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EVALUATION OF DRINKING WATER AUDITING SYSTEM DURING COVID 19 PANDEMIC IN IRAQ

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Abstract:

Background: Drinking water quality monitoring programs aim to support provision of safe drinking water by informing water quality management. Little evidence or guidance exists on best monitoring practices for low resource settings. Lack of financial, human, and technological resources reduce a country's ability to monitor water supply, Water safety plans (WSP) are a comprehensive risk assessment and risk management approach that encompasses all steps in the water supply from catchment to consumer. The methods used in water treatment, such as disinfection and physical removal of pollutants, are the next lines of defense against contamination of the drinking water system after source water protection. Water Safety auditing is a crucial component of WSPs that are implemented sustainably. **Materials and methods:** This cross-sectional study was conducted in audit health department/ public health directories/ ministry of health, Republic of Iraq. The data was collected from the register monthly reported from 2018 through 2021, for the health facilities in the 16 directorate of Iraq, except Kurdistan. A purposive (convenience) sampling technique was adopted. **Aim:** The evaluation of the impact of COVID 19 on the water auditing system quality measured used the association of the drinking water validation with the years the samples collection. **Results:** bout 116408 water samples was collected in these primary health centers during 2018 to 2021, of these was 63486 (54.5%) water samples was valid while the rest was 52922 (45.5%) of water samples was invalid for drinking, The maximum collected samples was during 2019 which was 41116 (35.3%) and it include 21771 (52.9%) valid samples and 19345 (47.1%) invalid water samples, while the minimum water collection samples rate was during 2021 which was 14371 (12.3%) and it include 7869 (54.8%) valid water samples and 6502 (45.2%) invalid samples, however, there was no significant differences between the water validation with the years of samples collection. **Conclusion:** The drinking water treatment system in Iraq is not up to the standard required for drinking water. Despite the difference in the proportions of validity and invalidity water over the study years, it found that these differences are not statistically significant.

Keywords: Water safety, auditing, water management system, drinking water validation.

INTRODUCTION:

The quality and safety of drinking water have always been major public health concerns [1]. The need for water is growing as a result of rising population density, rapid urbanization, industry, and agricultural [2]. Unsafely managed drinking water services are not available to 2.2 billion people worldwide, nor are safe sanitation services to 4.2 billion people, and basic handwashing facilities are not available to 3 billion people, according to a UNICEF report [3]. Exposure to enteric pathogens is largely a result of poor sanitation and dietary sources. Drinking water is a significant source of microbial pathogens and is thought to be one of the primary causes of rising child death rates in developing nations [4].

Water-related diseases are likely to be impacted by climate change[5]. More than 2 billion people reside in nations with water shortages, which are predicted to get worse in some areas due to climate change and population expansion [6]. Arsenic, fluoride, and nitrate provide the greatest chemical dangers in drinking water, but new pollutants such pesticides, medicines, per- and polyfluoroalkyl substances, and microplastics also cause public concern [7]. Every year, 3.4 million people, most of them are children, lose their lives to various diseases brought on by a lack of access to clean water sources, inadequate sanitation, and poor hygiene [8]. Water quality conditions are easily assessed utilizing techniques based on the Water Quality Index concept [9].

Water safety plans (WSP) are a comprehensive risk assessment and risk management approach that all steps in the water supply from catchment to consumer [10]. The methods used in water treatment, such as disinfection and physical removal of pollutants, are the next lines of defense against contamination of the drinking water system after source water protection[11]. Water Safety auditing is a crucial component of WSPs that are implemented sustainably. The WSP is audited to ensure that it is comprehensive, current, and being implemented correctly. The procedure encourages ongoing improvement, which is essential to the WSP methodology [12].

