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# Comparative Study of Infection with Diarrhea in Two Regions in Baghdad

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**Abstract**

**Background:** Diarrheal diseases remain a major public health challenge in developing countries, often linked to contaminated water and poor sanitation.

**Objective:** To compare the rates and etiological agents of diarrheal infections between Al-Obaidi city and Palestine Street city in Baghdad across two time periods (2007 and 2022) and to assess the role of water chlorination and sanitation infrastructure.

**Methods:** A comparative cross-sectional study was conducted on 300 patients with diarrhea. Stool specimens were examined for parasites, bacteria, and rotavirus (latex agglutination). Free residual chlorine in water was measured at three water stations.

**Results:** Infection rates in Al-Obaidi dropped from 50.66% in 2007 to 14% in 2022, while Palestine Street rates declined from 10.66% to 6.66%. Protozoan parasites (G. lamblia, E. histolytica, E. coli, T. hominis) were more prevalent in Al-Obaidi across all age groups. Rotavirus was detected only in children under 10 years. Salmonella infections were low in both areas, while Shigella was not detected. Vibrio cholerae was present only in Al-Obaidi in 2007 (6 cases) and absent in 2022. Chlorine levels in Al-Obaidi improved from 0.1 ppm at 2 km distance in 2007 to 0.6 ppm in 2022, while Palestine Street maintained adequate levels (>0.8 ppm) in both periods.

**Conclusion:** Marked reduction in diarrheal infections in Al-Obaidi between 2007 and 2022 corresponds with improved water infrastructure, sewage systems, and waste management. Palestine Street consistently maintained lower infection rates due to better baseline services. Environmental interventions are critical for controlling diarrheal diseases in urban settings.

# دراسة مقارنة للإصابة بالإسهال في منطقتين ببغداد

إسراء محمد عبد الخالق وعبد اللطيف جبار ناصر

**الخلاصة**

**المقدمة**

لا تزال أمراض الإسهال تشكل تحدياً كبيراً للصحة العامة في الدول النامية، وغالباً ما ترتبط بالمياه الملوثة وسوء الصرف الصحي.

**الهدف**

مقارنة معدلات الإصابة والمسببات المرضية للإسهال بين مدينة "العبيدي" ومدينة "شارع فلسطين" في بغداد عبر فترتين زمنيتين (2007 و2022)، وتقييم دور كلورة المياه وبنية الصرف الصحي التحتية.

**المرضى وطرق العمل**

أُجريت دراسة مقطعية مقارنة على 300 مريض يعانون من الإسهال. تم فحص عينات البراز للكشف عن الطفيليات، البكتيريا، وفيروس الروتا (عن طريق اختبار التلازن اللاتكس). كما تم قياس نسبة الكلور الحر المتبقي في المياه في ثلاث محطات مياه.

**النتائج**

انخفضت معدلات الإصابة في منطقة العبيدي من 50.66%عام 2007 إلى 14%عام 2022، بينما انخفضت المعدلات في شارع فلسطين من 10.66%إلى 6.66%.كانت الطفيليات الابتدائية (*G. lamblia, E. histolytica, E. coli, T. hominis*) أكثر انتشاراً في العبيدي عبر جميع الفئات العمرية. تم اكتشاف فيروس الروتا (Rotavirus) فقط لدى الأطفال دون سن 10 سنوات. كانت إصابات السلمونيلا منخفضة في كلتا المنطقتين، بينما لم يتم اكتشاف بكتيريا الشيجلا. ظهرت بكتيريا الكوليرا (*Vibrio cholerae*) فقط في العبيدي عام 2007 (6 حالات) واختفت تماماً في عام 2022. تحسنت مستويات الكلور في العبيدي من 0.1جزء في المليون (على بعد 2 كم) عام 2007 إلى 0.6جزء في المليون عام 2022، بينما حافظ شارع فلسطين على مستويات كافية 0.8>) جزء في المليون) في الفترتين.

**الاستنتاج**

يعود الانخفاض الملحوظ في إصابات الإسهال في منطقة العبيدي بين عامي 2007 و2022 إلى تحسن البنية التحتية للمياه، وأنظمة الصرف الصحي، وإدارة النفايات. حافظت منطقة شارع فلسطين باستمرار على معدلات إصابة أقل بسبب جودة الخدمات الأساسية المتوفرة مسبقاً. تعد التدخلات البيئية أمراً حاسماً للسيطرة على أمراض الإسهال في المناطق الحضرية.

الكلمات المفتاحية :الإسهال، الكوليرا، فيروس الروتا، الطفيليات، كلورة المياه، العراق.

