

## Check the status of health indicators of water quality swimming pools in Kermanshah

<sup>1</sup>Younes Sohrabi, <sup>2</sup>Kamran Tari, <sup>3</sup>Seyedeh Shadi Charganeh,  
<sup>4</sup>Farshad Rahmani Tabar, <sup>1</sup>Diyari Abdollahzadeh and <sup>4</sup>Mandi Dabirian  
<sup>1</sup>Department of Environmental Health Engineering, Students Research Committee,  
Kermanshah University of Medical Sciences, Kermanshah, Iran  
<sup>2</sup>Department of Environmental Health Engineering, School of Health,  
Qazvin University of Medical Sciences, Qazvin, Iran  
<sup>3</sup>Department of Environmental Health Engineering, School of Health,  
Zabol University of Medical Sciences, Zabol, Iran  
<sup>4</sup>Social Determinations in Health Promotion Research Center,  
Hormozgan University of Medical Sciences, Bandar Abbas, Iran

**Abstract:** Water hygiene in swimming pools is paramount knowing that it affects the swimmer's health. Failure to meet hygiene standards in swimming pools increases the risk of several diseases in swimmers. The present study is aimed at examining hygiene indices of swimming pools water located in Kermanshah City-Iran. The study was carried out as a descriptive and cross-sectional study in 21 public swimming pools in 2015. Free residual chlorine, PH, turbidity, heat resistant coliform and HPC were examined and the results were compared with Iran National Standard (11230). The results showed that residual chlorine, PH, turbidity, heat resistant coliform and HPC were desirable in 92.2%, 100%, 99.7%, 91.3% and 91.7% of the cases respectively. Highest levels of residual chlorine, heat-resistant coliform and HPC were observed during fall and these indices were at minimum level during winter. In addition, highest levels of residual chlorine, heat-resistant coliform and HPC were obtained in August-September. The results showed that quality of water in swimming pools located in Kermanshah city was at average level and there was a need to improve quality of water of swimming pools in this city. It is possible to improve quality of swimming pools water by permanently monitoring free residual chlorine and PH levels.

**Key word:** Water, swimming, pool, swimming, Kermanshah

---

### INTRODUCTION

Because of direct contact between the human's body and water in swimming pools, they have high potential of being a source of contamination (Rasti *et al.*, 2011; ISIR, 2008). Increase in popularity of the swimming pool in absence of a reliable monitoring and maintenance services may lead to several risks to the public health. Swimming is a sport and leisure activity from physical and psychological viewpoint and it can be a great help in improving health and welfare of individuals provided that health concerns of these facilities are addressed properly. One of the main hygiene concerns is quality of water in swimming pools (Mansoorian *et al.*, 2013). From health standard viewpoint, swimming water, like drinking water, need to have specific physical, chemical and microbial specifications; otherwise, this joyful hobby or sport might

lead to outbreak of variety of diseases (Panyakapo *et al.*, 2008; Lourencetti *et al.*, 2010). The swimming waters are prone to be polluted by body hair and oil of the swimmers, microbes of reproductive system, digestion, respiratory system microbe and other bacteria and unwanted materials from the swimmer's body. The more a swimming pool is used by individuals, the higher the rate of pollutions in the water and higher the health risks for the swimmers. Therefore, public swimming pools are a potential threat to health of the users (Zazouli *et al.*, 2015; Abedi *et al.*, 2014). These risks are categorized in three categories of physical, chemical and microbial risks and in general, microbial risk and the diseases are more serious (Zangiabadi *et al.*, 2011; Abedi *et al.*, 2012). Among the communicable diseases under consideration, typhoid fever, dysentery, trachoma, leptospirosis, ringworms, skin infections, scabies, itching,

