

A survey of attitudes and acceptance of wastewater reuse in Iran: Shiraz City as a case study

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ABSTRACT

People's attitudes are a key issue in the use of reclaimed wastewater. Unfortunately, there is not enough research on the use of reclaimed wastewater in developing countries such as Iran. The present study aimed to investigate public acceptance and citizens' attitudes toward reclaimed wastewater in Shiraz, Iran. A two-part questionnaire, designed to collect demographic data and information about people's willingness to reuse wastewater, was distributed among 562 citizens of Shiraz. The results showed that most respondents knew nothing about the chemical quality (67.4%) or microbiological quality (81.5%) of the wastewater treatment plant effluent. The maximum acceptance of treated wastewater use was related to public consumption (87%), car washing (85%) and flush tank (80%), respectively. The minimum acceptance was related to cooking and drinking (8%). Also, a significant correlation was observed between citizens' willingness to use reclaimed wastewater and variables such as level of education, gender, awareness of wastewater treatment process and awareness of quality of reclaimed wastewater. Shiraz citizens, like other people in the world, were less willing to use reclaimed wastewater for cooking, drinking, laundry and bathing, but their willingness was obviously greater in applications with less skin contact.

Key words | acceptance, attitude, reclaimed wastewater, Shiraz, wastewater reuse

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INTRODUCTION

During recent decades, increasing water demand on one hand and increasing droughts and imbalance in rainfall in different areas of the world on the other have clearly highlighted the importance of alternative sources of water (Menegaki *et al.* 2007; Bakopoulou *et al.* 2010). Reclaimed wastewater is a valuable alternative source (Bakopoulou *et al.* 2010). Using this valuable resource is an important way to reduce the pressure on water sources (Matos *et al.* 2014), and it is taken into consideration as an essential part of water resource management (Marlow *et al.* 2013). In the past three decades, focus on wastewater reuse has significantly increased (Tram Vo *et al.* 2014) and today, in many

areas of the world, wastewater reuse plans are being implemented (Baghapour *et al.* 2013). Several studies have been conducted on various aspects of wastewater reuse, but it should be noted that public acceptance is the most important factor for sustainable use of wastewater (Buyuk-kamaci & Alkan 2013; Tram Vo *et al.* 2014; Wester *et al.* 2015). Public opposition before, during and after implementation of such projects can lead to failure (Friedler *et al.* 2006). So far, such projects have failed because of community opposition and factors such as fanatical beliefs, fears, lack of awareness and public doubts (Friedler *et al.* 2006; Pham *et al.* 2011; Wester *et al.* 2015). For example, it has been reported that in the 1990s in the United States, a number of wastewater reuse projects stalled due to strong public opposition and even then people had used terms like 'Toilet to Tap' and 'Sewage Beverage' to describe

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these projects (Hartley 2006). Hence, due to the fact that people are end-users of reclaimed wastewater, general population participation and support is a very important issue in wastewater reuse projects (Bakopoulou *et al.* 2010).

The early studies about public perception were conducted in 1970s and 1980s in the United States (Miller & Buys 2008). Since then, many studies have been conducted to determine the level of public acceptance of wastewater reuse. Most of these studies have been performed in the United States, Western Europe and Australia (Friedler *et al.* 2006). This important aspect of wastewater reuse has been less studied in other areas of the world, including the Middle East; therefore, due to differences in climate, environment and culture, clarification of public acceptance in these areas is particularly important.

The Middle East is one of the most water-stressed regions in the world (International Water Management Institute 2006). This region and North Africa have just 1% of the world's freshwater resources and so are considered as the driest regions in the world (Qadir *et al.* 2009). Hence, the use of reclaimed wastewater in these communities may be a realistic option for dealing with water scarcity (Alfarra *et al.* 2011; Baghapour *et al.* 2013).

