne diseases, it is important to control bacteriological quality of water. This study intended to determine the bacteriological condition of indicator bacteria like coliform and heterotrophic plate counts (HPC) in drinking water in hospitals in Rasht.

Razi, Heshmat, Al-Zahra, and Aria hospitals are private hospitals in Rasht. Razi Hospital is a specialty infectious disease hospital with 204 beds, Heshmat Hospital is a cardiac specialty hospital with 180 licensed beds and 140 active beds, Al-Zahra Hospital is a specialty gynecology and obstetrics hospital with 400 beds, and Aria Hospitals has 110 beds.

Material and Methods

The quality of drinking water of the closest inlet valve to the water cooler and the water cooler located in the hospitals under study were tested in terms of total coliform and HPC. The research was conducted in the spring and summer of 2014 in Rasht. The number of randomly selected water coolers among numerous water coolers in hospitals were 13 and samples were taken from the closest inlet valve adjacent to the water cooler and one sample from the water cooler itself. Sampling and testing procedures were according to standard methods for the examination of water and wastewater [10].

Samples were collected in glass bottles with ground glass joints, each being 300 ml volume containing 1% sodium thiosulfate (2-3 drops per 100 ml of the sample). The sampling containers were sterilized for one hour at 180 °C prior to sampling. The temperature was measured using a thermometer and chlorine and pH were measured onsite using chlorine test kit (diethyl-p-phenylenediamine (PDP)) and phenol-red, respectively. The samples were transferred to the laboratory at proper temperature within one hour of sample collection.

According to the standards of water and wastewater microbiological examinations, total coliforms were measured using common technique of multiple tube fermentation and most probable number (MPN); and HPC was measured using Pour Plate Count method [10].

For multiple tube fermentation, lactose broth culture medium at a concentration of 26 g/L (double strength) and 13 g/L (single strength) was used to identify possible coliforms. Green diamond culture medium at concentration of 40 g/L was also used in order to confirm the presence of coliforms; and EC (Escherichia coli) broth at concentration of 37 g/L was used in the supplementary stage.

R2Agar culture medium was used for HPC test to determine colonies of heterotrophic bacteria. The samples for culture media of lactose broth, green diamond and R2Agar were incubated at 35±2 °C for 24-48 hours, and they were incubated at 44 °C for 24 hours for EC broth medium.

Then Presence/Absence of coliforms and heterotrophic bacteria were tested after the prescribed incubation time and the results were statistically analyzed using Excel and SPSS 16 software.

Results

A total of 26 samples, with 13 samples taken from water coolers, were collected every month and they were tested regularly for a total of three months.

Table 1. Microbial analyses of residual chlorine, pH and turbidity of water samples at sampling locations in the first month

Sampling location		Indicators					Types of water coolers
		Cl	pH	Turbidity	HPC	Total coliform	
Razi1	Prior to entering water cooler	0.2	7.7	1.53	Negative	Negative	Drinking fountain
	After leaving water cooler	0	8.5	0.99	Negative	Negative	
Razi2	Prior to entering water cooler	0.3	7.8	1.08	Negative	Negative	Drinking fountain
	After leaving water cooler	0	6.5	0.85	Negative	Negative	
Razi3	Prior to entering water cooler	0.3	7.9	1.68	Negative	Negative	Double valve
	After leaving water cooler	0.2	8.08	0.83	Negative	Negative	
Heshmat1	Prior to entering water cooler	0.1	7.8	1.66	Negative	Negative	Four valves
	After leaving water cooler	0	7.9	1.12	Negative	Negative	
Heshmat2	Prior to entering water cooler	0	7.9	1.31	Negative	Negative	Drinking fountain
	After leaving water cooler	0	7.9	1.13	Negative	Negative	
Heshmat3	Prior to entering water cooler	0	7.9	1.85	Negative	Negative	Double valve
	After leaving water cooler	0	7.8	1.19	Negative	Negative	
Al-Zahra1	Prior to entering water cooler	0.3	7.9	1.16	Negative	Negative	Three valves
	After leaving water cooler	0	6.9	1.09	Negative	Negative	
Al-Zahra2	Prior to entering water cooler	0.3	7.8	0.82	Negative	Negative	Double valve
	After leaving water cooler	0	8.4	1.20	Negative	Negative	
Al-Zahra3	Prior to entering water cooler	0.3	7.7	0.94	Negative	Negative	Double valve
	After leaving water cooler	0	8.0	0.88	Negative	Negative	
Al-Zahra4	Prior to entering water cooler	0.3	8.03	1.10	Negative	Negative	Drinking fountain
	After leaving water cooler	0	7.6	1.55	Negative	Negative	
Aria1	Prior to entering water cooler	0	7.9	1.45	Negative	Positive	Double valve
	After leaving water cooler	0	8.00	1.07	Positive	Positive	
Aria2	Prior to entering water cooler	0	8.4	0.9	Negative	Negative	Double valve
	After leaving water cooler	0	8.2	0.9	Negative	Negative	
Aria3	Prior to entering water cooler	0	8.1	0.89	Negative	Negative	Double valve
	After leaving water cooler	0	7.8	1.34	Negative	Negative	

