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Assessment of the Status of Liquid Medical Waste in Dhi Qar Governorate and Methods of Disposal

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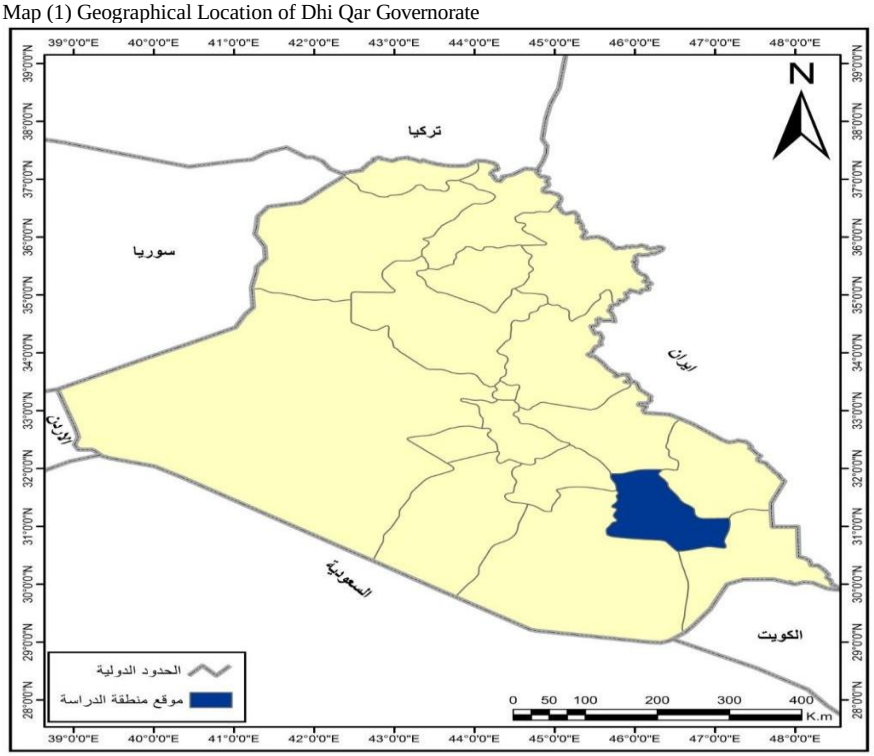
Abstract
The research aims to study the reality of liquid medical waste generated by hospitals and primary health care centers in Dhi Qar Governorate ,identify its spatial variations, and reveal the reality of liquid medical waste treatment .The research relied on the descriptive and analytical approaches based on data from relevant authorities .The research concluded that the research area is affected by the problem of liquid medical waste generated by health institutions and the spatial variation in its quantities .Medical waste treatment is not carried out in a safe manner ,as health institutions lack treatment units. The research proposed several proposals to determine the size of the problem and develop appropriate solutions for it.