Iran, like other countries in the Middle East and North Africa, faces water scarcity and is in a severe water crisis situation according to reports from the United Nations and International Water Management Institute (Ehsani 2005). This situation increases the need for plans and studies on the use of alternative water sources, e.g. reclaimed wastewater, in Iran. However, due to the lack of information about public acceptance of wastewater reuse in Iran, the success of such projects is uncertain. The present study aimed to investigate Iranian citizens' attitudes toward reclaimed wastewater reuse for various applications. Shiraz, which is planning a big wastewater reuse project, was selected as a case study and the willingness of its citizens to reclaimed wastewater reuse was determined.

MATERIALS AND METHODS

Characteristics and location of the study area

Shiraz is located in southwest Iran. The average annual precipitation in this city is about 335 mm. Its climate is arid and

semi-arid and frequent droughts of different intensities are one of the main characteristics. Shiraz has a population of over 1.2 million people and is one of the six major cities in Iran. Electronics and petrochemical industries are the main industrial activities in Shiraz. Tourism is one of the main sources of people's income and agriculture also plays a major role in the city's economy. A municipal wastewater treatment plant which is located in the southeastern part of the city uses the conventional activated sludge process for wastewater treatment. The final coverage of inhabitants by this plant will be 584,000 and the current module covers 409,000 inhabitants. The Shiraz Regional Water Authority intends to use 29.5 million cubic metres of effluent from this plant for various applications (agricultural irrigation, landscape irrigation and groundwater recharge) (Baghapour *et al.* 2013).

Questionnaire and sampling

To measure Shiraz citizens' willingness to reuse reclaimed wastewater, a multiple choice questionnaire was prepared. The questionnaire had three main parts: the first one determined the respondents' demographic data, including age, gender and level of education. The second part determined the level of respondents' awareness about environmental issues including awareness about wastewater treatment processes, treated wastewater quality (physical, chemical and biological) and shortage of water resources in Shiraz. The third part determined Shiraz citizens' willingness to use reclaimed wastewater for 11 different purposes: public consumption (landscape and parks irrigation, firefighting), car washing, flushing toilet, air conditioning, house cleaning, irrigation of crops which are consumed raw, irrigation of crops which are cooked, fish farming, washing clothes, cooking and drinking. Respondents who did not wish to use reclaimed wastewater for any of these purposes, were asked to specify their reason by choosing one of the options: religious, health concerns, aesthetic reasons (colour, odour and turbidity). Questionnaires were distributed in 10 districts of Shiraz Municipality and were completed by face-to-face interviews. The number of questionnaires distributed in each municipal district was determined based on its population size. At the first step, a number of streets were randomly selected in each district, then four houses were arbitrarily selected in each street and almost three

questionnaires per house were completed. Participants were selected from 15–70-year-old residents.

Statistical analysis

Kruskal–Wallis and Mann–Whitney statistical tests were used to determine the relationship between citizens' willingness to use reclaimed wastewater and independent variables such as citizens' awareness of wastewater treatment processes, water scarcity and effluent quality. The chi-square test was used to survey the relationship between level of education and gender and acceptance of every reuse option, and one-way analysis of variance (ANOVA) test was used to study the relationship between age and acceptance. All statistical analyses were performed using SPSS version 21 and Microsoft Excel 2010.

RESULTS

A total of 562 questionnaires were completed by Shiraz citizens. The response rate of the participants was approximately 75%. Demographic data obtained from questionnaires are shown in Table 1. A slightly higher percentage

Table 1 | Demographic information on participants

	Frequency	Percentage
Gender		
Male	280	49.8
Female	282	50.2
Age group		
Under 20	85	15.1
20–29	208	37.0
30–39	124	22.1
40–49	73	13.0
Over 50	72	12.8
Education		
Primary	13	2.3
School Certificate	22	3.9
High School Certificate	70	12.5
College	133	23.7
University	324	57.6

of women than men participated. The 20–29-year-old group with 208 (37.0%) respondents had the maximum percentage of respondents; the 40–49 and older than 50-year-old groups with 73 (13.0%) and 72 (12.8%) respondents, respectively, had the minimum percentages of respondents. Moreover, almost half of participants (almost 57%) in this study had an academic degree.