respiratory diseases, sinusitis and ear and throat infection are notable. For instance, mycobacterium momium causes eyes, ears and skin infections which leads to granuloma (Moeinian *et al.*, 2016; Farzianpour *et al.*, 2014). Several studies have been conducted on swimming pool water in Iran and other countries. Among many, studies in Isfahan (Nikaeen *et al.*, 2010), Shiraz (Neghab *et al.*, 2004), Ouromieh (Nanbakhsh *et al.*, 2004), Zanjan (Nourian *et al.*, 2006), East of Greece (Nichols, 2006), Sant Galen in Sweden (Barben *et al.*, 2005), Naples-Italy (Guida *et al.*, 2009), Munich and Lipzing Germany (Schoefer *et al.*, 2008) and Eman in Jordan (Rabi *et al.*, 2007) are notable. All these studies have reported relative contamination in different sections of public pools with fungi like dermatitis (Azizjalali and Behrangi, 2009; Kazemi-Fard *et al.*, 2006), index microorganism like pseudomonas and specially aeruginosa (Schoefer *et al.*, 2008), coliforms (Rabi *et al.*, 2007), streptococcus (Nikaeen *et al.*, 2010; Neghab *et al.*, 2004), staphylococcus (Yousefi 2009) and variety of parasites (Nanbakhsh *et al.*, 2004) in particular. Studies have highlighted necessity of codifying pools hygiene controls and standards to avoid communicable and prevalent diseases. Therefore, implementation of an efficient management and permanent monitoring system in swimming pools is essential to make sure that the water used in the pools is hygienic, treated and inline with public health codes (Hambly *et al.*, 2010). Microbial indices such as Heterotroph Pallet Count (HPC) and coliform bacteria are the main indices of effectiveness of disinfection measures; coliform and fecal streptococcus are the main fecal contamination indexes; and staphylococcus aureus and pseudomonas aeruginosa are the main health risk indices of swimming pools (Bahmani *et al.*, 2015). Taking into account importance and diversity of communicable diseases and microorganisms in swimming pools, microbial quality control in swimming pools is of great importance.

Therefore, the present study is an attempt to survey hygiene indices in swimming pools water in Kermanshah City.

## MATERIALS AND METHODS

The study was carried out as a descriptive cross sectional study on 21 active public swimming pools in Kermanshah. Parameters like turbidity, PH, residual chlorine and microbial residual were examined in 2013 in a 12 months period. Two or three samples were collected from each pool every month and the samples were tested in a health center. The samples for microbial assessment were collected in sterilized bottles with wide opening (250 mL) containing 10 drops of sodium thiosulfate. The samples were handled in ice and analyzed immediately in laboratory. Residual chlorine and pH were measured at the site. Turbidity was measured by a turbidimeter and the rest of the tests were carried out in laboratory based on available standard methods (APHA *et al.*, 2005). The data was analyzed in SPSS and the findings were compared with the standards (ISIR, 2008).

## RESULTS AND DISCUSSION

The results of the measurements and the standards are listed in Table 1 for comparison. Table 2 and 3 list the results based on the sampling month.

As listed in Table 2, the highest and lowest levels of residual chlorine, health-resistant coliform and HPC were observed in fall and winter respectively.

As listed in Table 3, highest levels of residual chlorine, heat-resistant coliform and UPC were observed in September and October. Increasing popularity of swimming pools and poor supervising and monitoring measures can create a serious threat to the public health (Mansoorian *et al.*, 2013). Literature review showed that

Table 1: Frequency (%) of different hygiene samples in public pools located in Kermanshah City (n = 21)

Variables	Number of sample in 12 month	Desirable	Undesirable	Iran national standards (11203)	WHO standard
Residual chlorine (ml/L)	760	793 (92.2%)	67 (7.8%)	0.6-1	s1
PH	794	794 (100%)	0	7.2-7.8	7/2-7/8
Turbidity (NTU)	428	427 (99.7%)	1 (0.3%)	Max: NTU0.5	
Heat resistant coliform (MPN/100ml)	437	399 (91.3%)	38 (8.7%)	<1 per ml (Iran national standard, No.3759) based Iran national standard (9412) and WHO standard	
HPC	437	401 (91.7%)	36 (8.3%)		>200

Table 2: Frequency (%) of physical, chemical and microbial parameters based in season (N = 21)

HPC		Heat resistant coliform (MPN/100 mL)		Turbidity (NTU)		PH		Residual chlorine (ml/L)		Season
Undesirable	Desirable	Undesirable	Desirable	Undesirable	Desirable	Undesirable	Desirable	Undesirable	Desirable	
5 (5.5%)	87 (94.5%)	5 (5.5%)	87 (94.5%)	1 (1.1)	91 (98.9)	0	198 (100%)	9 (4%)	195 (96%)	Spring
10 (7.9%)	118 (92.1%)	11 (8.6%)	117 (91.4%)	0	119	0	265 (100%)	15 (5.7)	250 (94.3)	Summer
18 (14.4%)	107 (85.6%)	19 (15.2%)	106 (84.8%)	0	125	0	207 (100%)	29 (14%)	178 (86%)	Fall
3 (3.3%)	89 (96.7%)	3 (3.3%)	89 (96.7%)	0	92	0	124 (100%)	14 (7.6%)	170 (92.4%)	Winter