Introduction
Liquid medical waste is considered a hazardous waste source that requires careful handling and adherence to safe disposal methods and procedures to protect the environment from pollution. This waste is considered highly polluting because it originates from healthcare facilities that directly treat patients and the injured.
First: The Problem Statement
The governorate includes a number of public and private hospitals and primary healthcare centers that generate varying quantities of medical waste. Therefore, this research aims to investigate the problem, which is addressed by the main question: What is the current state of liquid medical waste in Dhi Qar Governorate, and how can it be disposed of? This question is further divided into the following sections:
1- What is the volume of liquid medical waste in Dhi Qar Governorate?
2- Is there a spatial variation in the distribution of liquid medical waste in Dhi Qar Governorate?
3- What is the current state of liquid medical waste treatment and safe disposal in Dhi Qar Governorate? Second: Study Hypothesis
The main research hypothesis is that Dhi Qar Governorate suffers from a problem of liquid medical waste generated by government and private hospitals and primary healthcare centers. Furthermore, the methods for disposing of this waste face numerous challenges, including:
1- Healthcare institutions in Dhi Qar Governorate generate significant quantities of liquid medical waste.
2- There is spatial variation in the distribution of liquid medical waste across the districts of Dhi Qar Governorate.
3- The treatment of medical waste in Dhi Qar Governorate faces numerous challenges.
Third: Research Objective:This research aims to determine the quantities of liquid medical waste generated by government and private hospitals and primary healthcare centers in the study area, identify variations in these quantities, and understand the current state of medical waste treatment and disposal.
Fourth: Research Significance:The research is significant because it addresses a highly important topic. It focuses on studying a source of waste that is considered one of the most dangerous types of waste. Therefore, the research sheds light on the quantities of liquid medical waste, its spatial variations, and how it is treated, with the goal of developing appropriate solutions to mitigate the problems encountered in its treatment. Fifth: Research Methodology
The research adopted the scientific methodologies used in environmental research and studies. It employed the descriptive method, which presents facts and events, and the analytical method, which involves case studies and analysis of the findings.
Sixth: Research Scope:The geographical scope was defined by the boundaries of Dhi Qar Governorate in 2023, with an area of 12,900 km². Dhi Qar Governorate is located in southern Iraq, extending between latitudes 30°37' and 32°00' North and longitudes 45°39' and 47°10' East. It is bordered to the north by Wasit Governorate, to the east by Maysan and Basra Governorates, to the west by Muthanna and Qadisiyah Governorates, and to the south by Basra and Muthanna Governorates (see Map 1).
The temporal scope was defined by the year 2023, with reference to previous years as needed and based on data availability. The scope of the study included examining liquid medical waste (sewage) from government and private hospitals and primary healthcare centers in the study area.
Map (1) Geographical Location of Dhi Qar Governorate



Source: Republic of Iraq, Ministry of Water Resources, General Survey Authority, Map Production Department, Digital Unit, Administrative Map of Dhi Qar Governorate, Scale 1/10000, Baghdad 2023.
Seventh: Research Structure:The research includes a theoretical framework consisting of an abstract, introduction, research problem, hypothesis, significance, objectives, spatial and temporal boundaries, definition of liquid medical waste, and two sections. The first section addresses the current quantities of liquid medical waste in Dhi Qar Governorate, and the second section addresses the treatment and disposal of liquid medical waste. The research concludes with recommendations and a list of sources.
Eighth - Definition of Liquid Medical Waste
Liquid waste is produced through the use of water in various industrial and agricultural processes, including oils and sewage. It is mostly discharged into flowing water

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sources (valleys, rivers, and seas). Every day, urban and rural communities generate enormous quantities of sewage from various activities. This sewage contains relatively high
concentrations of organic matter, mineral salts, and microbes. The amount of sewage is directly proportional to the population size and the amount of water consumed in homes and other facilities (1).

Wastewater emits several gases, most notably methane (70%) and carbon dioxide (25- 28%). Ammonia and hydrogen sulfide follow, constituting between 3-35%. Furthermore, it contains human feces, one of the most dangerous pollutants in water, as it adds various nutrients, particularly phosphorus and nitrogen. This encourages prolific algal growth, contributing to eutrophication. This makes wastewater a suitable environment for the growth of various microorganisms and their diverse needs. Eutrophication is the increase in phosphorus and nitrogenous substances that algae and some plants in water consume. It is one of the most serious environmental problems occurring in bodies of water. The main causes of this phenomenon are the use of chemical fertilizers, animal waste, and wastewater discharged into seas and oceans. Eutrophication produces toxic substances that harm marine plants and animals. Algal blooms in freshwater can also cause livestock deaths and pose a risk to humans. See: Ibtihal Shaker Majeed, "The Variation of Nutritional Enrichment in the Abu Al-Khasib Canal and its Health Effects," Iraqi University Journal, Issue 60, Part 1, 2022, p. 479.

