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# Level of Heavy Metals and Pathogenic Bacteria in Tap Water of Rusafa side Hospitals in Baghdad

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## Abstract

**Background:** The quality of drinking water supplied to hospitals is directly related to the quality of health services provided to people.
**Objective:** To assess the chemical and microbial standards provided to four public hospitals on Baghdad's eastern side.
**Patients and Methods:** In this study, 100 water samples were collected from water taps supplied to hospitals. Scientific methods were followed to collect samples in clean, sterile bottles. The chemophysical characteristics of the collected water samples were estimated (Hospital Imam Ali, Martyr Al-Sadr Hospital, Ibn Al Balady Maternity & Children's Hospital, Fatmih Alzahraa Maternity Hospital). In addition, the contamination of water with fecal-coliform bacteria was estimated.
**Results:** In this study, 100 water samples were collected from water taps supplied to hospitals. Scientific methods were followed to collect samples in clean, sterile bottles. The chemophysical characteristics of the collected water samples were estimated (Hospital Imam Ali, Martyr Al-Sadr Hospital, Ibn Al Balady Maternity & Children's Hospital, Fatmih Alzahraa Maternity Hospital). In addition, the contamination of water with fecal-coliform bacteria was estimated.
**Conclusion:** It can be concluded from the current study that the quality of water supplied to the hospitals covered by the study was within the standard level of physiochemical specifications. In addition, all samples were free of fecal-coliform bacteria, which indicates that the water supplied to the hospitals is not contaminated with feces.
**Keywords:** Baghdad city, Fecal coliform, Public hospitals, Physiochemical, Tap water



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## Introduction

Water quality has a direct impact on public health. Water quality has a significant impact on the occurrence of many diseases and epidemics. As a result, maintaining good drinking water quality specifications will have a positive impact on the health of those who consume water [1]. The World Health Organization (WHO) emphasizes the importance of water education, as it is an important factor in transmitting many diseases, and it has published a number of periodicals in which it has set appropriate standards for drinking water [2]. The commitment of environmental and municipal

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institutions to these specifications reflects the level of health care in cities. The standards adopted by the WHO focus on the chemical specifications of water in addition to the microbial contamination of water [2]. Many studies have shown a direct correlation between the level of microbial contamination of water and the spread of dangerous epidemics [3].

The quality of water is not only related to the health aspect but is also related to the economic aspect, as water pollution can pressure and affect the health system, which will therefore affect the budgets of countries, especially in Iraq, since health care in Iraq is sponsored by the state. In addition to what has already been stated, the spread of water-related epidemics has an impact on the production of fish, farms, poultry, and cows, which has a direct impact on the economies of countries [4-6].

Paying attention to the quality of the water that is distributed to the houses is important and is especially important to hospitals. This is because hospitals are the places where injured people are treated, in the cleaning, the labs, and surgery rooms; and water is associated with most of the health activities in the hospital, as it is used for washing and organizing hospital facilities. As a result, the quality of water supplied to hospitals has a significant impact on the level of health care provided [7, 8].

There have been very few studies on the specifications and quality of water supplied to hospitals. In addition, the current study focused on a number of hospitals located in the most crowded areas in the city of Baghdad, which are inhabited by low-income people. In other words, the contamination in these hospitals will greatly affect the health care system in Iraq. Therefore, our study aims to shed light on the quality and specifications of the water supplied to four hospitals, which are located on the Rusafa side of Baghdad, and these areas are characterized by large population density.

## Patients and Methods

### Study area

The study included four hospitals on Baghdad's northeastern outskirts, specifically to the east of Al-Qanat. The four hospitals are either inside or on the outskirts of Al-Sadr City, which has a very high population density and a low economic level. Figure (1) depicts the location of the hospitals included in the study in relation to Al-Sadr City and Baghdad in general.