Table 2. Microbial analyses of residual chlorine, pH and turbidity of water samples at sampling locations in the second month

Sampling location		Indicators					Types of water coolers
		Cl	pH	Turbidity	HPC	Total Coliform	
Razi1	Prior to entering water cooler	0.6	7.9	1.51	Negative	Negative	Drinking fountain
	After leaving water cooler	0	8.6	1.19	Negative	Negative	
Razi2	Prior to entering water cooler	0.4	7.8	1.13	Negative	Negative	Drinking fountain
	After leaving water cooler	0	6.9	0.8	Negative	Negative	
Razi3	Prior to entering water cooler	0.4	7.7	1.33	Negative	Negative	Double valve
	After leaving water cooler	0.4	7.6	1.43	Negative	Negative	
Heshmat1	Prior to entering water cooler	*0.3*	8.3	0.99	Negative	Negative	Four valves
	After leaving water cooler	0	8.2	0.75	Negative	Negative	
Heshmat2	Prior to entering water cooler	0.3	8.3	1.30	Negative	Negative	Drinking fountain
	After leaving water cooler	0	8.2	1.02	Negative	Negative	
Heshmat3	Prior to entering water cooler	0.2	8.7	1.27	Negative	Negative	Double valve
	After leaving water cooler	0	8.7	0.65	Negative	Negative	
Al-Zahra1	Prior to entering water cooler	0.3	7.3	1.22	Negative	Negative	Three valves
	After leaving water cooler	0	6.9	0.97	Negative	Negative	
Al-Zahra2	Prior to entering water cooler	0.3	7.9	0.83	Negative	Negative	Double valve
	After leaving water cooler	0	8.2	1.78	Negative	Negative	
Al-Zahra3	Prior to entering water cooler	0.3	8.1	1.04	Negative	Negative	Double valve
	After leaving water cooler	0	7.9	1.00	Negative	Negative	
Al-Zahra4	Prior to entering water cooler	0.3	7.5	0.79	Negative	Negative	Drinking fountain
	After leaving water cooler	0	7.6	0.87	Negative	Negative	
Aria1	Prior to entering water cooler	0	7.3	2.00	Negative	Negative	Double valve
	After leaving water cooler	0	8.2	1.07	Negative	Positive	
Aria2	Prior to entering water cooler	0	8.4	0.8	Negative	Negative	Double valve
	After leaving water cooler	0	8.2	0.9	Negative	Negative	
Aria3	Prior to entering water cooler	0	8.1	1.20	Negative	Negative	Double valve
	After leaving water cooler	0	7.8	0.75	Negative	Negative	

Table 3. Microbial analyses of residual chlorine, pH and turbidity of water samples at sampling locations in the third month