## 1. Introduction

Many diseases in developing countries are associated with drinking contaminated water (World Health Organization & UNICEF, 2000). Dehydration resulting from diarrhea as a result of drinking this water, which is estimated at about 4 million cases annually, is the cause of the death of about 2.2 million children under the age of five annually (World Health Organization & UNICEF, 2000). It can be caused by a variety of bacteria, viruses or parasites. The infection usually spreads through contaminated food or drinking water, or from one person to another due to poor personal hygiene. Nearly one billion people lack access to safe drinking water(Ibrahim & Hameed, 2015), and diarrheal disease was, in 2004, the third most important cause of death in low-income countries, causing 6.9% of all deaths(John & Petri, 2006&Forbes et al., 2007). Cholera is an epidemic and endemic disease in many countries of the world, especially in developing countries. This disease has spread throughout history in six epidemic attacks that took place between 1817-1923 with *Vibrio cholera* and the classical type. The seventh attack took place in the year 1961 with the classical type (John & Petri, 2006). As a result of the difficult and bad conditions in which a large number of individuals live, this has led to an increase in the number of infected people, which requires mobilizing efforts to combat this disease and limit its spread.

## 2. Materials and Methods

A total sample of (300) patients of different ages were collected, (150) samples obtained from patients in AL-Obaidi city, and another (150) samples obtained from patients in Palestine Street city who attended the AL-Kindy Teaching Hospital lab. Pathological as well as non-pathological parasites were recorded with other pathogens, which are transmitted through contaminated food, drinking water, insects, or from one person to another due to poor personal hygiene(John & Petri, 2006&Forbes et al., 2007).. Also, there were viruses and bacteria. A special form was prepared to collect information about the patients. The patient's data were collected for the period from October 2007 till December 2007, while the second study was done in the period from October 2020 till December 2020. The percentage of chlorine in the water of the two study areas was measured to identify the percentage of water pollution in them. This was done by taking measurements for three consecutive days to confirm the measurement percentage and extract the pollution rate.

### 2.1.Examination of Parasites and Worms

The method of direct examination (feces) was used to identify worms, their eggs, and the motile and cystic phase of parasites, by microscopic examination of a slide prepared using saline & Iodine.

### 2.2.Salmonella Spp.

The diagnosis was made by culturing the feces sample on Tetrathionate broth and incubating for 24 hours in the incubator at a temperature of 37 C, then it was grown on XLD Agar and incubated for 24 hours in the incubator at a temperature of 37 C, and a biochemical examination was Biochemical test - set sugar and Antisera Examination(Dennehy et al., 1988).

### 2.3.Shigella Spp.

Stool sample was cultured on peptone water for a period of (6-8) hours in the incubator at a temperature of 37 C, then it was grown on XLD Agar and incubated for (24) hours in the incubator at a temperature of 37 C. A biochemical set was tested. and Antisera examination (Dennehy et al., 1988).

### 2.4. Vibrio Cholera

The common method for taking samples from people with cholera diarrhea and diagnosing them is feces sample. The feces sample are grown on peptone water for (6-8) hours in an incubator at a temperature of 37 °C, after which they are growth on MacConkey agar culture media in which it appears. The colonies are pale in color, not fermented to lactose, the blood agar medium shows hemolysis, and the selective media for Vibrio TCBS shows yellow colonies as a result of sucrose fermentation. Then, cholera bacteria are diagnosed using the Vibriostatic disc 0129 and the Antisera test (Dennehy et al., 1988).

## 2.5.Chlorine Test

By using the color comparative indicator device, the more intense the pink color, the greater the concentration of chlorine in the water. These colors are numbered and graded from 0.1 - 5.0 ppm. The normal percentage of chlorine in the tap water is between 0.750 and 3.0 (World Health Organization & UNICEF, 2000).

## 2.6.Rotavirus Diagnosis

By using the rapid test method to determine the *Rotavirus* group antigen in the feces on a glass slide by Agglutination of latex particles, the examination is done by adding 2 ml of normal saline in a glass tube and adding 0.2 g of feces, mix well and leave at a temperature Room for ten minutes, the tube is placed in the centrifuge at a speed of 1000 revolutions per minute for ten minutes, a drop of supernatant was taken on a glass slide, then a drop of antigen reagent was placed on it, if a clear grain appeared, the result is positive, but if it does not appeared, the result is negative.