Their numbers range from half a million to tens of millions per millimeter, and the microbial communities vary between aerobic and anaerobic groups, nitrifying, sulfuric, and iron bacteria, and include enteric bacteria, pathogenic and non-pathogenic coliform bacteria, spore bacteria, various fungi, lactic acid bacteria, and types of viruses such as poliovirus, hepatitis virus, and enteroviruses (2).

Wastewater also contains a number of pollutants, with organic matter constituting approximately 70%. The most significant organic materials are proteins (65%), carbohydrates (25%), and fats (10%). These organic materials are responsible for oxygen depletion in the water, which affects aquatic organisms and plants. Inorganic materials include sand, sediment, and salts, as well as heavy metals, which alter the water's properties due to salt dissolution (3).

The presence of heavy metals in wastewater, such as zinc, copper, nickel, cadmium, and lead, can lead to the contamination of agricultural land through irrigation with polluted water. This contributes to increased concentrations of heavy metals. These metals may bind to soil colloids via plants or to organic matter in the soil, becoming absorbable by plants over time. Alternatively, they may be sparingly soluble in water, in which case they are unavailable for plant uptake (4).

Section One: The Reality of Liquid Medical Waste in Dhi Qar Governorate

A- Spatial Trends of Liquid Waste (Sewage) from Hospitals (Governmental and Private)

It is evident from the data in Table (1) that the total daily sewage discharge rate from hospitals reached (730,235) liters/day*. This is also noted in the previous table and Map (2).

*The researcher relied on data from the Dhi Qar Health Department and the Dhi Qar Water and Sewerage Department, where the rates were calculated by multiplying (the average number of patients per day × 187 liters of wastewater discharge per person/day).

Table (1) Relative Distribution of Liquid Waste Rates from Hospitals by District in Dhi Qar Governorate for the year 2023.

%	Discharge rate (liters/day)	With daily reviewers	With monthly reviewers	Al-Qadaa	No
38,1	278256	1488	44632	Nasiriyah	1
21,7	158576	848	25447	Al-Shatra	2
11,5	83963	449	13461	Al-Rifai	3
17,5	127908	684	20533	Suq Al-Shuyukh	4
11,2	81532	436	13073	Al-Jubayish	5
100	730235	3905	110467		Total

The research source relies on:

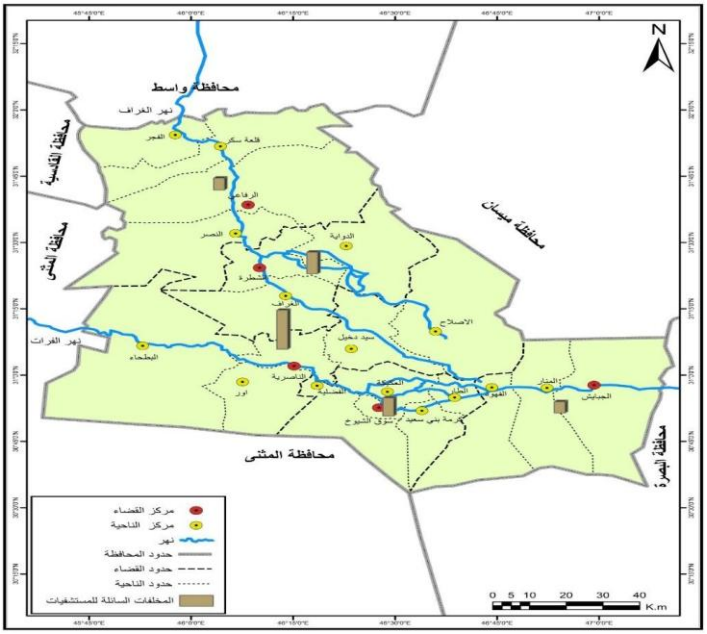
1- Dhi Qar Health Department, Planning and Human Resources Development Division, Health and Vital Statistics Unit, for the year 2023.