Also, the results showed that citizens' awareness about physical, chemical and biological quality of wastewater treatment plant effluent was 51.0, 18.5 and 32.6%, respectively.

On average, 58.2% of respondents agreed with reclaimed wastewater reuse in various applications, only 24.1% of respondents disagreed and 17.7% had no opinion. Figure 1 shows the results of Shiraz citizens' willingness to use reclaimed wastewater for different purposes. As can be seen in Figure 1, 74.9% of respondents were opposed to using reclaimed wastewater for cooking and drinking, and only 8.9% agreed with using it. More than half of respondents agreed with the use of reclaimed wastewater in irrigation; 21.5 and 14.9% of people opposed its use in irrigation of crops which are consumed raw and irrigation of crops which are cooked, respectively. The data showed that 45.2, 32.0 and 39.3% of Shiraz citizens agreed with the use of reclaimed wastewater in fish farming, bathing and washing clothes. Also, the maximum willingness to use reclaimed wastewater was related to public consumption (87.7%), car washing (85.8%), air conditioning (70.1), flush tank (81.0%) and house cleaning (68.7%). Thus, the status of Shiraz citizens' acceptance for various applications was as follows: public consumption > car washing > flushing toilet > air conditioning > house cleaning > agricultural irrigation (crops which are cooked before eating) > agricultural irrigation (crops which are consumed raw) > fish farming > washing clothes > bathing > cooking > drinking.

The respondents who did not agree with any of the uses mentioned selected from the religious, health and aesthetic options as the reason for their opposition; their reasons are presented in Figure 2. As can be seen, the main reason for opposition was health concerns while religious and aesthetic concerns were less important. In addition, only in air conditioning, are aesthetic concerns significantly high (39.6%). From the religious point of view, the highest concern was related to public consumption (17.5%). In

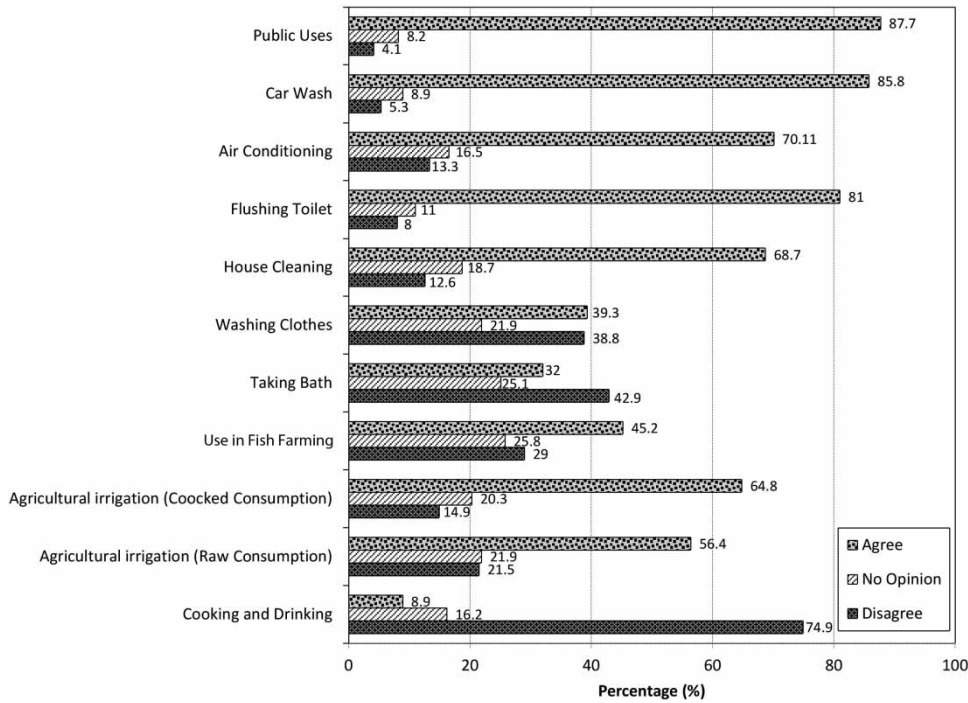


Figure 1 | Shiraz citizens' willingness to reuse reclaimed wastewater for different purposes.