Table 3: Frequency (%) of physical, chemical and microbial parameters based in months (N = 21)

HPC		Heat resistant coliform (MPN/100 mL)		Turbidity (NTU)		PH		Residual chlorine (ml/L)		Months
Desirable	Undesirable	Desirable	Undesirable	Desirable	Desirable	Undesirable	Desirable	Undesirable	Desirable	
3 (10%)	27 (90%)	3 (10%)	27 (90%)	0	30 (100%)	0	54 (100%)	4 (6.7%)	56 (93.3%)	Mar. Apr.
2 (5.5%)	35 (94.5%)	2 (5.5%)	35 (94.5%)	1 (2.7%)	36 (97.3%)	0	74 (100%)	5 (6.8%)	69 (93.2%)	Apr. May
0	25 (100%)	0	25 (100%)	0	25 (100%)	0	70 (100%)	0	70 (100%)	May Jun.
3 (8.9%)	31 (91.1%)	3 (8.9%)	31 (91.1%)	0	25 (100%)	0	74 (100%)	1 (1.4%)	73 (98.6%)	Jun. Jul.
4 (8%)	46 (92%)	4 (8%)	46 (92%)	0	50 (100%)	0	101 (100%)	6 (6%)	95 (94%)	July. Aug.
3 (6.9%)	41 (93.1%)	4 (9.1%)	40 (90.9%)	0	44 (100%)	0	90 (100%)	8 (8.9%)	82 (91.1%)	Aug. Sep.
13 (30.3%)	30 (69.7%)	11 (25.6%)	32 (74.4%)	0	43 (100%)	0	43 (100%)	15 (34.1%)	29 (65.9%)	Sep. Oct.
5 (12.2%)	36 (87.8%)	7 (17.1%)	34 (82.9%)	0	41 (100%)	0	82 (100%)	9 (11%)	73 (89%)	Oct. Nov.
0	41 (100%)	1 (2.5%)	40 (97.5%)	0	41 (100%)	0	82 (100%)	5 (6.2%)	76 (93.8%)	Nov. Dec.
1 (3.2%)	31 (96.8%)	1 (3.2%)	31 (96.8%)	0	32 (100%)	0	32 (100%)	4 (6.3%)	60 (93.7%)	Dec. Jan.
0	28 (100%)	0	28 (100%)	0	(100%)28	0	28 (100%)	3 (5.4%)	53 (94.6%)	Jan. Feb.
2 (6.3%)	30 (93.7%)	2 (6.3%)	30 (93.7%)	0	32 (100%)	0	64 (100%)	7 (11%)	57 (89%)	Feb. Mar.

hygiene of swimming pool water was effective on controlling disease among swimmers. A study by Paul Roy in the USA showed that measuring PH, residual chlorine and number of users of a pool gives a reliable measure (confidence level of 95%) of microbial contamination (Mehdnejad, 2003). The present study indicated that residual chlorine was at desirable level in 92.2% of the cases and 7.8% of the cases failed to meet the standards (Table 1). Residual chlorine level less than the standards leads to higher turbidity, which in turn accelerates growth of algae and microorganisms. This problem can be solved by increasing the level of residual chlorine and adjust pH level (Mansoorian *et al.*, 2013). A study by Ghaneian in Yazd showed that 44.18% of the samples met the standards of residual chlorine while in 55.82% of the cases, residual chlorine was higher than the standards (Ghaneian *et al.*, 2012). Rabi *et al.* (2007) showed that residual chlorine in 49.4% of public pools in Aman- Jordan met the standards (Rabi *et al.*, 2007). Khodadadi *et al.* (2009) carried out a study in Birj and Iran and reported the residual chlorine in public pools was in undesirable level in 75% of the samples. Comparison of the obtained results and those of other studies indicates that residual chlorine level in our study was in better condition than that reported by other studies. The results also indicated that residual chlorine in the swimming pools under study was in better condition during spring (Table 2). Consistently, shahriari in Gorgan measured residual chlorine level based on seasons and reported that during spring, the index was in the best condition (Shahriari *et al.*, 2011). Our results showed that the samples were at standard level regarding PH level (Table 1). Similar studies in Oroumieh, Zahedan isfahan and Shahrekord indicated that mean PH level was at standard level (Nikaeen *et al.*, 2010; Nanbakhsh *et al.*, 2004; Sohrabi *et al.*, 2003; Fadaei *et al.*, 2005). Low pH level of water accelerates decay process of the installation, causes eyes and skin irritation and reduces chlorine in water and quality of water (Nikaeen *et al.*, 2010;