2- Dhi Qar Water and Sewerage Department, Operations Division, for the year 2023.

The wastewater discharge rates varied across districts. Nasiriyah District had the highest rate (38.1%), followed by Shatra District (21.7%), Suq al-Shuyukh District (17.5%), Rifa'i District (11.5%), and Al-Jubayish District (11.2%).

This variation can be attributed to differences in population size, the number of public and private hospitals, and the number of patients.

Map (2) shows the relative distribution of liquid waste rates from hospitals in Dhi Qar Governorate for the year 2023.



Source: Researcher relying on data from Table (1).

Regarding the geographical distribution of liquid waste rates according to hospital ownership, Table (2) shows that government hospitals accounted for the largest share of liquid waste (93.6%), while private hospitals accounted for (6.4%) of the total liquid waste rates. See Figure (1).

Regarding the rates of liquid waste disposal by hospital, the table above and Figure (2) show that these rates varied. Al-Shatra Hospital ranked first with a rate of (21.7%), followed by Suq Al-Shuyukh Hospital in second place with (17.5%), Al-Nasiriyah General Hospital (Turkish) in third place with (17%), Al-Rifai Hospital in fourth place with (11.5%), Al-Jubayish Hospital in fifth place with (11.2%), Al-Haboubi Hospital in sixth place with (5.2%), Muhammad Al-Musawi Hospital in seventh place with (4.4%), Bint Al-Huda Hospital in eighth place with (3.4%), the Heart Center in ninth place with (1.1%), and Al-Hussein Teaching Hospital in tenth place with (0.5%). Liquid waste disposal rates in private hospitals varied slightly, ranging from a high of (1.7%) at Al-Rahman Hospital and Al-Amal Hospital to a low of (0.8%) at Al-Hadarat Hospital.

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B- Spatial Trends of Liquid Waste from Primary Healthcare Centers

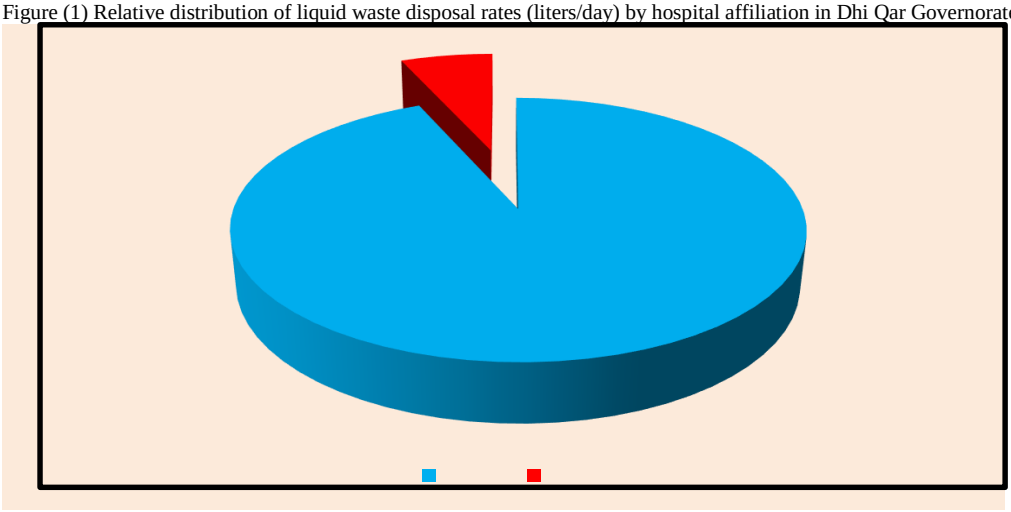
Table (3) shows that the total daily wastewater discharge from primary healthcare centers in the study area for 2023 amounted to (228,784) liters/day. The table and map (3) also reveal that the wastewater discharge rates varied across districts. Al-Rifai district accounted for the highest percentage (23.4%) of the total wastewater discharge rates, followed by Al-Shatra district at (22.3%), Al-Nasiriyah district at (20.9%), Al- Jubayish district at (17.4%), and finally, Suq Al-Shuyukh district at (16%).