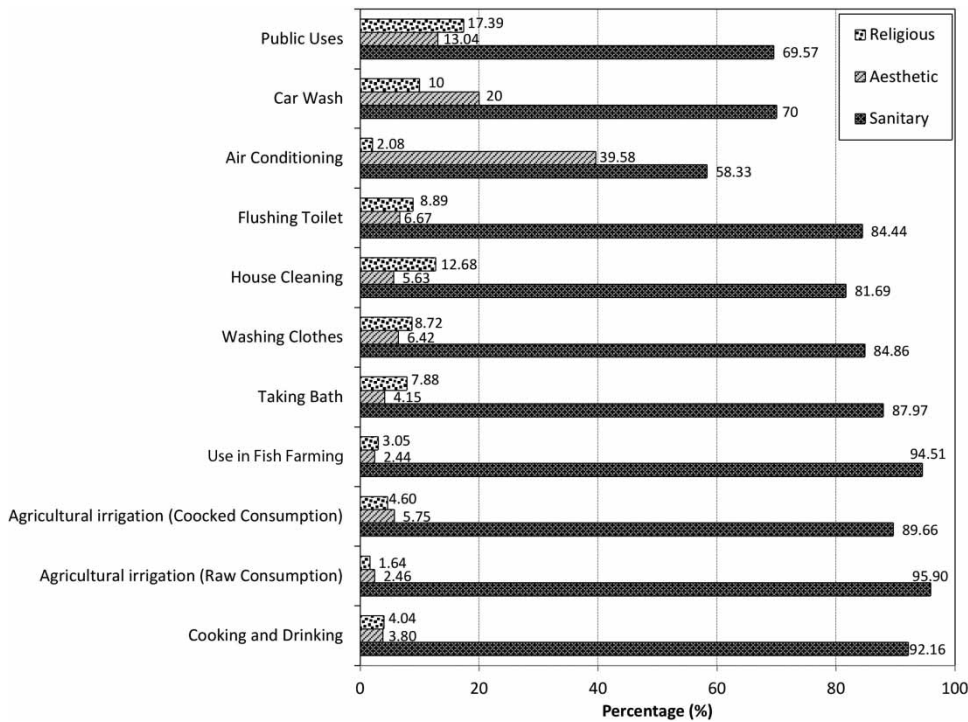


Figure 2 | Shiraz citizens' reasons for opposition to use reclaimed wastewater for different purposes.

general, by considering all reuse options, a total of 84.3% of respondents mentioned health problems as the reason for their opposition while 8.4% and 7.2% selected aesthetic and religious options, respectively.

The results of the statistical analysis showed that people with academic education were more supportive than other groups of use of reclaimed wastewater in cooking, car washing, flush tank, air conditioning and public consumption ($p < 0.05$, $df = 2$). Also, men more than women have accepted the use of reclaimed wastewater in bathing, washing clothes, irrigating crops that are consumed raw and house cleaning ($p < 0.05$, $df = 4$).

The data revealed that there is no significant difference between various age groups in the use of reclaimed wastewater ($p < 0.05$, $df = 2$). There was a significant relation ($p < 0.05$, $df = 3$) between participants' awareness about wastewater treatment processes and their willingness to reuse wastewater in various applications. The Mann-Whitney test showed that tendency to reuse wastewater is greater in people with more awareness than those with a lower level of awareness about wastewater treatment processes. Also, data analysis indicated that there is a significant relation between awareness about physical, chemical and biological quality of wastewater plant effluent and citizens' acceptance of reclaimed wastewater reuse ($p < 0.05$, $df = 2$). In the case of drought, the results showed that there is no significant difference between participants' knowledge about drought and citizens' acceptance of reclaimed wastewater reuse ($p < 0.05$).