## 3. Results

The number of patients in the Al-Obaidi area and Palestine Street area was 150 patients for each, at different age groups, 1-60 years old, and they were distributed according to the results. Regarding types of pathogens such as parasites, bacteria, and viruses that are transmitted through contaminated food or drinking water, insects, or from one person to another, because of the low level of personal hygiene (Forbes et al., 2007&Fischbach & Dunning, 2009), and this was noted through the results in Table1-4. Table2 showed that Al-Obaidi area had a significant change in the rate of infection, as the infection decreased by a large percentage at different ages when compared with the Al-Obaidi area in Table1, this change was caused by the availability of services, including the replacement of water carrier pipes and the provision of heavy water sewers in proportion to the nature of the region and paving the streets that reduced exposure to infection resulting from the mixing of pipes at the water station in the Al-Obaidi area with groundwater and sewage water, due to the old and broken pipes at the water station, and also the chlorine content remained good. In Table2, it was able to maintain the cleanliness of the water and its pollution, and also enables garbage trucks to enter the area and remove it daily and regularly, and when comparing the infection rate for the Al-Obaidi area with Palestine Street for the years of study 2007, and 2022 in Table5, there was still a difference in the percentage of infection (50.66%, 14 %), and (10.66 %, 6.66 %) respectively, as the infection of the Al-Obaidi area was higher than the infection of the Palestine Street, that was because population density, small housing, and lack of health awareness when compared with the Palestine Street area.

**Table1: Pathological and Non-Pathological Parasites, Viruses, And Bacteria in Al-Obaidi Area In 2007 According to The Age Group.**

| Age group (years) | Sample number | parasites G. lamblia Entamoeba histolytica Entamoeba coli Trichomonas hominis | worms Enterobius vermicularis Hymenolipus nana | virus Rotavirus | bacteria Salmonella spp. | bacteria Vibrio cholera | total |
|---|---|---|---|---|---|---|---|
| 1-10 | 40 | 11 | 3 | 8 | - | 1 | 23 |
| 11-20 | 30 | 5 | 5 | - | 1 | 1 | 12 |
| 21-30 | 22 | 6 | 3 | - | 2 | 1 | 12 |
| 31-40 | 16 | 7 | 3 | - | 1 | 1 | 12 |
| 41-50 | 20 | 5 | 1 | - | 1 | 1 | 8 |
| 51-60 | 22 | 6 | 1 | - | 1 | 1 | 9 |
| **Total** | **150** | **40** | **16** | **8** | **6** | **6** | **76** |

**Table2: Pathological and Non-Pathological Parasites, Viruses, And Bacteria in Al-Obaidi Area In 2022 According to The Age Group.**

| Age group (years) | Sample number | Parasites G. lamblia E. histolytica E. coli T. hominis | Worms Enterobius vermicularis Hymenolipus nana | Virus Rotavirus | Bacteria Salmonella spp. | Bacteria Vibrio cholera | Total |
|---|---|---|---|---|---|---|---|
| 1-10 | 37 | 4 | 1 | 3 | 0 | 0 | 8 |
| 11-20 | 28 | 2 | 1 | | 1 | 0 | 4 |
| 21-30 | 24 | 2 | 0 | | 0 | 0 | 2 |
| 31-40 | 19 | 1 | 1 | | 1 | 0 | 3 |
| 41-50 | 22 | 2 | 0 | | 0 | 0 | 2 |
| 51-60 | 20 | 1 | 1 | | 0 | 0 | 2 |
| **Total** | **150** | **12** | **4** | **3** | **2** | **0** | **21** |

**Table3: Pathological and Non-Pathological Parasites, Viruses, and Bacteria in Palestine Street Area in 2007 According to The Age Group.**

| Age group (years) | Sample number | Parasites G. lamblia E. histolytica E. coli T. hominis | Worms Enterobius vermicularis Hymenolipus nana | Virus Rotavirus | Bacteria Salmonella spp. | Bacteria Vibrio cholera | Total |
|---|---|---|---|---|---|---|---|
| 1-10 | 32 | 2 | 1 | 2 | 0 | 0 | 5 |
| 11-20 | 22 | 1 | 1 | 0 | 1 | 0 | 3 |
| 21-30 | 19 | 2 | 0 | 0 | 1 | 0 | 3 |
| 31-40 | 27 | 1 | 1 | 0 | 0 | 0 | 2 |
| 41-50 | 30 | 1 | 0 | 0 | 1 | 0 | 2 |
| 51-60 | 20 | 1 | 0 | 0 | 0 | 0 | 1 |
| **Total** | **150** | **8** | **3** | **2** | **3** | **0** | **16** |

**Table4: Pathological and Non-Pathological Parasites, Viruses, And Bacteria in Palestine Street Area in 2022 According to The Age Group.**

| Age group (years) | Sample number | Parasites G. lamblia E. histolytica E. coli T. hominis | Worms Enterobius vermicularis Hymenolipus nana | Virus Rotavirus | Bacteria Salmonella spp. | Bacteria Vibrio cholera | Total |
|---|---|---|---|---|---|---|---|
| 1-10 | 33 | 1 | 1 | 1 | 0 | 0 | 3 |
| 11-20 | 21 | 1 | 0 | 0 | 0 | 0 | 1 |
| 21-30 | 20 | 1 | 0 | 0 | 0 | 0 | 1 |
| 31-40 | 26 | 1 | 1 | 0 | 0 | 0 | 2 |
| 41-50 | 31 | 1 | 0 | 0 | 1 | 0 | 2 |
| 51-60 | 19 | 1 | 0 | 0 | 0 | 0 | 1 |
| **Total** | **150** | **6** | **2** | **1** | **1** | **0** | **10** |

Percentage of infections in Al-Obaidi area in 2007, 2022 was (50.66 %, 14 %) respectively, while it was (10.66 %, 6.66 %) in Palestine Street area Table5.