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**Figure( 1):** The location of the four hospitals (Hospital Imam Ali, Martyr Al-Sadr Hospital, Ibn Al Balady Maternity & Children's Hospital, Fatmih Alzahraa Maternity Hospital) were included in the study in relation to Sadr City and Baghdad in general

**Sample Collection**

One hundred tap water samples were collected from four main public hospitals (Al-Sadar City Hospital, Imam Ali, Martyr Al-Sadr Hospital, Ibn Al Balady Maternity & Children's Hospital, Fatmih Alzahraa Maternity Hospital) were included in the current study. Twenty-five samples were collected from the hospitals. The tap was sterile by flame before sample collection. It was 50 ml of tap water, which was collected in a sterilized screw universal glass. The water was transferred immediately to the lab for chemical, physical, and microbiological examination. The samples were collected from October 2021 to February 2022.

**Bacteriological examination**

The standard method of Al-Bayatti *et al*, (2012) was followed to isolate and identify bacterial isolates from tap water samples [9]. Total bacterial species were determined by standard coliform fermentation technique including presumptive, confirmed, and completed tests [Guidelines for Drinking]. For identification of pathogenic enteric bacteria water samples were spread on nutrient agar, macConkey agar, blood agar, eosin-methylene blue agar (EMB), and thiosulfate citrate bile sucrose agar (TCBS)

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medium. The plates were incubated overnight at 37°C, and after incubation, cultures were examined for distinct colonies.

**Physical and Chemical Tests**

The standard method of AL-Dulaimi and Younes, (2017) was followed to check the pH, Total hardness, and concentrations of Chloride, Nitrite, Nitrate, Sulfite, Sulfate, Calcium, Magnesium, Iron, Lead, and Phosphate [10].

**Drinking water guidelines**

World Health Organization guidelines (2017) were used to identify the quality of tap water in SADR City, Baghdad, Iraq, because it is widely used by various countries and is used to determine the quality of drinking water.

## Statistical Analysis

All values have been used to give a mean value and the standard deviation has been calculated. The differences were analyzed by using Student's t-test and chi-square tests, employing Origin version 8.0 software. A value of $P < 0.05$ was considered to be statistically significant.

## Results

**Physiochemical parameters and Bacteriological contains tap water**

Table (1) shows the average values of chemical and physical specifications of tap water collected from different hospitals in Rusafa, Baghdad, Iraq. Table 1 demonstrates that all values were within the normal levels determined by WHO published reports, confirming that the water supplied through the pipe network within the study area was within acceptable levels that did not negatively affect the public health of its consumers.

**Table (1):** Mean values of the physiochemical parameters of tap water from different districts in Baghdad and the WHO limits

| | Physical and chemical parameters | Mean ± SD (different districts of east Baghdad city). | WHO GUIDELINES* |
|---|---|---|---|
| 1 | pH | 7.5 ± 0.2 | 6.6-8.5 |
| 2 | Chloride, mg/L | 181.75 ± 12.3 | 250 |
| 3 | Total hardness, mg/L | 584.425 ± 87 | 500 ppm as CaCO3 |
| 4 | Nitrite, mg/L | 0.065 ± 0.009 | 3 |
| 5 | Nitrate, mg/L | 1.225 ± 0.13 | 50 |
| 6 | Sulfite, mg/L | 26.25 ± 3.4 | — |
| 7 | Sulfate, mg/L | 356.825 ± 28.4 | 500 |
| 8 | Calcium, mg/L | 62.5 ± 11.2 | — |
| 9 | Magnesium, mg/L | 18.7 ± 2.1 | — |
| 10 | Iron, µg/L | 92.275 ± 13.2 | 300 |
| 11 | Lead, µg/L | 0.0375 ± 0.0089 | 0.1 |
| 12 | Phosphate mg/ml | 0.3225 ± 0.09 | 1 |

The current study showed that out of 100 tap water samples collected from four hospitals on the Rusafa side of Baghdad, four samples only gave positive results to the bacterial isolation test. All the bacterial isolates were non-fecal coliforms. The positive samples were in the samples collected from Martyr Al-Sadr Hospital (two isolates), Hospital Imam Ali (one isolate), and Fatmih Alzahraa Maternity Hospital (one isolate).

