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Original Article

# Investigating and Determining the Critical Points Ahvaz Drinking Water

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## Abstract

**Background & Aims:** The quality of drinking water includes the microbial, chemical and physical parameters of water, and non-standard values of these parameters cause water pollution. Water improvement has a direct relationship with the reduction of infectious diseases. The aim of this study was to Investigating and determining the critical points Ahvaz drinking water.

**Materials and Methods:** This descriptive sectional study was done during 2019 to 2022 (3 years). Tests and monthly reports are based on the methods listed in the method standard were collected directly from distribution network drinking water in Ahvaz drinking water. Statistical analysis, including the one-sample t-test was used to compare the average with the standard level. The significance level was 0.05 used by SPSS version 22 software in all analyses.

**Results:** result of this study, out of 172 cases, the cause of the crisis is due to broken water pipes, 62 cases are in the west region and 110 cases are in the east region. Based on result, out of 22 cases, the cause of the crisis is due to the lack of sewage overflow in 1 case in the western region and 21 cases in the eastern region. In total, there is a significant difference in the occurrence of crisis causes in the water network between the east and west regions of Ahvaz, and the east region (86.4% of crisis cases) has a higher percentage of crisis causes than the west region of Ahvaz (13.6%). from crisis cases) is included.

**Conclusion:** In general, the best way to guarantee the quality of drinking water, reduce incidents and record critical cases in the drinking water distribution network is to implement a comprehensive management system with the cooperation of all relevant organizations. The new approach of the World Health Organization (WHO) to achieve this goal is to implement the water safety program.

**Keywords:** Drinking water, Hazard analysis and critical control points, Water distribution network, Ahvaz, Iran

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## 1. Introduction

Earth's water generally includes all the water that exists in different forms on the earth and in the atmosphere [1]. Water makes up about 56% of the body weight of living beings and is undoubtedly considered a vital combination for all creatures on earth [2]. Access to safe drinking water sources is an important issue in many countries of the world. Based on reported of the World Health Organization (WHO), 1.1 billion people in the world do not have access to safe drinking water every year, and about 08% of children's deaths due to digestive diseases such as diarrhea occur after consuming contaminated drinking water [3,4].

From this point of view, the physical, chemical and microbial properties of water are very important in ensuring the health and safety of drinking water and the level of satisfaction of consumers. Physical parameters are those characteristics of water that can be recognized by the senses of sight, touch, taste and smell [2,5].

Water resources play an important role in biological, ecological, social balance, economic growth and industrial development. Khuzestan province due to having huge water resources of the rivers Karun, Arvand, Dar and Karkheh, some of these rivers are also the communication route of the neighboring countries [6,7]. These sources play a very important role in the transfer of petroleum products and the export and import of commercial and agricultural goods [6,7]. The Karun River is the longest and most abundant river in the country, which has a strategic position in the western

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and southwestern regions of Iran due to the existence of numerous industrial centers, agricultural lands and large cities on its outskirts, and the optimal monitoring of its water quality is a national necessity [7].

According to the layers and layers of the earth and the composition of the tributaries, the presence of salt water in the river, as well as the transport of sediments and other soluble salts, reduces the quality of water. The direct and unfiltered discharge of all kinds of sewage from agricultural lands, industrial effluents and domestic urban sewage and villages in the plain of Khuzestan causes an increase in all kinds of physical or chemical and biological pollution of the water of the Karun River due to the direct and unfiltered discharge of these effluents [8-11].

Considering the importance of the subject of the present study was performed with the aim of determining the critical points Ahvaz drinking water in Ahvaz at southwest of Iran in the year 2019 to 2022 (3 years).

## 2. Materials and Methods

### *2.1. The study area*

This descriptive-cross-sectional study was conducted in Ahvaz drinking water, located in southwest Iran in 2022 (Figure 1). Ahvaz is located at 31 degrees and 30 minutes of latitude north and 48 degrees and 65 minutes of longitude east, in the plains of Khuzestan, at a height of 12 meters above sea level [12,13].

### *2.2. Method, data collection and statistical analysis*

This study was conducted a cross-sectional descriptive study to investigating and determining the critical points Ahvaz drinking water in Ahvaz at southwest of Iran in the year 2019 to 2022.