Table (2) shows the relative distribution of wastewater discharge rates (liters/day) by government and private hospitals in Dhi Qar Governorate for 2023.

%	Discharge rate (liters/day)	Monthly review rate	Hospital Names	No	Returns
0,5	4683	572	Al-Hussein Teaching Hospital	1	
5,2	50975	6117	Al-Haboubi General Hospital	2	
17	166483	19978	Al-Nasiriyah Turkish General Hospital	3	
4,4	42475	5097	Mohammed Al-Mousawi Children's Hospital	4	
3,4	32908	3949	Bint Al-Huda Maternity and Gynecology Hospital	5	
1,2	12141	1457	Al-Nasiriyah Heart Hospital	6	
21,7	212058	25447	Al-Shatra Hospital	7	
11,5	112175	13461	Al-Rifai Hospital	8	
17,5	171108	20532	Souq Al-Shuyoukh Hospital	9	
11,2	108941	13073	Al-Jubayish Hospital	10	Government
93,6	913947	109673	Total		
1,1	11091	1331	Spring	1	
1,7	15666	1880	Hope	2	
1,7	16400	1968	The Merciful	3	
1,1	10941	1313	Al-Azhar	4	
0,8	8250	980	Civilizations	5	Eligibility
6,4	62348	7472	Group		
93,6	913947	109673	Governmental	10	
6,4	62348	7472	Private	5	Total
100	976295	117146		15	

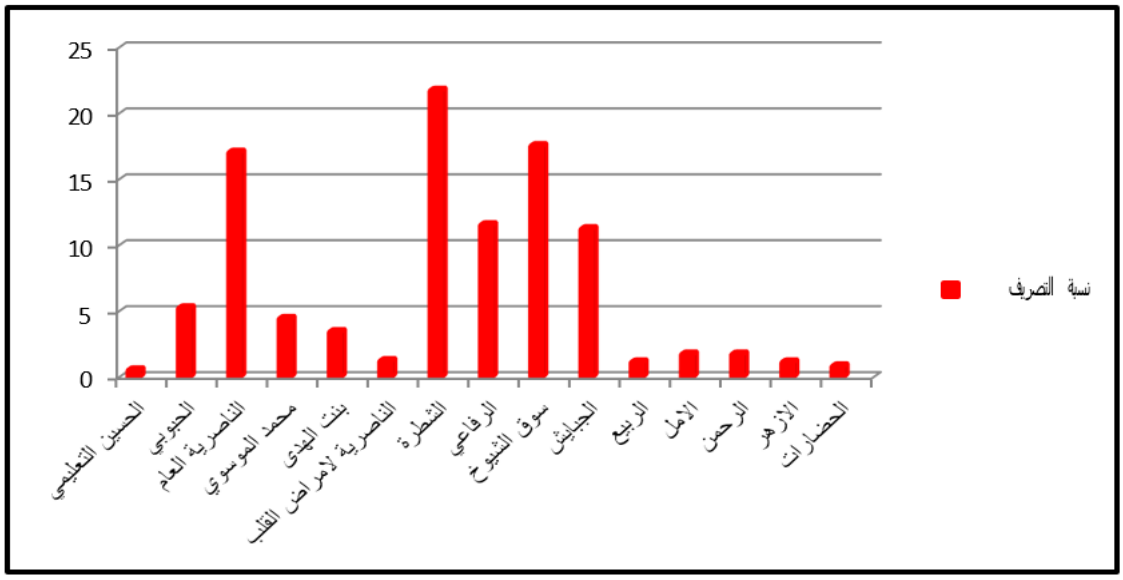
Source: Republic of Iraq, Ministry of Health, Dhi Qar Health Directorate, Planning and Human Development Department, Infection Control Division, 2023.