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The results of this study confirm that the microbial contamination that occurred in some areas of the study was caused by cracks and erosion in some drinking water distribution pipes, and fortunately, this erosion was far from the sewage network, so the contamination that occurred was from soil near the corroded pipes. The study showed that the quality of water collected from Hospital Imam Ali Table (2) was within the standard ranges of the WHO, except the total hardness was higher than the standard levels of the WHO. The level of chloride was lower than that seen in the other hospitals covered in the present study.

**Table (2):** Mean values of the physiochemical parameters of tap water collected from Hospital Imam Ali

| | Physical and chemical parameters | Mean ± SD (different districts of east Baghdad city). | WHO GUIDELINES* |
|---|---|---|---|
| 1 | pH | 7.45 ± 0.18 | 6.6-8.5 |
| 2 | Chloride, mg/L | 179 ± 19 | 250 |
| 3 | Total hardness, mg/L | 590.9 ± 110 | 500 ppm as CaCO3 |
| 4 | Nitrite, mg/L | 0.07 ± 0.007 | 3 |
| 5 | Nitrate, mg/L | 1.32 ± 0.67 | 50 |
| 6 | Sulfite, mg/L | 27.5 ± 4 | — |
| 7 | Sulfate, mg/L | 349.6 ± 65 | 500 |
| 8 | Calcium, mg/L | 63.2 ± 7.3 | — |
| 9 | Magnesium, mg/L | 19.9 ± 4.3 | — |
| 10 | Iron, µg/L | 95.7 ± 8.9 | 300 |
| 11 | Lead, µg/L | 0.034 ± 0.002 | 0.1 |
| 12 | Phosphate mg/ml | 0.4 ± 0.07 | 1 |

The physiochemical parameters of tap water collected from the Martyr Al-Sadr Hospital are shown in Table (2). All parameters were in line with the standard levels of WHO except for the total hardness, which was higher than the standard level of total hardness shown in WHO guidelines. The pH level in the tap water collected in this hospital was higher than the pH level of the tap water collected from other hospitals included in the current study. The other parameters were at a normal level, proving the standard quality of water supplied to this hospital.

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**Table (3):** Mean values of the physiochemical parameters of tap water collected from Martyr Al-Sadr Hospital

| | Physical and chemical parameters | Mean ± SD (different districts of east Baghdad city). | WHO GUIDELINES* |
|---|---|---|---|
| 1 | pH | 7.6 ± 1.1 | 6.6-8.5 |
| 2 | Chloride, mg/L | 186 ± 20.1 | 250 |
| 3 | Total hardness, mg/L | 580.3 ± 89.7 | 500 ppm as CaCO3 |
| 4 | Nitrite, mg/L | 0.08 ± 0.01 | 3 |
| 5 | Nitrate, mg/L | 0.98 ± 0.12 | 50 |
| 6 | Sulfite, mg/L | 23.6 ± 3.4 | — |
| 7 | Sulfate, mg/L | 371.4 ± 19.4 | 500 |
| 8 | Calcium, mg/L | 60.6 ± 7.3 | — |
| 9 | Magnesium, mg/L | 18.8 ± 4.2 | — |
| 10 | Iron, µg/L | 90.4 ± 21 | 300 |
| 11 | Lead, µg/L | 0.04 ± 0.0098 | 0.1 |
| 12 | Phosphate mg/ml | 0.3 ± 0.078 | 1 |

Table (4) shows the physicochemical parameters of tap water collected from Ibn Al Balady Maternity & Children's Hospital. All parameters measured in the present study were within the standard levels published by the WHO, except that the total hardness (580.3 ± 89.7) was higher than the standard level that was shown by the WHO guidelines (500 ppm). Otherwise, all other parameters were in line with the standard levels which proves that the water supplied to Ibn Al Balady Maternity & Children's Hospital was within the standard quality.