The tools used in this study included a reviewing the articles and library studies, the required information is gathered. In this study, using the qualitative results of the central laboratory of the deputy health department of Jundishapur Ahvaz University of Medical Sciences (West and East Health Center), Ahvaz, during the years 2021 to 2022, the quality of drinking water in this city will be investigated and discussed. Finally, the collected data on the physical and chemical quality and bacteriology of Ahvaz drinking water will be analyzed using statistical analysis.

### *2.3. Statistical analysis of data*

In the section of the cross-sectional study, central indices, dispersion, frequency, percentages and analysis of variance were used to identify the difference between different variables related to the physical, chemical and bacteriological quality of Ahvaz drinking water. The normality of the data was checked through the Shapiro-Wilk test, then the one-way analysis of variance test, and to ensure the normality of the data, a parametric test was used to compare the averages in different

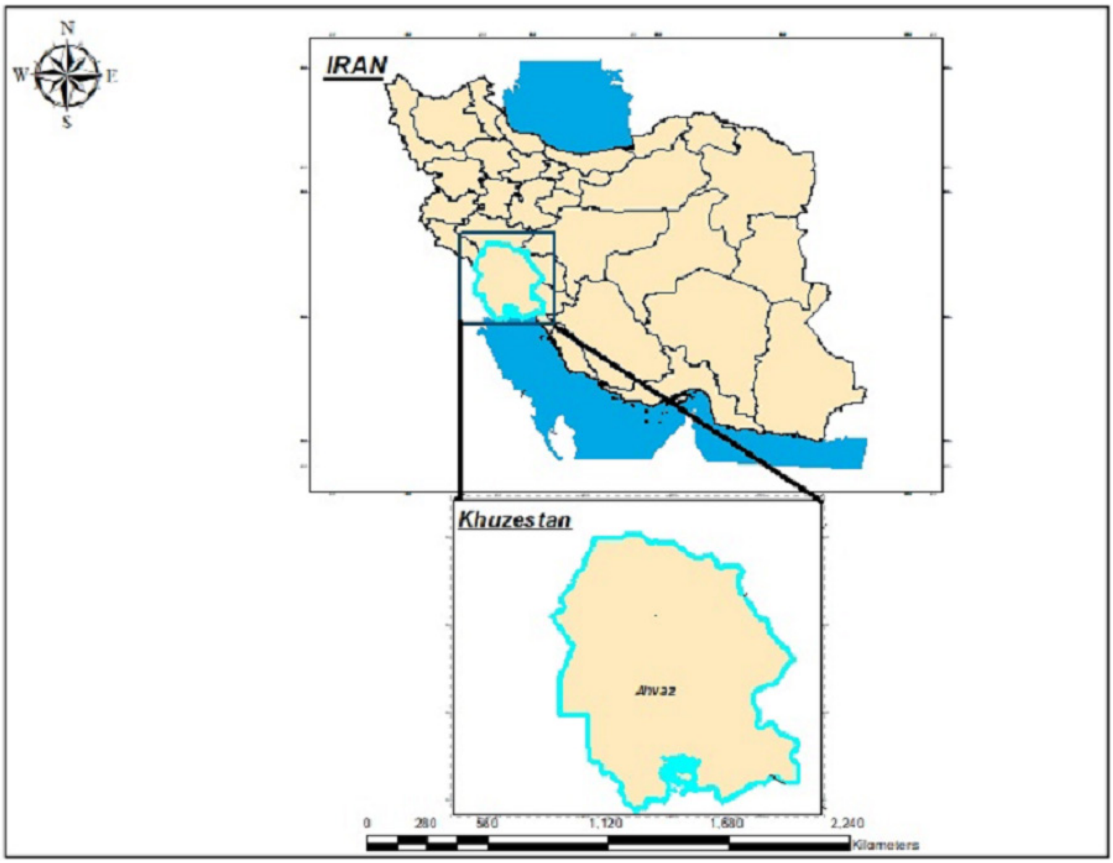


**Figure 1.** The location of the study areas

stations. Sperman's correlation test was used to check the correlation between the data. Comparison of averages in different stations was done using ANOVA test. The data analyzed were used to SPSS version 16 statistical software.