Sampling location		Indicators					Types of water coolers
		Cl	pH	Turbidity	HPC	Total coliform	
Razi1	Prior to entering water cooler	0.5	7.8	1.23	Negative	Negative	Drinking fountain
	After leaving water cooler	0	7.9	1.12	Negative	Negative	
Razi2	Prior to entering water cooler	0.3	7.6	1.10	Negative	Negative	Drinking fountain
	After leaving water cooler	0	6.8	0.7	Negative	Negative	
Razi3	Prior to entering water cooler	0.3	7.2	1.25	Negative	Negative	Double valve
	After leaving water cooler	0.3	7.8	1.87	Negative	Negative	
Heshmat1	Prior to entering water cooler	*0.2*	8.3	0.73	Negative	Negative	Four valves
	After leaving water cooler	0	8.2	1.15	Negative	Negative	
Heshmat2	Prior to entering water cooler	0.3	8.3	1.01	Negative	Negative	Drinking fountain
	After leaving water cooler	0	8.2	1.26	Negative	Negative	
Heshmat3	Prior to entering water cooler	0.3	8.2	1.21	Negative	Negative	Double valve
	After leaving water cooler	0	8.3	0.66	Negative	Negative	
Al-Zahra1	Prior to entering water cooler	0.3	7.83	1.12	Negative	Negative	Three valves
	After leaving water cooler	0	7.00	0.99	Negative	Negative	
Al-Zahra2	Prior to entering water cooler	0.3	7.5	0.72	Negative	Negative	Double valve
	After leaving water cooler	0	8.2	1.25	Negative	Negative	
Al-Zahra3	Prior to entering water cooler	0.3	7.6	0.86	Negative	Negative	Double valve
	After leaving water cooler	0	7.9	0.89	Negative	Negative	
Al-Zahra4	Prior to entering water cooler	0.3	7.7	1.00	Negative	Negative	Drinking fountain
	After leaving water cooler	0	7.6	1.45	Negative	Negative	
Aria1	Prior to entering water cooler	0	7.9	1.45	Negative	Negative	Double valve
	After leaving water cooler	0	8.00	1.07	Positive	Positive	
Aria2	Prior to entering water cooler	0	8.4	0.9	Negative	Negative	Double valve
	After leaving water cooler	0	8.2	0.9	Negative	Negative	
Aria3	Prior to entering water cooler	0	8.1	0.89	Negative	Negative	Double valve
	After leaving water cooler	0	7.8	1.34	Negative	Negative	

The variables of pH and turbidity were tested before and after the filtration systems of the water coolers. Associated figures to each of these variables are summarized as below.

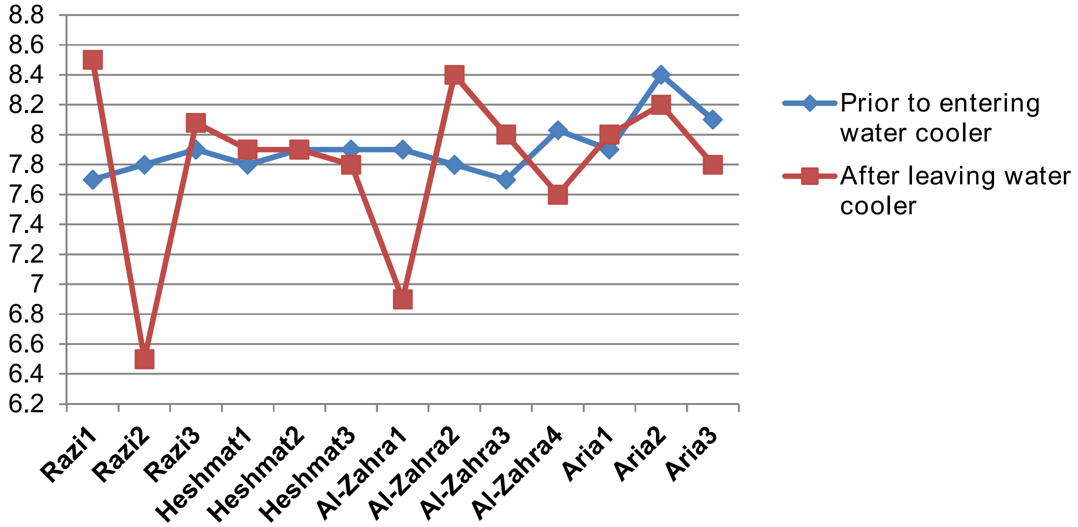

Figure 1. pH analyses of water samples before and after filtration in the first month