Borgmann-Strahsen, 2003). Sodium carbonate can be used to adjust pH level; while, excessive use of sodium carbonate increases the risk of respiratory and allergic problems and increases sediments and turbidity of water. To reduce pH, diluted muriatic acid and sulfuric acid can be used (Uyan *et al.*, 2009). Our results showed that 99.7% of the samples were at desirable level regarding turbidity and only 0.3% of the samples failed to meet the standards. Taking into account importance of turbidity in microbial hygiene of water, standard level of turbidity for swimming pool is 0.5 NTU (ISIR, 2008). The purpose of measuring turbidity is to determine transparency of water. High turbidity causes problems such as decrease in performance of disinfection process and reduction in effectiveness of disinfection agents (Mansoorian *et al.*, 2013). Ghaneian in Yazd reported that 13.6% of the samples had turbidity higher than the standards (Ghaneian *et al.*, 2012). Other studies have emphasized on necessity of examining public pools water with regard to microbial pollutions (Mansoorian *et al.*, 2013). Our results from 21 public swimming pools in Kermanshah showed that 8.7% and 8.3% of the samples were in undesirable condition regarding heat-resistant coliform and HPC, respectively (Table 1). Mansourian *et al.* (2013) carried out similar study in Kerman City and found that 82% of the samples were in undesirable condition from microbial contamination viewpoint; this figure in our study was 92%. Results of microbial quality examination showed that heat-resistant coliform and HPC levels were at minimum levels during winter (Table 2). Shahriari *et al.* (2011) reported that swimming pools in Gorgan had no microbial contamination during spring. In addition, the results showed that heat-resistant coliform and UPC were at highest level during Summer and fall between September and November (Table 2 and 3). Shahriari *et al.* (2011) reported in their study in Gorgan that highest coliform and pseudomonas aeruginosa level was observed in fall and the highest fecal streptococcus level was in Summer. Chlorine measurement showed that highest residual

chlorine concentration was observed in fall; apparently, lack of residual free chlorine is a great contributor in higher microbial contamination. In this regard, our results are consistent with (Shahriari *et al.*, 2011; Zazuli *et al.*, 2015; Rakestraw *et al.*, 1994) in addition, Martins *et al.* (1995) found a negative relationship between residual chlorine and bacteria contamination. Some of the risk assessment methods must be used in water pool for assessing health risk factor (Yarmohammadi *et al.*, 2016). Technical committee of nosocomial infections is useful in management of pollution of water pool, etc (Vatankhah *et al.*, 2014). knowledge, attitude and performance of staff of water pools in relation to job's environmental health must be useful in pollution of water pool (Almasi, 2016).

## CONCLUSION

Knowing that the highest concentration of free chlorine residual was observed in fall, it appears that lack of free residual chlorine explains higher microbial contamination in this season. Therefore, free residual chlorine is an effective factor in reducing microbial agents and turbidity, which needs to be monitored continuously. To have better control over disinfection agents, PH level must be monitored regularly. we recommended Effects of Administrative Interventions on Improvement of Safety and Health in Workplace is proven must be done in water pool (Ebrahimi *et al.*, 2016).