**Table5: Percentage of Infected People in Al-Obaidi Area &Palestine Street Area in 2007 & 2022.**

| Percentage of the infections % | | | |
|---|---|---|---|
| **Al-Obaidi area 2007** | **Al-Obaidi area 2022** | **Palestine Street area 2007** | **Palestine Street area 2022** |
| 50.66 % | 14 % | 10.66 % | 6.66 % |

Regarding protozoa, a low percentage of infections was recorded in the Palestine Street area in 2007 &2022, compared to Al-Obaidi area in all age groups, and the isolated parasites were (G. lamblia, Entamoeba histolytica, Entamoeba coli, and Trichomonas hominis) Tables6 and 7.

**Table6: Number & Percentage of Infection with Parasites (Protozoa) In the Al-Obaidi Area &Palestine Street Area In 2007**

| **Parasites (PROTOZOA), *G. lamblia, Entamoeba histolytica, Entamoeba coli, Trichomonas hominis*** | | | | |
|---|---|---|---|---|
| **Age group/Year** | **Al-Obaidi area** | | **Palestine Street area** | |
| | **n** | **Percentage%** | **n** | **Percentage%** |
| **1 -10** | 11 | 7.33 | 2 | 1.33 |
| **11-20** | 5 | 3.33 | 1 | 0.66 |
| **21-30** | 6 | 4 | 2 | 1.33 |
| **31-40** | 7 | 4.66 | 1 | 0.66 |
| **41-50** | 5 | 3.33 | 1 | 0.66 |
| **51-60** | 6 | 4 | 1 | 0.66 |

**Table7: Number & Percentage of Infection with Parasites (Protozoa) In the Al-Obaidi Area &Palestine Street Area In 2022.**

| **Parasites (PROTOZOA), *G. lamblia, Entamoeba histolytica, Entamoeba coli, Trichomonas homini*** | | | | |
|---|---|---|---|---|
| **Age group/Year** | **Al-Obaidi area** | | **Palestine Street area** | |
| | **n** | **Percentage%** | **n** | **Percentage%** |
| **1 -10** | 4 | 2.66 | 1 | 0.66 |
| **11-20** | 2 | 1.33 | 1 | 0.66 |
| **21-30** | 2 | 1.33 | 1 | 0.66 |
| **31-40** | 1 | 0.66 | 1 | 0.66 |
| **41-50** | 2 | 1.33 | 1 | 0.66 |
| **51-60** | 1 | 0.66 | 1 | 0.66 |

Because of the difficulty of examining pinworms, Enterobius vermicularis, which is diagnosed using tape that is attached to the anal area and examined (Dennehy et al., 1988; Forbes et al., 2007), the percentage of infection with worms was high despite the ease of transmission through contaminated food or drinking water or from one person to another due to the low level of personal hygiene (Forbes et al., 2007). And, the self-infection of the infected patient through the mouth and anus - few, because it appears in the laboratory by direct examination is rare (Dennehy et al., 1988; John & Petri, 2006). Also, physicians depended on diagnosing pinworms based on the symptoms, and the infected people were left untreated, which led to a higher number of parasitic infections. For infection with worms Hymenolepis nana, the percentage was expected, as a result of the high sources of infection in the Al-Obaidi area compared to the Palestine Street area. Table9, showed low percentage of infections (0.66%) in Al-Obaidi area when compared with the same area in 2022 as showed in Table8, and this is because the services provided to the Al-Obaidi area, which in turn reduced infections, but when comparing with infections to Palestine Street area in 2007, noticed that there is still a difference in infections between the two regions. Table8, this was due to population density and health culture, which play a role in reducing infections.