## 3. Results

The findings obtained from the study in the form of various tables and charts in the general section of the determining the critical points Ahvaz drinking water.

Table 1 shows the results of the causes of the city's drinking water crisis in the east and west regions of Ahvaz during the years 2019 to 2022. Table 1 displays the flooding of roads, sewage over flow, flooding of roads, broken water pipe, absence of manhole door, unstandardized turbidity, no chlorine, unstandardized chlorine, unstandardized sample. In total, there is a significant difference in the occurrence of causes of crisis in the water network between the east and west regions of Ahvaz, and the east region includes a higher percentage of the causes of crisis (Table 1).

In total, there is a significant difference in the occurrence of crisis causes in the water network between the east and west regions of Ahvaz, and the east region (86.4% percent of crisis cases) has a higher percentage of crisis causes than the west region of Ahvaz (13.6% from crisis cases) is included (Table 1).

Figure 2 shows the comparison of the causes of the city's drinking water crisis in the east and west regions of Ahvaz during the years 2019 to 2022. Flooding of roads, sewage over flow, flooding of roads, broken water pipe, absence of manhole door, unstandardized turbidity, no chlorine, unstandardized chlorine, unstandardized sample showed in Figure 2. The results show that out of the total of 1098 crisis cases recorded in Ahvaz drinking water distribution network, 949 of cases occurred in the eastern region and 149 of cases occurred in the western region of Ahvaz (Figure 2).

## 4. Discussion

The current study is a descriptive analytical study that was

**Table 1.** The causes of the city's drinking water crisis in the east and west regions of Ahvaz during the years 2019 to 2022

| | | Region | | Total | Test statistics (*P* value) |
|---|---|---|---|---|---|
| | | East of Ahvaz | West of Ahvaz | | |
| Reason of crisis | | | | | |
| Flooding of roads | Count | 5 | 0 | 5 | 187.98 (<0.001) |
| | % Within reason | 100.0% | 0.0% | 100.0% | |
| | % Of total | 0.5% | 0.0% | 0.5% | |
| Sewage over flow | Count | 195 | 72 | 267 | |
| | % Within reason | 73.0% | 27.0% | 100.0% | |
| | % Of total | 17.8% | 6.6% | 24.3% | |
| Broken water pipe | Count | 110 | 62 | 172 | |
| | % Within reason | 64.0% | 36.0% | 100.0% | |
| | % Of total | 10.0% | 5.6% | 15.7% | |
| Absence of manhole door | Count | 21 | 1 | 22 | |
| | % Within reason | 95.5% | 4.5% | 100.0% | |
| | % Of total | 1.9% | 0.1% | 2.0% | |
| Unstandardized turbidity | Count | 182 | 8 | 190 | |
| | % Within reason | 95.8% | 4.2% | 100.0% | |
| | % Of total | 16.6% | 0.7% | 17.3% | |
| No chlorine | Count | 218 | 5 | 223 | |
| | % Within reason | 97.8% | 2.2% | 100.0% | |
| | % Of total | 19.9% | 0.5% | 20.3% | |
| Unstandardized chlorine | Count | 120 | 1 | 121 | |
| | % Within reason | 99.2% | 0.8% | 100.0% | |
| | % Of total | 10.9% | 0.1% | 11.0% | |
| Unstandardized sample | Count | 98 | 0 | 98 | |
| | % Within reason | 100.0% | 0.0% | 100.0% | |
| | % Of total | 8.9% | 0.0% | 8.9% | |
| Total | Count | 949 | 149 | 1098 | |
| | % Within reason | 86.4% | 13.6% | 100.0% | |
| | % Of total | 86.4% | 13.6% | 100.0% | |