DISCUSSION

Experience in past decades suggests that identifying community concerns about wastewater reuse projects plays an important role in better implementation of these projects. Despite the implementation of many reclaimed wastewater reuse projects in Iran, unfortunately no study on people's acceptance of such projects has been conducted in its cities. Hence, in the present study, Shiraz was selected as a case study and its citizens' acceptance of reclaimed wastewater reuse was investigated.

The present study showed that Shiraz citizens strongly agreed with reclaimed wastewater use in applications such

as public consumption (87.7%), car washing (85.8%), air conditioning (70.1%), flush tank (81%), house cleaning (68.7%) and even agricultural irrigation (64.8% and 56.4% for crops which are consumed cooked and raw, respectively). In general, the acceptance of reclaimed wastewater for non-potable applications is higher (Boyer *et al.* 2012). For example, Dolnicar & Schäfer (2009) conducted a study in Australia and showed that people strongly agreed with reclaimed wastewater reuse in non-potable applications, such as toilet flushing (90%), watering the garden (89%), firefighting (86%), irrigation of sports fields (82%) and car washing (79%). In a study conducted in Israel, Friedler *et al.* (2006) achieved similar results which are consistent with our findings.

After 40 years of experience in the use of reclaimed wastewater for drinking, scientists still have reported no negative health effects associated with such projects (Miller & Buys 2008). However, many studies have shown that most opposition is related to wastewater reuse in food making and drinking (Dolnicar & Schäfer 2009). For example, Alhumoud & Madzikanda (2010) studied Kuwait citizens' acceptance of reclaimed wastewater reuse and concluded that 77.9% of participants were opposed to using reclaimed wastewater for drinking, and 78.0% of them opposed using reclaimed wastewater in cooking. Ormerod & Scott (2012) showed that just 8% of Tucson citizens in the United States supported the use of reclaimed wastewater for drinking; however, 48% of them agreed with groundwater recharge for this application (indirect potable reuse).

In our study, only 8.9% of respondents agreed with wastewater reuse for drinking and cooking, and 74.9% of them disagreed with this type of wastewater reuse. This result was perfectly in accordance with Alhumoud & Madzikanda (2010) and Ormerod & Scott (2012). It should be noted that with increasing drought, reclaimed wastewater reuse projects for drinking purposes are increased (Wilson & Pfaff 2008) and it seems that, over time, by increasing people's awareness, acceptance of reclaimed wastewater, even in cases such as drinking, will increase. For example, a study in San Diego county from 2004 to 2011 showed that the percentage of people who support the use of reclaimed wastewater for drinking increased from 12% to 34%, and on the other hand, the percentage of people who

strongly opposed use of reclaimed wastewater for drinking decreased from 45% to 11% (Tram Vo *et al.* 2014).

Skin contact with reclaimed wastewater is one of the important factors in the response of people to different reuse options. Various studies have shown that the level of skin contact has an inverse correlation with citizens' willingness to use reclaimed wastewater. Hence, in applications such as bathing, washing clothes and swimming, general acceptance is also reduced (Friedler *et al.* 2006; Hartley 2006; Pham *et al.* 2011). In the present study, many respondents disagreed with applications with high skin contact, so that only one-third of respondents agreed with bathing and washing clothes; these findings are in good agreement with the studies of Miller & Buys (2008) and Pham *et al.* (2011). In fact, characteristics of community and local context including physical geography and regional circumstances (arid climate or awareness about water quality and availability of water resources) greatly determine attitudes of different societies toward reclaimed wastewater reuse (Ormerod & Scott 2012). That is why some studies have shown that in some communities even consumptions with low skin contact have met public opposition. For example, Ahmad (1991) in a survey conducted in Qatar showed that 92% of respondents opposed use of reclaimed wastewater for agricultural irrigation, 50% for lawn and garden irrigation, 50% for car washing and 88% for industrial reuse.