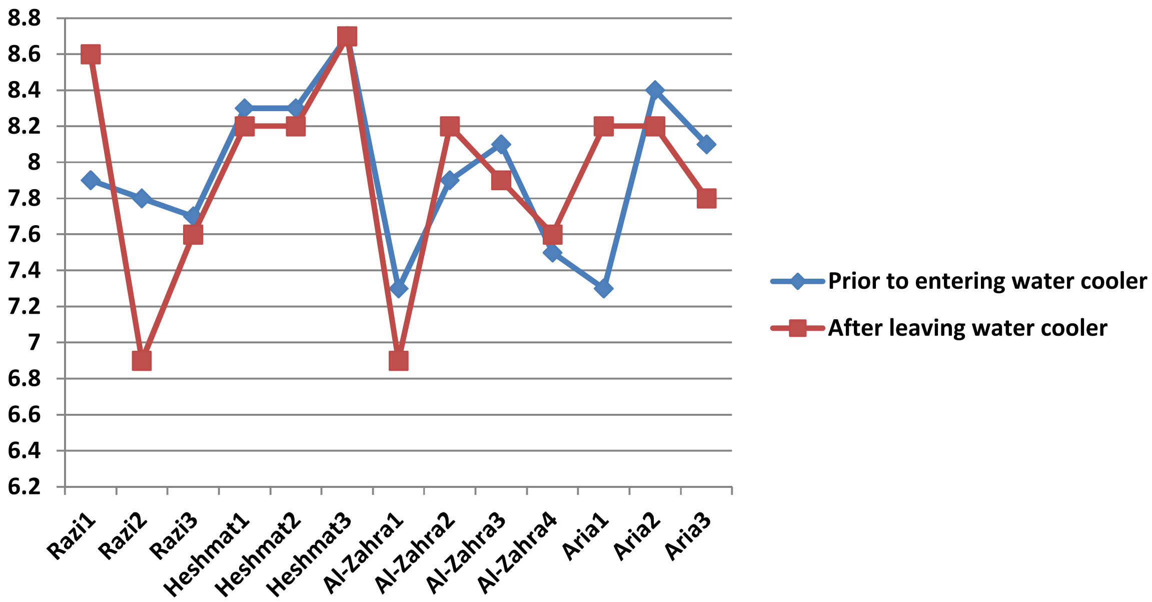

Figure 2. pH analyses of water samples before and after filtration in the second month

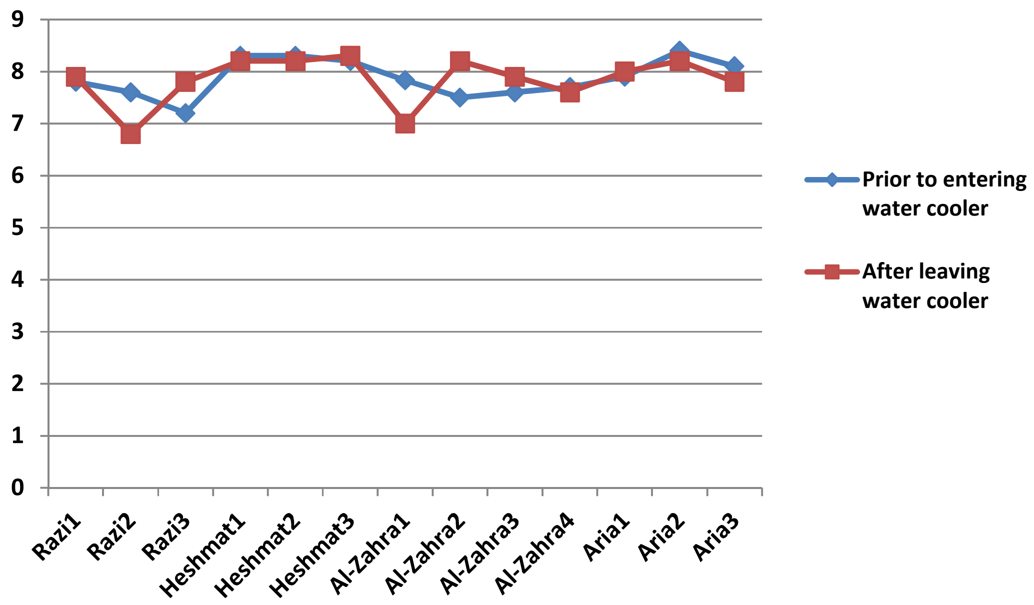

Figure 3. pH analyses of water samples before and after filtration in the third month