Figure (1) Relative distribution of liquid waste disposal rates (liters/day) by hospital affiliation in Dhi Qar Governorate for the year 2023.



Source: Data from Table (2)

Figure (2) Relative distribution (%) of liquid waste discharge rates by hospital in Dhi Qar Governorate for the year 2023



Source: Data from Table (2)

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Table (3) Liquid Waste Discharge Rates for Primary Healthcare Centers in Dhi Qar Governorate for the year 2023.

%	Discharge rate (liters/day)	Monthly review rate	Al-Qadaa	No
20,9	173349	27816	Nasiriyah	1
22,3	185130	29692	Al-Shatra	2
23,4	192984	30955	Al-Rifai	3
16	132957	21338	Suq Al-Shuyukh	4
17,4	144364	23173	Al-Jubayish	5
100	228784	132974		Total

Sources:

1- Dhi Qar Health Department, Planning and Human Resources Development Division, Health and Vital Statistics Unit, 2023.

2- Dhi Qar Water and Sewerage Department, Operations Division, 2023.

Section Two: Medical Waste Treatment

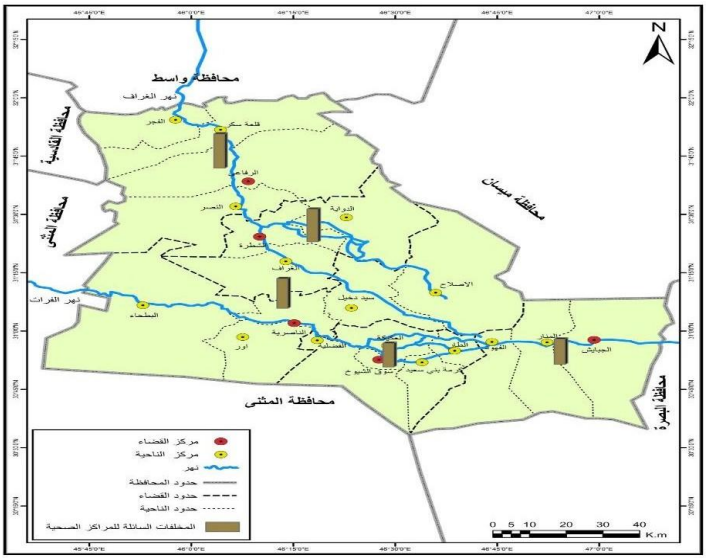
The process of modifying waste in a specific way before it goes to the final disposal site is called treatment. This waste needs treatment for the following reasons (5):

1- Disinfecting and sterilizing the waste so that it does not become a source of pathogenic organisms, making it safer for disposal after treatment.

2- Reducing the total volume of waste.

3- Making certain recyclable items indistinct so that they cannot be reused by irresponsible parties or individuals, such as needles and syringes. Treatment may take place inside or outside the hospital, and there are several treatment methods, each with its own advantages and disadvantages.

Map (3) Relative distribution of liquid waste rates for primary health care centers in Dhi Qar Governorate for the year 2023.



Based on the data in Table (3), the researcher found in Table (4) that most hospitals in the study area suffer from a lack of wastewater treatment units. This is due to various reasons, some of which are the absence of treatment units, while others are outdated, dilapidated, and frequently out of service.