**Table8: Number & Percentage of Infection with Parasites (Metazoa) in the Al-Obaidi Area &Palestine Street Area In 2007.**

| Worms (METAZOA), *Enterobius vermicularis, Hymenolepis nana* | | | | |
|---|---|---|---|---|
| Age group/Year | Al-Obaidi area | | Palestine Street area | |
| | n | Percentage% | n | Percentage% |
| 1 -10 | 3 | 2 | 1 | 0.66 |
| 11-20 | 5 | 3.33 | 1 | 0.66 |
| 21-30 | 3 | 2 | 0 | 0.00 |
| 31-40 | 3 | 2 | 1 | 0.66 |
| 41-50 | 1 | 0.66 | 0 | 0.00 |
| 51-60 | 1 | 0.66 | 0 | 0.00 |

**Table9: Number & Percentage of Infection with Parasites (Metazoa) In Al-Obaidi Area &Palestine Street Area in 2022.**

| Worms (METAZOA), *Enterobius vermicularis, Hymenolepis nana* | | | | |
|---|---|---|---|---|
| Age group/Year | Al-Obaidi area | | Palestine Street area | |
| | n | Percentage% | n | Percentage% |
| 1 -10 | 1 | 0.66 | 1 | 0.66 |
| 11-20 | 1 | 0.66 | 0 | 0.00 |
| 21-30 | 0 | 0.00 | 0 | 0.00 |
| 31-40 | 1 | 0.66 | 1 | 0.66 |
| 41-50 | 0 | 0.00 | 0 | 0.00 |
| 51-60 | 1 | 0.66 | 0 | 0.00 |

It is noteworthy that choosing the rotavirus, which represents the most common cause of diarrhea, especially in children under five years old, increases the probability of infection in the winter(Troeger et al., 2018). Table10 and 11. It is noteworthy that choosing the rotavirus, which represents the most common cause of diarrhea, especially in children under five years old (Levy-Lambert, 1974;Gaspard & Schwartzbrod, 1995 and John & Petri, 2006), increases the probability of infection in the winter Table10 and 11.

**Table10: Number & Percentage of Infection with *Rotavirus* in Al-Obaidi Area & Palestine Street Area In 2007**

| Rotavirus | | | | |
|---|---|---|---|---|
| Age group/Year | Al-Obaidi area | | Palestine Street area | |
| | n | Percentage% | n | Percentage% |
| 1 -10 | 8 | 5.33 | 2 | 1.33 |
| 11-20 | 0 | 0.00 | 0 | 0.00 |
| 21-30 | 0 | 0.00 | 0 | 0.00 |
| 31-40 | 0 | 0.00 | 0 | 0.00 |
| 41-50 | 0 | 0.00 | 0 | 0.00 |
| 51-60 | 0 | 0.00 | 0 | 0.00 |

**Table11: Number & Percentage of Infections with *Rotavirus* in Al-Obaidi Area &Palestine Street Area In 2022**

| Rotavirus | | | | |
|---|---|---|---|---|
| Age group/Year | Al-Obaidi area | | Palestine Street area | |
| | n | Percentage% | n | Percentage% |
| 1 -10 | 3 | 2 | 1 | 0.66 |
| 11-20 | 0 | 0 | 0 | 0 |
| 21-30 | 0 | 0 | 0 | 0 |
| 31-40 | 0 | 0 | 0 | 0 |
| 41-50 | 0 | 0 | 0 | 0 |
| 51-60 | 0 | 0 | 0 | 0 |

Widal test analysis, which shows old infections and recent infections together, the carrier of the disease, taking the typhoid vaccine, the naturally acquired immunity, and cross reaction with other microorganisms (Tomatala, 2025). Therefore, the

infections appear in many ways and in an exaggerated way The analysis takes a long time when compared to the Widal test analysis. Table12 and 13. As for the absence of infections with the Shigella bacteria, it may be attributed to the fact that this bacterium appears in epidemic attacks, and the number of carriers is much less than the number of carriers of salmonella(Gupta et al., 2004), as well as the researchers' reliance on diagnosing Shigella on S.S Agar due to the lack of Hekton, XLD, and Xylos-lysin-Deoxycholate agar. (Enteric agar). Therefore, it was difficult to diagnose Shigella(Dekker & Frank, 2015). The incidence of Salmonella in the Al-Obaidi area is compared to the second region, due to the presence of the previously mentioned sources of infection. When comparing the infections in the Al-Obaidi area to the Palestine Street area in Table12, noted that there is still a difference in infections between the two regions. This is due to population density and health culture, which play a role in reducing infections. As for infections with the Shigella bacteria, the infection did not appear despite the use of researchers Hekton, XLD and Xylos-lysin-Deoxycholate agar (enteric agar). As for the absence of infections with Shigella, it may be attributed to the fact that this bacterium appears in epidemic attacks, and the number of carriers is much less than the number of carriers of salmonella(Tickell et al., 2017).