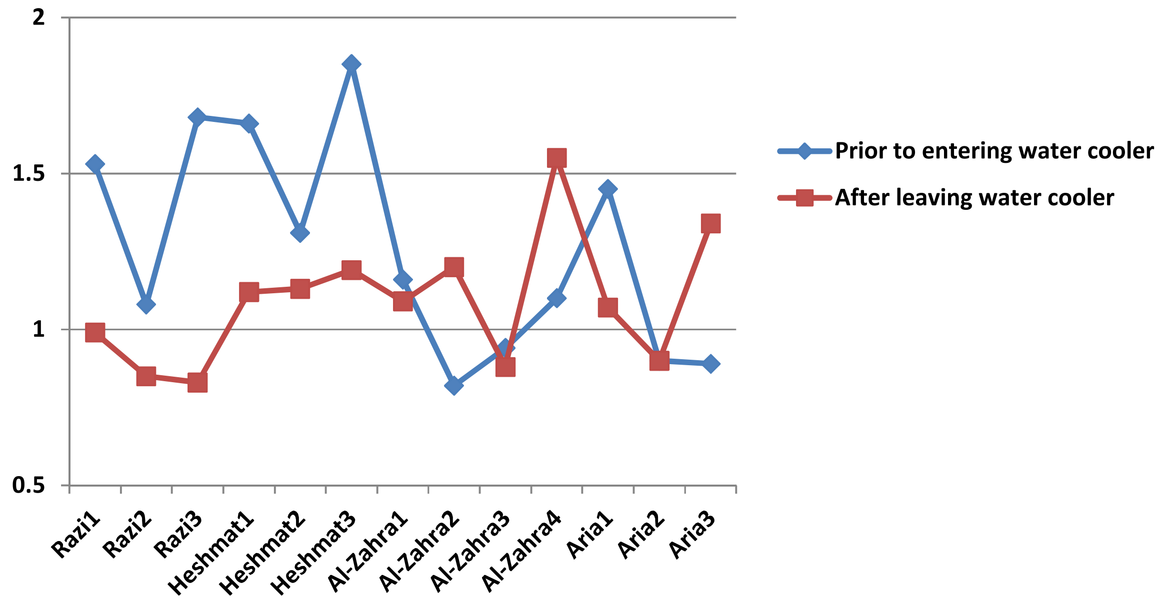

Figure 4. Turbidity analyses of water samples before and after filtration in the first month