**Table (4):** Mean values of the physicochemical parameters of tap water collected from Ibn Al balady Maternity & Children's Hospital

| | Physical and chemical parameters | Mean ± SD (different districts of east Baghdad city). | WHO GUIDELINES* |
|---|---|---|---|
| 1. | pH | 7.5 ± 0.13 | 6.6-8.5 |
| 2. | Chloride, mg/L | 180 ± 18.9 | 250 |
| 3. | Total hardness, mg/L | 578.9 ± 58.8 | 500 ppm as CaCO3 |
| 4. | Nitrite, mg/L | 0.07 ± 0.0089 | 3 |
| 5. | Nitrate, mg/L | 1.1 ± 0.12 | 50 |
| 6. | Sulfite, mg/L | 25.1 ± 6.2 | — |
| 7. | Sulfate, mg/L | 350.5 ± 89.4 | 500 |
| 8. | Calcium, mg/L | 65.7 ± 9.4 | — |
| 9. | Magnesium, mg/L | 17.9 ± 3.1 | — |
| 10. | Iron, µg/L | 89 ± 14.3 | 300 |
| 11. | Lead, µg/L | 0.05 ± 0.0087 | 0.1 |
| 12. | Phosphate mg/ml | 0.24 ± 0.098 | 1 |

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The physiochemical parameters of tap water collected from Fatmih alzahraa Maternity Hospital were shown in table 5. The studied parameters measured in the present study were matching with the guidelines of the WHO as shown in table 5, except the total hardness (587.6 ± 45.2) was higher than the standard level that shown by the WHO guidelines (500 ppm).

The results confirm that the water supplied to the main hospitals at al-Rusafa and Baghdad City was of good quality. The results showed that there is no significant difference in the specification of water supplied to all hospitals (P>0.05). That is why there is a high similarity in the specifications of water supplied to all hospitals.

**Table (5):** Mean values of the physiochemical parameters of tap water collected from Fatmih alzahraa Maternity Hospital

| | Physical and chemical parameters | Mean ± SD (different districts of east Baghdad city). | WHO GUIDELINES* |
|---|---|---|---|
| 1 | pH | 7.45 ± 0.18 | 6.6-8.5 |
| 2 | Chloride, mg/L | 182 ± 11.1 | 250 |
| 3 | Total hardness, mg/L | 587.6 ± 45.2 | 500 ppm as CaCO3 |
| 4 | Nitrite, mg/L | 0.04 ± 0.005 | 3 |
| 5 | Nitrate, mg/L | 1.5 ± 0.078 | 50 |
| 6 | Sulfite, mg/L | 28.8 ± 3.6 | — |
| 7 | Sulfate, mg/L | 355.8 ± 30.1 | 500 |
| 8 | Calcium, mg/L | 60.5 ± 4.2 | — |
| 9 | Magnesium, mg/L | 18.2 ± 1.02 | — |
| 10 | Iron, µg/L | 94 ± 5.56 | 300 |
| 11 | Lead, µg/L | 0.026 ± 0.0013 | 0.1 |
| 12 | Phosphate mg/ml | 0.35 ± 0.02 | 1 |

## Discussion

Several studies have confirmed the direct correlation between the quality of water supplied to hospitals and the quality of public health. The quality of water affects the level of health service provided by hospitals, and therefore, the contamination of water supplied to hospitals will negatively and significantly affect the level of health care as well as the control of communicable diseases [8].

The current study included a survey of the quality of tap water supplied through the pipes to four major public hospitals in the most crowded places in the city of Baghdad. As the study site was four hospitals were located either inside Al-Sadr City or on the out of the city, which is known for its large population density and low economic level for its residents. The current study sheds light on the main physiochemical characteristics, as well as the level of contamination with fecal microbes. The study showed that despite the old pipe network, as well as the cracks in it, the physiochemical water specifications were within the standard specifications approved by the WHO. The study also showed that the water supplied to hospitals was not contaminated with fecal bacteria, as the diagnosed microbial contamination was due to contamination with non-fecal bacteria. This confirms that the

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water supplied to these hospitals is not contaminated with feces, which supports that the specifications of the water supplied to the hospitals included in the study were within the specifications and ranges allowed by the World Health Organization.