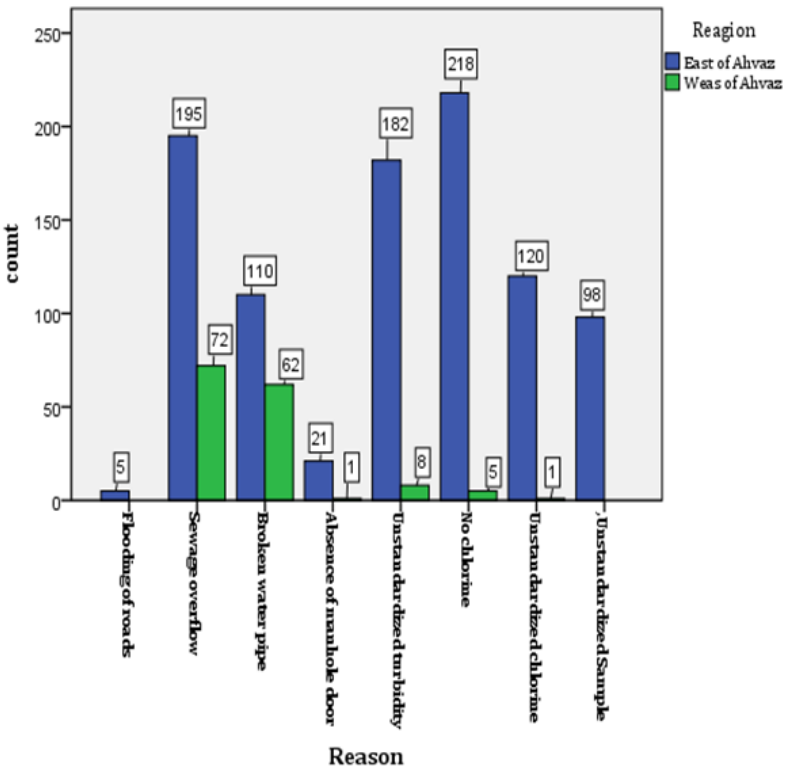


**Figure 2.** Comparison of the causes of the city's drinking water crisis in the east and west regions of Ahvaz during the years 2019 to 2022

conducted with the aim of investigating and determining the critical points Ahvaz drinking water in southwest of Iran 2019 to 2022.

In total, 24.3% of the causes of the crisis were sewage over flows, out of 100% of cases sewage overflows, 73% of cases occurred in the eastern region of Ahvaz (Table 1). Also, based on result 0.5% of the causes of the crisis were flooding of roads, from 100% of cases flooding of roads, 100% of cases occurred in the eastern region of Ahvaz (Table 1).

Result showed that 15.7% of the causes of the crisis were broken water pipe, out of 100% of cases broken water pipe, 64% of cases occurred in the eastern region of Ahvaz (Table 1). According to the result absence of manhole door had 2% of the total cases that 95.5% of cases occurred in the eastern region of Ahvaz (Table 1). 17.3% of the causes of the crisis were unstandardized turbidity, out of 100% of cases unstandardized turbidity, 95.8% of cases occurred in the eastern region of Ahvaz (Table 1).

Result showed the 20.3% of the total of cases occurred due to no chlorine that 97.8% of cases occurred in the eastern region of Ahvaz. Unstandardized chlorine was included 11 percent of the total cases that 99.2% of cases occurred in the eastern region of Ahvaz (Table 1).

Figure 2 showed the number of cases in the eastern and western regions of Ahvaz between 2019 and 2021. Out of 190 cases, the cause of the crisis is due to unfavorable turbidity in 8 cases in the western region and 182 cases in the eastern region (Figure 2). Of the 121 cases, the cause of the crisis is caused by undesirable chlorine, 1 case in the west region and 120 cases in the east region (Figure 2). Out of 172 cases, the cause of the crisis is due to broken water pipes, 62 cases are in the west region and 110 cases are in the east region (Figure 2). Out of 22 cases, the cause of the crisis is due to the lack of sewage overflow in 1 case in the western region and 21 cases in the eastern region (Figure 2). Out of 267 cases, the cause of the crisis is due to sewage overflow, 72 cases in the West region and 195 cases in the East region (Figure 2). Of the 5 cases, the cause of the crisis is caused by the flooding of roads, 0 cases in the western region and 5 cases in the eastern region (Figure 2).