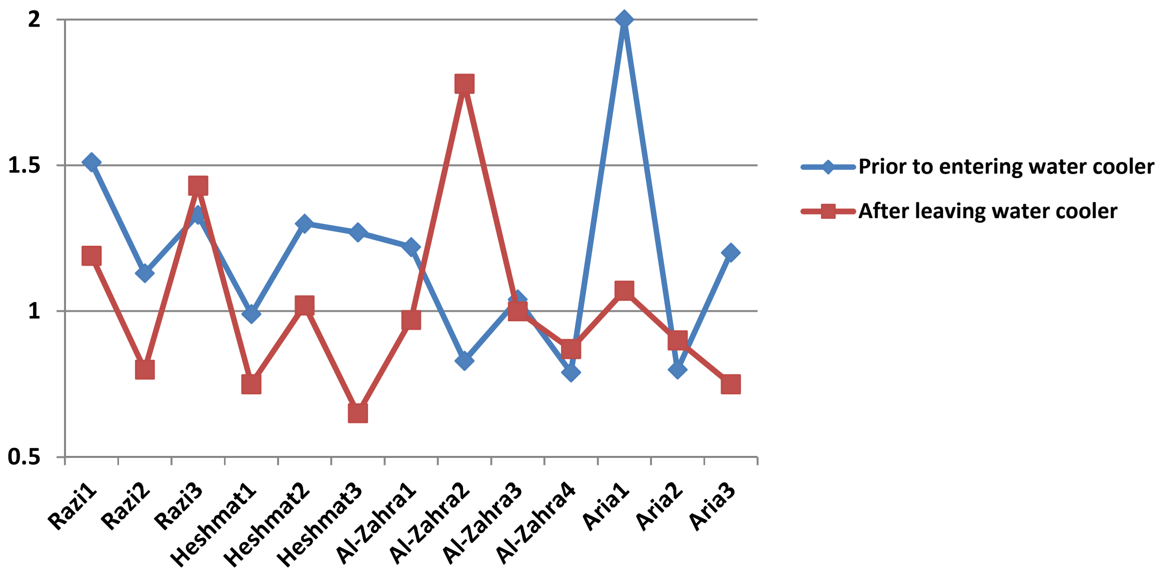

Figure 5. Turbidity analyses of water samples before and after filtration in the second month

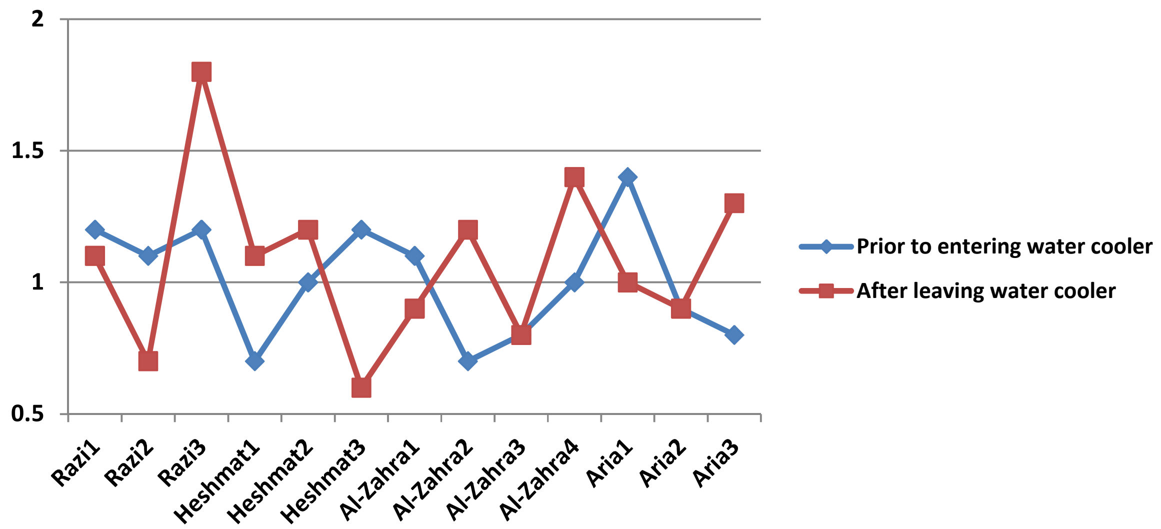

Figure 6. Turbidity analyses of water samples before and after filtration in the third month

There was no significant difference between pH values of the water cooler and the tab (p=0.47) meaning that the filtration systems installed on water coolers do not have a significant impact on adjusting pH values.

Table 4. pH values and associated indicators

	pH				
	Mean	**Median**	**Standard deviation**	**Minimum**	**Maximum**
Water cooler (tank)	7.96	8.08	0.52	6.57	9.72
Water cooler (tab)	7.85	7.87	0.30	7.21	8.44

The statistical test showed that filtration systems reduced the turbidity of water (p=0.021) so it can be said that these systems reduce turbidity in water coolers.

Table 5. Turbidity values and associated indicators

	Turbidity				
	Mean	**Median**	**Standard deviation**	**Minimum**	**Maximum**
Water cooler (tank)	1.27	1.04	0.99	0.65	5.3
Water cooler (tab)	1.46	1.15	1.2	0.72	6.3

There was a significant difference in residual chlorine values (p<0.001) so it can be said that filtrations systems reduce the residual chlorine levels in water.