**Table12: Number & Percentage of Infection with *Salmonella* in The Al-Obaidi Area &Palestine Street Area In 2007**

| Bacteria, *Salmonella* spp. | | | | |
|---|---|---|---|---|
| **Age group/Year** | **Al-Obaidi area** | | **Palestine street area** | |
| | **n** | **Percentage%** | **n** | **Percentage%** |
| 1 -10 | 0 | 0.00 | 0 | 0.00 |
| 11-20 | 1 | 0.66 | 1 | 0.66 |
| 21-30 | 2 | 1.33 | 1 | 0.66 |
| 31-40 | 1 | 0.66 | 0 | 0.00 |
| 41-50 | 1 | 0.66 | 1 | 0.66 |
| 51-60 | 1 | 0.66 | 0 | 0.00 |

**Table13: Number & Percentage of Infections with *Salmonella* in The Al-Obaidi Area &Palestine Street Area In 2022**

| Bacteria, *Salmonella* spp. | | | | |
|---|---|---|---|---|
| **Age group/Year** | **Al-Obaidi area** | | **Palestine Street area** | |
| | **n** | **Percentage%** | **n** | **Percentage%** |
| 1 -10 | 0 | 0.00 | 0 | 0.00 |
| 11-20 | 1 | 0.66 | 0 | 0.00 |
| 21-30 | 0 | 0.00 | 0 | 0.00 |
| 31-40 | 1 | 0.66 | 0 | 0.00 |
| 41-50 | 0 | 0.00 | 1 | 0.66 |
| 51-60 | 0 | 0.00 | 0 | 0.00 |

Health culture of cholera, which included the two study regions equally, and the presence of health services through the health centers located in the two study regions, prevented infection in the Palestine Street area and did not prevent it in the Al-Obaidi area table14, because the sources of infection are many in this area, and cannot prevented the spread of flies, insects, rodents in the presence of a large amount of waste spread in the area, and sewage water spread in the streets and alleys. However, when observing Table15 in the two study regions, showed that the number of infections with the epidemic disease is zero when compared with Table14, which showed low infections in the Al-Obaidi area only, but the availability of services ended the epidemic disease despite the population density and lack of health awareness when compared with the two study regions, but it prevented cholera.

**Table14: Number & Percentage of Infection with *Vibrio Cholera* in Al-Obaidi Area &Palestine Street Area in 2007**

| Bacteria, *Vibrio cholera* | | | | |
|---|---|---|---|---|
| Age group/Year | Al-Obaidi area | | Palestine Street area | |
| | n | Percentage% | n | Percentage% |
| 1 -10 | 1 | 0.66 | 0 | 0.00 |
| 11-20 | 1 | 0.66 | 0 | 0.00 |
| 21-30 | 1 | 0.66 | 0 | 0.00 |
| 31-40 | 1 | 0.66 | 0 | 0.00 |
| 41-50 | 1 | 0.66 | 0 | 0.00 |
| 51-60 | 1 | 0.66 | 0 | 0.00 |

**Table15: Number & Percentage of Infection with *Vibrio Cholera* in Al-Obaidi Area &Palestine Street Area In 2022**

| Bacteria, *Vibrio cholera* | | | | |
|---|---|---|---|---|
| Age group/Year | Al-Obaidi area | | Palestine street area | |
| | n | Percentage% | n | Percentage% |
| 1 -10 | **0** | **0.00** | **0** | **0.00** |
| 11-20 | **0** | **0.00** | **0** | **0.00** |
| 21-30 | **0** | **0.00** | **0** | **0.00** |
| 31-40 | **0** | **0.00** | **0** | **0.00** |
| 41-50 | **0** | **0.00** | **0** | **0.00** |
| 51-60 | **0** | **0.00** | **0** | **0.00** |

Water tank project in the city pumps water with a good percentage of chlorine, and this is evident in the reading of the nearest house of the project in the two study areas, the natural percentage of chlorine in the water station is limited to between 0.750 - 3.0 ppm, and the amount of chlorine in the water station is important for the district on bacteria, viruses and parasites in them, this is done when the concentration of free chlorine was maintained to 5.0 per part in a million (5.0 PPM) for 30 minutes at a temperature not less than 5 C and PH 6-7, then a quantity of free chlorine is left after 30 minutes from the time of the first contact within the normal limits (World Health Organization & UNICEF, 2000). The residual chlorine in the water station is of great importance in maintaining the water quality (World Health Organization & UNICEF, 2000). However, in the Table16 it was noticed in the Al-Obaidi area that the percentage of chlorine drops significantly, 1 km away from the nearest house to the water station, and 2 km from the nearest house, the water station was more declining, this is because of the broken pipes at the water station due to its age and its inadequacy with the nature of the region and its mixing with groundwater (Al-Obaidi area is a lower area than the neighboring areas, and it is a place for groundwater to collect). The matter was different in the area of Palestine Street, as the reading remained good even at a distance of 2 km from the nearest house to the water station that the good service of it is one of the factors to prevent the sources of infection, this is contrary to the data recorded in the Al-Obaidi area. In Table17, noticed that the percentage of chlorine is normal in the Al-Obaidi area as the reading remained good even at a distance of 2 km from the nearest house to the water station, and the reason is after the availability of services for the water station and the renewal of water delivery pipes to the Al-Obaidi area suitable for the nature of the region and the disposal of groundwater by providing a sewage water network after it did not exist. As for the Palestine Street area, the percentage of chlorine remained almost the same as in the Table16, so the good services remain the same.