The present study is the pioneer study, as the focus on the quality of water supplied to the hospital in Baghdad is very scanty that is why we could not able to compare the present study with the previous similar study. But the previous study done by other investigators about the quality of water in Baghdad showed data similar to the data present in the current study [11-13].

One of the most important reasons that reduced the presence of indicators of contamination of drinking water supplied to hospitals by fecal enteric bacteria is the high level of chlorine that was estimated in water supplied to hospitals [14, 15]. The high levels of chlorine play a major role in eliminating pathogenic microorganisms, especially fecal bacteria, as fecal bacteria are isolated from humans and animals [16]. Fecal bacteria are characterized by having low resistance to chlorine as compared with environmental bacteria in soil and water, which have adapted to hard environmental conditions [17-19]. This explains the isolation of non-fecal coliform bacteria in the drinking water supplied to these hospitals.

## Conclusions

It can be concluded from the current study that the specifications and qualifications of water supplied to public hospitals, which are located in the most crowded places in Baghdad, fall within the standard specifications granted by it, which confirms that the water supplied to hospitals in the city of Baghdad is considered acceptable according to the specifications set by the World Health Organization.

## Recommendations

The outcome of the current study recommends that the study has to cover more hospitals on both sides of Baghdad. We also recommend that future studies should be included private hospitals and laboratories.

**Source of funding:** Self-funding study.

**Ethical clearance:** The study was approved by the ethical clearance of the ministry of health in Baghdad, Iraq.

**Conflict of interest:** Nil

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# مستوى المعادن الثقيلة والبكتريا المرضية في الماء الصافي لمستشفيات جانب الرصافة في بغداد

د. حميدة كاظم زغير[1]

## الملخص

**خلفية الدراسة:** الدراسة الحالية تركز الضوء على ارتباط جودة مياه الشرب المقدمة للمستشفيات ارتباطًا مباشرًا بجودة الخدمة الصحية المقدمة للناس.

**اهداف الدراسة:** لتقييم المواصفات الكيميائية والميكروبية المقدمة لأربعة مستشفيات عامة في الجانب الشرقي من بغداد .

**المرضى والطرائق:** في هذه الدراسة ، تم جمع ١٠٠ عينة مياه من صنابير المياه التي تم توفيرها للمستشفيات. تم اتباع الطرق العلمية لجمع العينات في زجاجيات نظيفة ومعقمة. ومن ثم تم تقدير الخصائص الفيزيائية و الكيميائية لعينات المياه المجمعة (مستشفى الإمام علي ، مستشفى الشهيد الصدر ، مستشفى ابن البلدي للولادة والأطفال ، مستشفى فاطمة الزهراء للولادة) بالإضافة إلى تقدير تلوث المياه ببكتيريا القولون البرازية.

**النتائج:** أظهرت النتائج أن جميع المواصفات الفيزيوكيميائية لعينات المياه المأخوذة كانت ضمن المستوى المقبول الذي نشرته منظمة الصحة العالمية (WHO). ثم تم عزل البكتريا القولونية من أربع عينات من المياه ، وجميعها ليست بكتريا قولونية برازية.

**الاستنتاجات:** يمكن الاستنتاج من الدراسة الحالية أن جودة المياه الموردة للمستشفيات التي شملتها الدراسة كانت ضمن المستوى القياسي للمواصفات الفيزيوكيميائية ، بالإضافة إلى أن جميع العينات كانت خالية من البكتيريا القولون البرازية ، مما يدل على أن المياه المزودة إلى المستشفيات غير ملوثة بالبراز.

**الكلمات المفتاحية:** مدينة بغداد ، بكتريا القولون البرازية ، المستشفيات العامة ، الكيمياء الفيزيائية ، مياه الشرب

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