In most communities, the main source of reclaimed wastewater is municipal wastewater; this could be the main reason for public concern about the use of reclaimed wastewater even for applications that do not have a direct skin contact. In a survey carried out in Orange County, California, people stated that the source of reclaimed wastewater is their main concern about wastewater reuse (Hartley 2006). Considering the origin of reclaimed wastewater, the major concerns can be related to biological and chemical pollution, aesthetic problems such as odour, colour and turbidity, as well as religious issues. For example, Higgins *et al.* (2002) concluded that health issues, such as pathogens and chemical agents, are the main concerns of respondents about wastewater reuse. In a study conducted in Australia, Pham *et al.* (2011) showed that health issues and concerns arising from odour with 76% were the respondents' main reasons for opposition to using reclaimed

wastewater. Our study respondents were most concerned about health issues so that in applications such as toilet flushing, house cleaning, washing clothes and bathing, up to 80% of respondents selected health concerns as the main reason for their opposition, and in applications that are somewhat related to eating and drinking, e.g. fish farming, agricultural irrigation, cooking and drinking, over 90% of concerns were associated with health issues. In some applications, such as agricultural irrigation (for crops that are consumed raw or cooked) compared to the applications like bathing, skin contact is much lower (so it has lower health risks); however, because it is food, respondents were more uneasy about health aspects. After health issues, aesthetic concerns (colour, odour and turbidity) with an average of 8.4% had the highest share of non-acceptance. Figure 2 illustrates that 39.6% of those respondents who disagreed with the use of reclaimed wastewater in air conditioning stated aesthetic aspects as the reason for their opposition; probably reclaimed wastewater odour is the most important reason for this.

Sometimes, ideological opposition may also prevent wastewater reuse (Wilson & Pfaff 2008). Muslims, in addition to mundane purposes such as drinking, cooking and washing dishes, use water for religious purposes to obtain ritual purity and from the viewpoint of Islam, it is classified into various categories (Farooq & Ansari 1981). In Islamic law, if impurities like urine and faeces contaminate water and change its odour, taste or colour, this water (called *mutanajjis*) cannot be used for mundane or religious purposes (in other words, this water is *haram* or unlawful according to Islam). Since raw wastewater is the source of reclaimed wastewater, some Muslims may consider reclaimed wastewater as *haram* and be opposed to its use. However, there are inconsistencies in different studies: some have shown the relationship between religious beliefs and public acceptance for wastewater reuse and others have rejected this relationship (Alhumoud & Madzikanda 2010; Wester *et al.* 2015). In this study, although all respondents were Muslims (more than 98% of Iranians are Muslims), only a small number (an average of just 7.2%) of them who disagreed with reclaimed wastewater use for various applications mentioned religious issues as the reason for their opposition. Wilson & Pfaff (2008) carried out a study in Durban and showed that there is no evidence

for Muslims' opposition to reuse of reclaimed wastewater on the basis of religious beliefs. This finding is consistent with the result of the present study. In contrast, [Alhumoud & Madzikanda \(2010\)](#), in a study on Kuwaiti citizens' willingness to reclaimed wastewater reuse, concluded that 29% of opposition was because of religious beliefs.

Many studies have shown that there may be a correlation between demographic variables and acceptance of reclaimed wastewater reuse ([Friedler *et al.* 2006](#); [Alhumoud & Madzikanda 2010](#); [Wester *et al.* 2015](#)). The results of the present study showed that respondents with an academic education were more likely to use reclaimed wastewater for cooking, car washing, flush tank, air conditioning and public consumption. Generally, people with an academic education have more information about environmental issues and tend to participate more in reuse projects. Many studies have shown that there is a correlation between education and acceptance of reclaimed wastewater use ([Dolnicar & Schäfer 2009](#)). For instance, [Wester *et al.* \(2015\)](#) showed that people with lower levels of education in the United States are more uncomfortable with wastewater reuse. In another study in Kuwait, [Alhumoud & Madzikanda \(2010\)](#) concluded that people with higher levels of education have more interest in treated wastewater reuse. The results from our study also showed that in applications such as bathing, washing clothes, irrigation of crops that are consumed raw and house cleaning, men tend to favour reuse of wastewater significantly more than women. The results of studies by [Wester *et al.* \(2015\)](#) and [Dolnicar & Schäfer \(2009\)](#) were also similar.