On February 24, 2020, in Najaf, a southern Baghdad neighborhood, the first case of COVID-19 in Iraq was identified [13]. The Iraqi government issued a number of partial and comprehensive lockdown measures beginning on March 1 to stop the spread of the COVID-19 across the country [14]. The purpose of this study was to determine the validation of drinking water during the period 2018 to 2021 to detect the impact of lockdown due to coronavirus on the application of the drinking water quality.

MATERIALS AND METHODS:

This cross-sectional study was conducted in audit health department/ public health directories/ ministry of health, Republic of Iraq. Its population in 2022 was estimated to be 42,427,057 based on the latest United Nations data, all the needs of drinking waters in Iraq are received by Tigris and Euphrates which are essential to the life of the country, but they sometimes threaten it. The health audit units in the health directories in the different governorate of Iraq send their monthly report about the monthly procedures to monitoring the drinking water validation in the Water Treatment Plant, and the public health centers.

The data was collected from the register monthly reported from 2018 through 2021, for the health facilities in the 16 directorate of Iraq, except Kurdistan. A purposive (convenience) sampling technique was adopted. The evaluation of the impact of COVID 19 on the water auditing system quality measured used the association of the drinking water validation with the years the samples collection, years preceding and during the COVID 19 pandemic.

The data were coded and each report assigned with a serial identifying number then entered by the researcher into the computer using Statistical Package for Social Sciences (SPSS) version 26. Data were presented in simple measures of frequency, percentage, mean and standard deviation.

The significance of difference of different percentages (qualitative data) were tested using independent t test with application of ANOVA test whenever applicable. Statistical significance was considered whenever the P value was less than 0.05.

RESULTS:

From 1241 primary health care all over Iraq except Kurdistan, data about occupying of the water auditing plan was collected during the period 2018 to 2021. About 116408 water samples was collected in these primary health centers during 2018 to 2021, of these was 63486 (54.5%) water samples was valid while the rest was 52922 (45.5%) of water samples was invalid for drinking as shown in figure 1.

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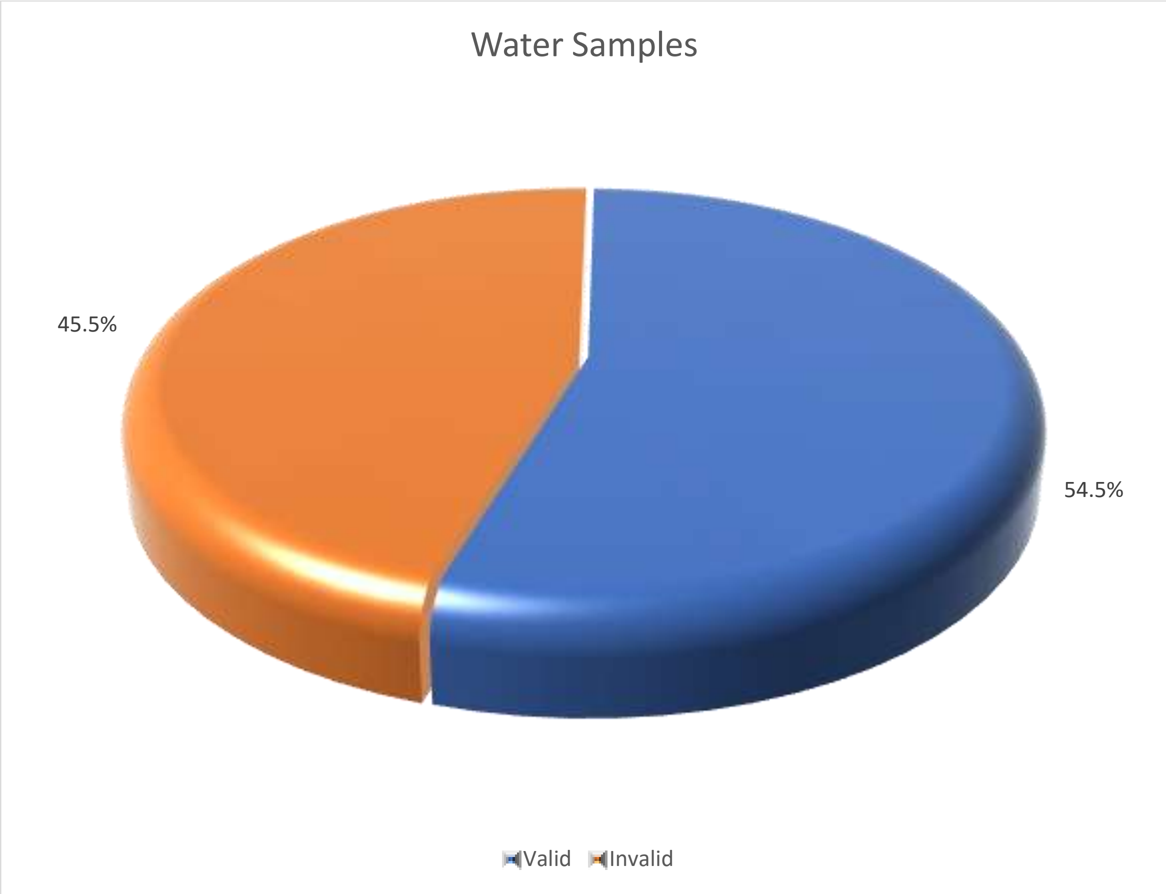