Table (4): Medical Waste Treatment in Hospitals in Dhi Qar Governorate for the Year 2023

Treatment		Hospital
Notes	sewage units	
Directly to the sewer	None	Al-Nasiriyah General Turkish School
Concrete sinks	Works sluggishly	Al-Hussein
Directly to the sewer	None	Al-Haboubi
Directly to the sewer network	None	Bint Al-Huda
Directly to the sewer	None	Muhammad Al-Mousawi
Directly to the sewer network	None	Al-Nasiriyah Heart Center
Directly to the sewer network	None	Al-Rabee Private School
Directly to the sewer network	None	Al-Rahman Private School
Directly to the sewer network	None	Al-Amal Private School
Directly to the sewer	None	Al-Hadarat Private School
Directly to the sewer	None	Al-Azhar Private School
Concrete sinks	None	Al-Shatra General School
Directly to the sewer	None	Al-Rifai Educational School
Directly to the sewer	None	Souq Al-Shuyoukh General School
Notes	None	Al-Jubayish

The researcher relied on:

(1) Republic of Iraq, Ministry of Health, Dhi Qar Health Directorate, Planning and Human Development Department, Infection Control Division, for the year 2023.

(2) Republic of Iraq, Ministry of Environment, Dhi Qar Governorate Environment Directorate, Urban Environment Department, Health Institutions Inspection Forms for the year 2023.

It is clear from the preceding table that most government and private hospitals lack wastewater treatment units. Consequently, all hospital wastewater is discharged untreated into the sewage system, with the exception of Al-Hussein Teaching Hospital and Al-Rifai Teaching Hospital. Surgical waste is disposed of in concrete septic tanks and collected periodically by tanker trucks for disposal at the city's outskirts in a landfill. Wastewater from other departments is discharged into the sewage system without treatment.

Regarding the treatment of medical waste from primary healthcare centers in the study area, Table (5) shows that primary healthcare sectors in the study area lack wastewater treatment plants, and wastewater is disposed of into domestic wastewater. Table (5) Treatment of medical waste in primary health care centers in Dhi Qar Governorate for the year 2023.

Processing	Sector	No
None	Nasiriyah 1st	1

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None	Nasiriyah 2nd	2
None	Sayyid Dakhil	3
None	Suq al-Shuyukh	4
None	Karmah Bani Saeed	5
None	Marshes	6
None	Al-Gharraf	7
None	Al-Shatrah	8
None	Al-Dawayah	9
None	Al-Nasr	10
None	Al-Rifai	11
None	Qalat Sukkar	12
None	Al-Fajr	13

The researcher relied on: Republic of Iraq, Ministry of Health, Dhi Qar Health Directorate, Planning and Human Development Department, Infection Control Division, for the year 2023.

Conclusions:

1- The total wastewater discharge rates in hospitals in the study area for the year 2023 amounted to (976,295) liters/day. These rates varied according to district, with the highest rate in Nasiriyah District (38.1%) and the lowest in Al-Jubayish District (11.2%). Wastewater discharge rates also varied according to hospital affiliation, with the highest rate (93.6%) in government hospitals and the lowest (6.4%) in private hospitals. Furthermore, rates varied among individual hospitals, with the highest rate (21.7%) in Al-Shatra Hospital and the lowest (0.5%) in Al-Hussein Teaching Hospital.

2- The total wastewater discharge rate for primary healthcare centers reached 1,107,590 liters/day. Rates varied across districts, with the highest rate in Al-Rifai District (23.4%) and the lowest (16%) in Suq Al-Shuyukh District.

3- Wastewater treatment in the study area suffers from a lack of wastewater treatment units in most hospitals, with the exception of Al-Hussein Teaching Hospital, which operates sluggishly and discharges wastewater from all other hospitals into public sewage networks, rivers, and the sewer system without treatment. All primary healthcare centers lack treatment units, resulting in wastewater being discharged directly and untreated into public sewage networks, the sewer system, and waterways.

Recommendations:

1- Raise awareness among healthcare workers, particularly in hospitals and primary healthcare centers, about the dangers of medical waste and ensure adherence to proper and safe procedures for handling it.

2- The necessity of establishing wastewater treatment units for healthcare facilities, as untreated liquid waste from these facilities should not be discharged into the sewage system or rivers.

3- Strengthening oversight of healthcare facilities and their wastewater disposal procedures to protect the environment from pollution.

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