Many studies have shown that, in general, women accept fewer risks than men, and men generally accept more new technologies. The reason of this is not been fully known but researchers believe that probably it is due to social and biological differences between women and men ([Miller & Buys 2008](#)). In the use of reclaimed wastewater, this difference could be due to women's greater concern about family and children safety.

Although some previous studies have shown that older people see more risks in reclaimed reuse than others ([Wester *et al.* 2015](#)), in this study, no significant differences were observed between different age groups. [Friedler *et al.* \(2006\)](#) also did not find a correlation between age and support of reuse.

Awareness about water sources scarcity and current or future drought phenomenon may also be an important factor in people's willingness to use reclaimed wastewater. People who experienced water use limitations are more willing to use reclaimed wastewater ([Wester *et al.* 2015](#)). [Pham *et al.* \(2011\)](#) showed that there is a significant correlation between respondents' awareness about water scarcity and their willingness to use treated wastewater. In another study in Tucson, Arizona, [Ormerod & Scott \(2012\)](#), showed that arid climate has caused respondents to consider reclaimed wastewater as a valuable water resource. However, in the present study no significant correlation between awareness about drought in Shiraz and willingness of respondents to use reclaimed wastewater was seen. Participants who were aware of drought, probably due to the fact that they used available freshwater, did not experience water scarcity for themselves. Therefore, they have not regarded reclaimed wastewater as an alternative water source for various reasons including psychological issues and lack of awareness about quality of treated wastewater. In other words, when communities face the problem of water scarcity, reclaimed wastewater as an alternative water source is usually more accepted by people, but in communities where access to freshwater resources is more assured, people are less willing to use reclaimed wastewater ([Exall *et al.* 2004](#)). It is expected that in the future, by experiencing water scarcity, Shiraz citizens will consider reclaimed wastewater as an alternative source of water more seriously.

This study also showed that people who were more aware of wastewater treatment processes as well as physical, chemical and biological quality, had generally higher willingness to use reclaimed wastewater. This may be due to more positive impressions of treated wastewater in these people. They know that quality of treated wastewater is basically different from raw wastewater, and use of it may be associated with lower risk. Thus, advertisements in the media, public workshops and establishment of information campaigns may increase public awareness about quality of reclaimed wastewater and encourage its use. Also, such factors may change those who still do not have any information on the use of reclaimed wastewater (their percentage was significant in this study, [Figure 2](#)), into supporters of reclaimed wastewater reuse. Direct site visits to wastewater

treatment plants and seeing effluent of such facilities could have a significant impact on increase of public acceptance because studies have shown that although people accept experts' opinions on quality of treated wastewater, they rely more on their personal impressions of effluent (often based on turbidity and particulate matter) (Hartley 2006).

CONCLUSIONS

Successful implementation of wastewater reuse projects, in addition to economic and technological aspects, mainly depends on public support. Thus, determining public support for such projects before implementing them is very important. Iran and Shiraz are the regions where wastewater reuse projects may be very useful due to scarce water resources, but so far, there is no study on the acceptability of such projects among Iranian citizens. The present study selected Shiraz as a case study and investigated citizens' acceptance of reclaimed wastewater reuse for a variety of applications. The results showed that Shiraz citizens tend to reuse reclaimed wastewater (on average, about 60% of respondents agreed with use of reclaimed wastewater for various applications) and a relatively small number (24%) oppose such projects. The study also revealed that, like the rest of the world, Shiraz citizens tend to use reclaimed wastewater in applications with low skin contact, such as public consumption (88%), car washing (86%), air conditioning (70%), toilet flush tank (81%), house cleaning (69%) and irrigation (crops that are consumed raw (56%), and cooked food crops (64%)). Nearly 75% of respondents opposed the use of this kind of water for drinking and cooking and they stated health concerns as the main reason for their opposition. Overall, it can be said that Shiraz citizens support reclaimed wastewater reuse well, also education and awareness via mass media and advertising campaigns can increase this support and the likelihood of successful implementation of reclaimed wastewater reuse projects.

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