**Table16: Chlorine Levels in Al-Obaidi Area &Palestine Street Area in 2007**

| location | Percentage of chlorine in the water of the Al-Obaidi area (ppm) | Percentage of chlorine in the water of the Palestine Street area (ppm) |
|---|---|---|
| The nearest house to the water filtration project | 1.9 | 1.8 |
| 1km from the nearest house to the project | 0.5 | 1.4 |
| 2km from the nearest house to the project | 0.1 | 0.9 |

**Table17: Chlorine Levels in Al-Obaidi Area &Palestine Street Area in 2022**

| location | Percentage of chlorine in the water of the Al-Obaidi area (ppm) | Percentage of chlorine in the water of Palestine Street (ppm) |
|---|---|---|
| The nearest house to the water filtration project | **1.7** | **1.5** |
| 1km from the nearest house to the project | **0.9** | **1.2** |
| 2km from the nearest house to the project | **0.6** | **0.8** |

## 4. Discussion

The significant differences in the infection rate between the two regions may be due to the lack of a sewer services in the Al-Obaidi area, which led to the people resorting to digging large basins inside their places of residence to collect sewer water, and because of the high cost of withdrawing this water, most of them are forced to take it out in the form of small watercourses to the alleys and streets, which led to the spread of this water in the streets and alleys. In contrast to the Palestine Street area, which has a regular sewer services, which reduces the infection rate in it, and one of the main sources of infection is flies, insects and rodents (Dennehy et al., 1988 ;John & Petri, 2006 ;Forbes et al., 2007) , which are spread in the Al-Obaidi area due to the accumulation of sewage and waste in the alleys and streets, in addition to the inability of garbage trucks to enter the area due to the roughness of the streets in all the alleys, either in the Palestine Street area, which has paved streets, which help garbage trucks enter the area it daily and completely and orderly. In addition to the mixing of pipes at the water station in the Al-Obaidi area with groundwater and sewage water, due to the old and broken pipes at the water station, and the population density in the Al-Obaidi area in general and in their places of residence in particular, and parents cannot keep their children in the home because of this density, which led to increase exposed to infections that are widely available outside the home, and for the above reasons, the infection rate is high in the Al-Obaidi area compared to the Palestine Street area. Because of the difficulty of examining pinworms, Enterobius vermicularis, which is diagnosed using tape that is attached to the anal area (Dennehy et al., 1988 ;Forbes et al., 2007) , the percentage of infection with worms was high despite the ease of transmission through contaminated food or drinking water, or from one person to another, due to the low level of personal hygiene (Forbes et al., 2007) , and also the self-infection of the infected patient through the mouth and anus - few, because it appears in the laboratory by direct examination is rare (Dennehy et al., 1988 ;John & Petri, 2006). Also, physicians depended on diagnosing pinworms based on the symptoms, and the infected people were left untreated, which led to a higher number of parasitic infections. For infection with worms Hymenolepis nana, the percentage was expected, as a result of the high sources of infection in the Al-Obaidi area compared to the Palestine Street area. Table9 showed low percentage of infections (0.66%) in Al-Obaidi area when compared with the same area in 2022 as showed in Table8, and this is because the services provided to the Al-Obaidi area, which in turn reduced infections, but when comparing with infections to Palestine Street area in 2007, noticed that there is still a difference in infections between the two regions. Table8, this was due to population density and health culture, which play a role in reducing infections. It is noteworthy that choosing the rotavirus, which represents the most common cause of diarrhea, especially in children under five years old increases the probability of infection in the winter(Troeger et al., 2018), Table10 and 11. Widal test analysis, which shows old infections and recent infections together, the carrier of the disease, taking the typhoid vaccine,