According to the studies and the obtained results, despite the establishment of the sewage treatment plant in East Ahvaz for several years, the said treatment plant is still not in operation, and it does not cover all urban areas in terms of collection, transmission and treatment in Ahvaz drinking water. Non-implementation of the comprehensive sewerage plan in some urban areas and the existence of frequent overflows of sewage, followed by numerous public complaints. Also, the long implementation process of some water and sewage improvement projects, street digging and creating accident-prone areas. Many people's complaints about the turbidity of the water in some areas (muddy water).

Based on result this study in spite of the problems mentioned, but quality of Ahvaz drinking water is within the recommended range and compared to the standards

of Iran and the World Health Organization, it has a relatively favorable quality.

Critical elements drinking water distribution networks in Tuindorp in Utrecht (the Netherlands) identifying by Meijer et al [14]. They reported that the most critical elements of a drinking water distribution networks were deterioration of this ageing due to an increased leakage and contamination risk [14]. In line with the present study, Babanejad et al investigated the quality of drinking water in the distribution network of Getab city in Mazandaran province (Iran) [2]. The results showed that in 0.06% of the samples, faecal coliform and in 6% of them, the plate count of heterotrophic bacteria was positive [2].

Kalantari et al. studied quantitative and qualitative drinking water resources of the villages in Qom province by use of four stability indexes (corrosion and scaling potential) [5]. The results illustrate that Qom village water according to the Langelier index equals 1.62 (±0.11), according to The Ryznar stability index (RSI) equals 10.5 (±0.17), based on aggressive index equals 12.035 (±0.14) and based on Pokurious index equals 9.92 (±0.13) respectively [5]. Comparison of four indexes showed that water conditions in all villages of Qom is in corrosive range [5].

Also, Izanloo et al in Qom province, Iran assessment risk the critical points in the water safety plan based on the characterization and validity of microbial indicator control [15]. They reported that in 30 points, the critical points were determined based on the fecal contamination indicators using the DotMapper software. Based on the risk assessment model and semi-quantitative method, the urban water distribution network was considered high-risk [15].

Hazards' critical control points in water supply systems investigated by Tsitsifli and Kanakoudis [16]. Based on reported they pumps, valves, pipes and various tanks are the main agents a drinking water supply system [16]. Einollahipeer et al. investigated some parameters that determine the quality of drinking water in the Sistan region and compared them with the existing standards [17]. The results of their study showed that none of the measured factors showed significant differences among different stations. Based on the results reported in this study, the amount of physical and chemical factors has the same distribution and do not originate from point sources [17].

The objectives of the drinking water safety program are to ensure the quality of drinking water based on risk management, which include prevention of contamination of the source of drinking water, water treatment to reduce or eliminate contamination to reach standards, prevention of re-contamination of water during storage, distribution and consumption.

## 5. Conclusion

In this study, we investigating and determining the critical points Ahvaz drinking water. According to the results of this study quality of drinking water is suitable for the distribution network of Ahvaz.

The results of the data analysis showed that the best way to ensure the quality of drinking water is to implement a comprehensive management system with the cooperation of all relevant organizations. In the present study, according to the obtained results, it is suggested to the equipping the water treatment plants with equipment should be done so that the drinking water delivered to the consumers of Ahvaz city has a higher quality, increasing the quantitative and qualitative executive and management capacity of water, adapting to valid global health standards, correct maintenance of networks and optimal use of existing systems, monitoring and timely control should always be considered by the authorities and operators of water affairs.

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**Supervision:** Mohammad Javad Mohammadi.
**Validation:** Yazdan Mahmodian, Saeed Ghanbari, Fereshteh Filban, Majid Farhadi, Mohammad Javad Mohammadi.
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**Writing–review & editing:** Yazdan Mahmodian, Saeed Ghanbari, Farshid Ghanbari, Fereshteh Filban, Majid Farhadi, Mohammad Javad Mohammadi.

### Competing Interests

The authors declare no competing interests.

### Consent for Publication

Not applicable.

### Data Availability Statement

The datasets generated during and/or analyzed during the current

study are available from the corresponding author on reasonable request.

## Ethical Approval

The Ethics Committee of Ahvaz Jundishapur University of Medical Sciences approved the study protocol. This study was originally approved by the Ahvaz Jundishapur University of Medical Sciences with code IR.AJUMS.REC.1402.232.

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