Table 6. Residual chlorine values and associated indicators

	Residual chlorine				
	Mean	**Median**	**Standard deviation**	**Minimum**	**Maximum**
Water cooler (tank)	0.033	0	0.13	0	0.6
Water cooler tab	0.21	0.3	0.16	0	0.6

A correlation coefficient test was also carried out to check whether there was any relationship between studied variables before and after the filtration system. There was a strong relationship between pH of input and output water (R=0.55) but the relationship between turbidity of input and output water was insignificant (R=0.13) (p=0.42). Also, no significant relationship was observed between residual chlorine levels of input water and output water from filtration systems (R=0.27).

Discussion and Conclusion

The results of the present study indicated possible existence of low values of coliform in the water supply network connected to water filtration network and water coolers. The values of residual chlorine before and after the treatment system of water coolers was different in that it had reduced after treatment, which might cause water contamination. There were only two cases of microbial contamination and heterotrophic growth in tested samples.

A comparison between results of the present study and other studies showed that pH-values in input and output water of water coolers was different fluctuating from 6.5 to 8.6. This indicated changes of quality in input and output drinking water of water coolers in hospitals, which requires more investigation while the study of Mohammadi Et al. showed less pH-fluctuation and very low levels of coliform and heterotrophic bacteria in water coolers located in educational unit of Shahid-Beheshti University [8]. The results of the study by Mosaferi and ShakerKhatibi on drinking water network in Tabriz indicated presence of heterotrophic bacteria in 50% of tested water samples [10]. Alipour et al. studied the quality of HPC and total coliform in water coolers placed in intercity buses in Bandar-Abbas and the results showed relatively high levels of contamination, whereas the microbial contamination was very low in the current study. The reason might be due to proper servicing and maintenance, the quality of input water, the type of water cooler, and other factors that require further studies [5]. Generally, microbial contamination in water coolers is caused by the presence of water contamination in inlet pipe, stagnation of water in water cooler tank, and damage to the body or connections of the water cooler. These conclusions are aligned with previous studies indicating that coliform and heterotrophic growth can originate from water coolers.

The results indicated absence of coliforms thus the drinking water was safe due to regular maintenance and cleaning of the devices, standard filter type used in water cooler filtration systems, and the fact that water samples were taken from urban treated water network.

Considering the presence of low levels of heterotrophic bacteria, it is recommended to clean and monitor devices on a monthly basis. However, there are several factors that played a crucial role in ensuring safety of drinking water from these water coolers including the type of water cooler, regular servicing, being connected to urban treated water supply, and having no leaks.

References

[1] Zazouli M.A., Bazrafshan E., Water and wastewater Technology, 1391.

[2] Hassan Amir Beyg; Principles of Water Treatment, 1391.

[3] Ashbolt NJ. Risk Analysis of Drinking Water Microbial Contamination Versus Disinfection by-Products (DBPs). Toxicology 2004; 198: 255–262.

[4] Malakootian M EM., Jafari Mansoorian H., Quality of drinking water consumed in interurban bus transportation system of Kerman in the first half of 2008. TOLOO-E-BEHDASHT, 2008; 7(1-2) 22-29.

[5] Alipour V DK., Zare., Shabzendedar M., Microbial Quality of Water Consumed in the Public Bus Transportation Systems of Bandarabas. Hormozgan Medical Journal, 2004; 7 (4).

[6] Kawamura S., Integrated Design and Operation of Water Treatment Facilities. John Wiley & Sons, 2000.

[7] Taheri E., Hassanzadeh M., Evaluation of the Influence of Conventional Water Coolers on Drinking Water Quality. Iran J Health & Environ, 2010; 2 (4): 275-268. [In Persian]

[8] Afsharinia MSM., Ghasemi M., Salari S., Ghasmi A., Saedi F., Evaluate the Microbial Quality of Water Dispenser in Gonabad in 1390. 16th National Conference on Environmental Health, Mehr 1392.

[9] Szymańska J., Biofilm and Dental unit Waterlines. Ann Agric Environ Med, 2003; 10: 151-157.

[10] Mosaferi M., Heterotrophic Bacteria in Drinking Water in Tabriz, Scientific Journal of School of Public Health and Institute of Public Health Research. 2011; 7 (4): 83-92.