the naturally acquired immunity, and cross reaction with other microorganisms. Therefore, the infections appear in many ways and in an exaggerated way (Tomatala, 2025)(. The analysis takes a long time when compared to the Widal test analysis Table12 and 13. As for the absence of infections with the Shigella bacteria, it may be attributed to the fact that this bacterium appears in epidemic attacks, and the number of carriers is much less than the number of carriers of salmonella (Warren et al., 2006) as well as the researchers' reliance on diagnosing Shigella on S.S Agar due to the lack of Hekton, XLD, and Xylos-lysin-Deoxycholate agar. (Enteric agar). Therefore, it was difficult to diagnose Shigella (Dennehy et al., 1988). The incidence of Salmonella in the Al-Obaidi area is compared to the second region, due to the presence of the previously mentioned sources of infection.(Philpott et al., 2000). When comparing the infections in the Al-Obaidi area to the Palestine Street area in Table12, noted that there is still a difference in infections between the two regions. This is due to population density and health culture, which play a role in reducing infections(Sambourg et al., 1985). As for infections with the Shigella bacteria, the infection did not appear despite the use of researchers Hekton, XLD and Xylos-lysin-Deoxycholate agar (enteric agar). As for the absence of infections with Shigella, it may be attributed to the fact that this bacterium appears in epidemic attacks, and the number of carriers is much less than the number of carriers of salmonella(Rogawski McQuade et al., 2020). Health culture of cholera, which included the two study regions equally, and the presence of health services through the health centers located in the two study regions, prevented infection in the Palestine Street area and did not prevent it in the Al-Obaidi area Table14, because the sources of infection are many in this area, and cannot prevented the spread of flies, insects, rodents in the presence of a large amount of waste spread in the area, and sewage water spread in the streets and alleys. However, when observing Table15 in the two study regions, showed that the number of infections with the epidemic disease is zero when compared with Table14, which showed low infections in the Al-Obaidi area only, but the availability of services ended the epidemic disease despite the population density and lack of health awareness when compared with the two study regions, but it prevented cholera. Water tank project in the city pumps water with a good percentage of chlorine, and this is evident in the reading of the nearest house of the project in the two study areas, the natural percentage of chlorine in the water station is limited to between 0.750 - 3.0 ppm. The amount of chlorine in the water station is important for the district on bacteria, viruses and parasites in them, this is done when the concentration of free chlorine was maintained to 5.0 per part in a million (5.0 PPM) for 30 minutes at a temperature not less than 5 C and PH 6-7, then a quantity of free chlorine is left after 30 minutes from the time of the first contact within the normal limits (World Health Organization & UNICEF, 2000), the residual chlorine in the water station is of great importance in maintaining the water quality (World Health Organization & UNICEF, 2000). However, in the Table16 it was noticed in the Al-Obaidi area that the percentage of chlorine drops significantly, 1 km away from the nearest house to the water station, and 2 km from the nearest house, the water station was more declining, this is because of the broken pipes at the water station due to its age and its inadequacy with the nature of the region and its mixing with groundwater (Al-Obaidi area is a lower area than the neighboring areas, and it is a place for groundwater to collect). The matter was different in the area of Palestine Street, as the reading remained good even at a distance of 2 km from the nearest house to the water station that the good service of it is one of the factors to prevent the sources of infection, this is contrary to the data recorded in the Al-Obaidi area. In table17, noticed that the percentage of chlorine is normal in the Al-Obaidi area as the reading remained good even at a distance of 2 km from the nearest house to the water station, and the reason is after the availability of services for the water station and the renewal of water delivery pipes to the Al-Obaidi area suitable for the nature of the region and the disposal of groundwater by providing a sewage water network after it did not exist. As for Palestine Street area, the percentage of chlorine remained almost the same as in the Table16, so the good services remain the same.

## Conclusion

This comparative study demonstrates a significant association between improvements in urban infrastructure and a marked reduction in the burden of diarrheal diseases. In Al-Obaidi, the dramatic decline in overall infection rates from 50.66% in 2007 to 14% in 2022 correlates strongly with concurrent upgrades to water chlorination systems, the installation of sewage networks, and the regularization of waste management services. The disappearance of *Vibrio cholerae* and the substantial decrease in protozoan and bacterial infections in this area by 2022 underscore the effectiveness of these targeted environmental interventions. Conversely, Palestine Street, which maintained more robust baseline sanitation and water infrastructure, exhibited consistently lower infection rates (10.66% in 2007 and 6.66% in 2022) throughout the study period. This contrast highlights the critical and sustained role of infrastructure in preventing the transmission of enteric pathogens. However, the persistent, though reduced, disparity in infection rates between the two areas in 2022 suggests that factors such as population density, health awareness, and specific diagnostic challenges also contribute to the overall disease prevalence. The findings affirm that diarrheal diseases, while multifactorial, are highly sensitive to environmental conditions. The study concludes that targeted investments in water quality, sewage systems, and solid waste management are not merely associated with, but are likely primary drivers in, the control of diarrheal diseases. For urban public health strategy, these environmental interventions remain the most effective cornerstone for preventing water-borne and hygiene-related infections, particularly in settings recovering from infrastructural deficits.

## Data availability statement

Data can be provided after reasonable request to corresponding author.

## Authors Contribution

**IMA** and **ALJ** jointly conceived and designed the study. **IMA** performed the experiments, analyzed the data, and wrote the initial draft. **ALJ** supervised the research, provided resources, and critically revised the manuscript. Both authors reviewed and approved the final submitted version.

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