## REFERENCES

- APHA, AWWA and WPCF., 2005. Standard Methods for the Examination of Water and Wastewater. 21st & In., American Public Health Association, Washington, DC., USA., ISBN-13: 978-0875530475.
- Abedi, G., H. Seiyamiyan and F. Rostami, 2012. The study of waiting line of receiving intensive care unit services in the hospitals. *Health MED.*, 6: 126-130.
- Abedi, G., S.H. Darvari, A. Nadighara and F. Rostami, 2014. The relationship between quality of life and marriage satisfaction in infertile couples using path analysis. *S. Mazandaran Uni. Med. Sci.*, 24: 184-193.
- Almasi, A., M. Mohamadi, M. Poursadeghiyan, Y. Sohrabi, S. Mohamadi and M. Komijani, 2016. The survey of knowledge, attitude and performance of female barbers in relation to job's environmental health: A case study of Malayer city. Iran. *S. Health Safety Env iron.*, 3: 573-577.
- Azizjalali, M.H. and E. Behrangi, 2009. Study of the prevalence of Tinea Pedis in swimmers of the West Pools of Tehran in 2007. *Razi S. Med. Sci.*, 16: 94-102.
- Bahmani, P., A. Maleki, M. Salimi and S. Sadeghi, 2015. Survey physico-chemical and microbial quality of Sanandaj city swimming pools water. *S. Environmental Health Eng.*, 2: 89-97.
- Barben, S., G. Hafen, S. Schmid and Swiss Paediatric Respiratory Research Group, 2005. *Pseudomonas aeruginosa* in public swimming pools and bathroom water of patients with cystic fibrosis. *S. Cystic Fibrosis*, 4: 227-231.
- Borgmann-Strahsen, R., 2003. Comparative assessment of different biocides in swimming pool water. *Int. Biodeteriorat. Biodegrad.*, 51: 291-297.
- Ebrahimi, M.H., M. Abbasi, M. Khandan, M. Poursadeghiyan, M. Hami and H. Biglari, 2016. Effects of administrative interventions on improvement of safety and health in workplace: A case study in an oil company in Iran (2011-2015). *5. Eng. Applied Sci.*, 11: 346-351.
- Fadaei, A., H. Moqhayem, K. Shakery and M. Torabi, 2005. Comparing the health status of swimming pools in Shahrekord city in 2005. *Proceedings of the 9th National Congress on Environmental Health*, November 7-9, 2005, Isfahan, Iran -.
- Farzianpour, F., S. Shojaei, G. Abedi, F. Rostami, 2014. Assessment of quality of life in cancer patients. *Am. S. Agric. Biol. Sci.*, 9: 147-152.
- Ghanian, M.T., M.H. Ehrampoush, V. Dad, M. Amrollahi, M. Dehviri and B. Jamshidi, 2012. An investigation on physicochemical and microbial water quality of swimming pools in Yazd. *S. Shahid Sadoughi Univ. Med. Sci.*, 20: 340-349.
- Guida, M., F. Galle, M.L. Mattei, D. Anastasi and G. Liguori, 2009. Microbiological quality of the water of recreational and rehabilitation pools: A 2-year survey in Naples, Italy. *Public Health*, 123: 448-451.
- Hambly, A.C., R.K. Henderson, M.V. Storey, A. Baker, R.M. Stuetz and S.S. Khan, 2010. Fluorescence monitoring at a recycled water treatment plant and associated dual distribution system-Implications for cross-connection detection. *Water Res.*, 44: 5323-5333.
- ISIRI, 2008. Swimming pools, general requirements 2008: Standard number 11203. Institute of Standard and Industrial Research of Iran.
- ISIRI, 2008. Swimming pools-general requirements: ISIRI No. 11203. Institute of Standards and Industrial Research of Iran.
- Kazemi-Farcl, H., G. Jandaghi and M. Safdari, 2006. The study of Dermatophytic infections in public swimming pools of Qom city during 2004. *Arak Med. Univ.* 5., 9: 67-72.