Figure 1 the overall drinking water validation during 2018-2021.

The maximum collected samples was during 2019 which was 41116 (35.3%) and it include 21771 (52.9%) valid samples and 19345 (47.1%) invalid water samples, while the minimum water collection samples rate was during 2021 which was 14371 (12.3%) and it include 7869 (54.8%) valid water samples and 6502 (45.2%) invalid samples (Figure 2).

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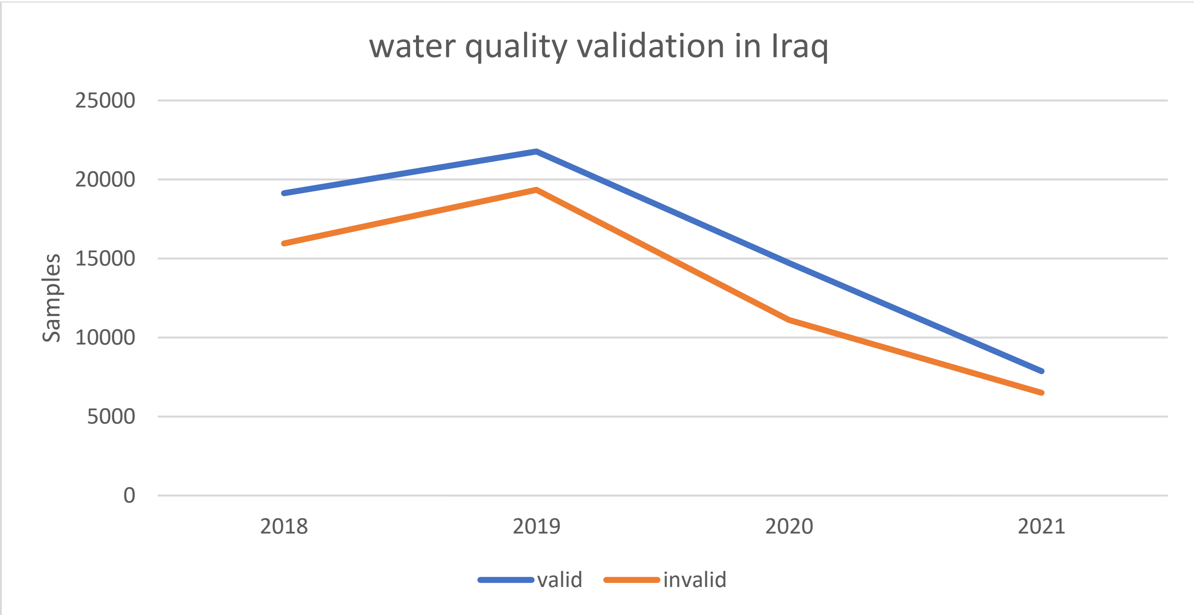

Figure 2 the distribution of the validation of drinking water samples collected in the primary health care centers in Iraq during the period 2018 to 2021.