- Khodadadi, M., B. Barikbin, M. Azizi and R. Aliabadi, 2009. The investigation of microbial status and physicochemical parameters in Swimming pools water of Birjand city. *J. Birjand Med. Sci. Univ.*, 12: 9-15.
- Lourencetti, C., C. Ballester, P. Fernandez, E. Marco, C. Prado, J.F. Periago and J.D. Grimalt, 2010. New method for determination of trihalomethanes in exhaled breath: Applications to swimming pool and bath environments. *Anal. Chim. Acta*, 662: 23-30.
- Mansoorian, H. J., A. Raj abizadeh, M.S. Modrek, S. Doulatshahi and B. Hatami, 2013. Water health indices in Kerman swimming pools, in 2011. *J. Health Dev.*, 2: 128-137.
- Martins, M. T., M.I.Z. Sato, M.N. Alves, N.C. Stoppe, V.M. Prado and P. S. Sanchez, 1995. Assessment of microbiological quality for swimming pools in South America. *Water Res.*, 29: 2417-2420.
- Mehdinejan, M.H., 2003. Determination of quality health index in swimming pool water of Gorgan city. *Gorgan Univ. Med. Sci.*, 5: 89-95.
- Moeinian, K. and T. Rastgoo, 2016. Survey on six microbial quality indices in chlorinated swimming pools and influence of pool depth and swimmers gender on it (case study). *Koomesh*, 17: Pe426-Pe432.
- Nanbakhsh, H., K. Diba and K. Hazrati, 2004. Study of fungal contamination of indoor public swimming pools. *Iran. J. Publ. Health*, 33: 60-65.
- Neghab, M., H.A. Gorji, M.A. Baghapour and A.R. Rajanfar, 2004. Survey on water contamination of swimming pools in Shiraz. *Scient. J. Kurdistan Univ. Med. Sci.*, 31: 41-49.
- Nichols, G., 2006. Infection risks from water in natural and man-made environments. *Euro Surveill*, 11: 76-78.
- Nikaeen, M., M. Hatamzadeh, M.V. Dastjerdi, A. Hassanzadeh, Z. Mosavi and M. Rafiei, 2010. An investigation on physical, chemical and microbial quality of Isfahan swimming pool waters based on standard indicators. *J. Isfahan Med. School*, 28: 346-356.
- Nourian, A.A., H. Badali and H. Hamzehei, 2006. Fungal contamination in indoor swimming pools in Zanjan-Iran 2005. *Pak. J. Biol. Sci.*, 9: 2524-2527.
- Panyakapo, M., S. Soontornchai and P. Paopuree, 2008. Cancer risk assessment from exposure to trihalomethanes in tap water and swimming pool water. *J. Environmental Sci.*, 20: 372-378.
- Rabi, A., Y. Khader, A. Alkafajei and A.A. Aqoulah, 2007. Sanitary conditions of public swimming pools in Amman, Jordan. *Int. J. Environ. Res. Public Health*, 4: 301-306.
- Rakestraw, L.F., G.D. Nelson, D.M. Flanery, M. Pabst and E. Gregos et al., 1994. A comprehensive study on the microbicidal properties of stabilized and unstabilized chlorine and the relationships of other chemical and physical variables in public swimming pools: A report of a study carried out in Pinellas county. National Swimming Pool Foundation.
- Rasti, S., M.A. Asadi, L. Iranshahi, H. Hooshyar, H.R. Gilasi and A. Zahiri, 2011. Evaluation of parasitic and fungal contamination and physicochemical parameters of indoor public swimming pools in Kashan during 2008-9. *Feyz J. Kashan Univ. Med. Sci.*, 15: 74-80.
- Schoefer, Y., A. Zutavem, I. Brockow, T. Schafer and U. Kramer et al., 2008. Health risks of early swimming pool attendance. *Int. J. Hygiene Environ. Health*, 211: 367-373.
- Shahriari, A., A.H. Nafez, S. Norouzi and M. Heidari, 2011. Investigation of common microbial indicators in swimming pool of Gorgan city. *J. Health Hygiene*, 2: 17-26.
- Sohrabi, A., M.I. Qureshi, M. Dehdar and A.R. Khorshid, 2003. Study of fungal and bacterial contamination of Zahedan indoor swimming pools. *Proceedings of the 6th National Congress on Environmental Health*, October 22-24, 2003, Sari, Iran -.
- Uyan, Z.S., S. Carraro, G. Piacentini and E. Baraldi, 2009. Swimming pool, respiratory health and childhood asthma: Should we change our beliefs? *Pediatric Pulmonol.*, 44: 31-37.
- Vatankhah, S., H. Mokarami, M. Karchani, Z. Hosseini, B. Izadi and F. Moradi, 2014. Effect of executive programs of infection control committees on the prevalence of nosocomial infections in Kermanshah's hospitals (2010-2011). *Electron. Physician*, 6: 768-770.
- Yarmohammadi, H., M. Poursadeghiyan, Y. Shorabi, M.H. Ebrahimi, G. Rezaei, H. Biglari and R. Rostami, 2016. Risk assessment in a wheat winnowing factory based on ET and BA method. *J. Eng. Applied Sci.*, 11: 334-338.
- Yousefi, Z., 2009. Study of the pollution condition of swimming pools in Sari city for the *Staphylococcus aureus*. *Iran. J. Health Environ.*, 2: 178-187.
- Zangiabadi, A., R. Aali, A. Zarei and R. Ghanbari, 2011. Spatial analysis and health grading of swimming pools. *J. Health Syst.*, 6: 800-809.
- Zazouli, M.A., Y. Mandavi, M.M. Golrokhi and D. Balarak, 2015. Investigation of water quality health indicators of the swimming pools in Unnia in 2013. *J. Rafsanjan Univ. Med. Sci.*, 13: 1033-1