According the application of the drinking water auditing plan, figure 3 show that the during 2019 about 79.5% of the primary health care centers apply the water auding plane and collect the water samples and notice that it was increased 4.4% than 2018 (75.1%), while there was decline in the application of the plan during 2020 to (69.8%) and severe drops during 2021 to (50.9%) as shown in figure 3

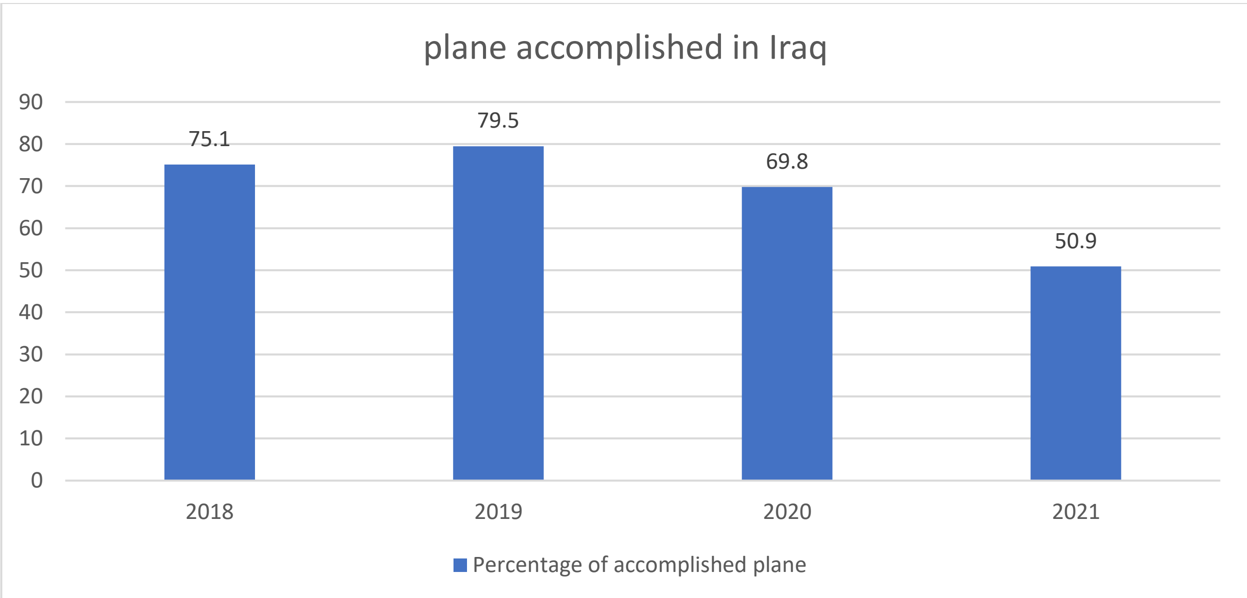

Figure 3 the application of the water auditing plan in the primary health care centers in Iraq during the period 2018 to 2021.

Regarding the water validation during 2018 to 2021, most of the directorate data show decrease in the water validation during 2020 and 2021 compare to 2018 and 2019, Nineveh was the most governorate that get valid water to drink in Iraq during 2019, while Diala was the top one during 2019 and 2020 followed by Kirkuk, Baghdad/Al-Karkh and Al-Dewaniya, while Al-Najaf and Wasit water validation severely drops

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after 2018, the unique exception was Al-Muthana and Al-Basrah that water validation was increased during 2021.

For Al_Anbar there was no data for the years 2018, 2020 and 2021 collected their due to the security situation in the governorate as shown in figure 4.

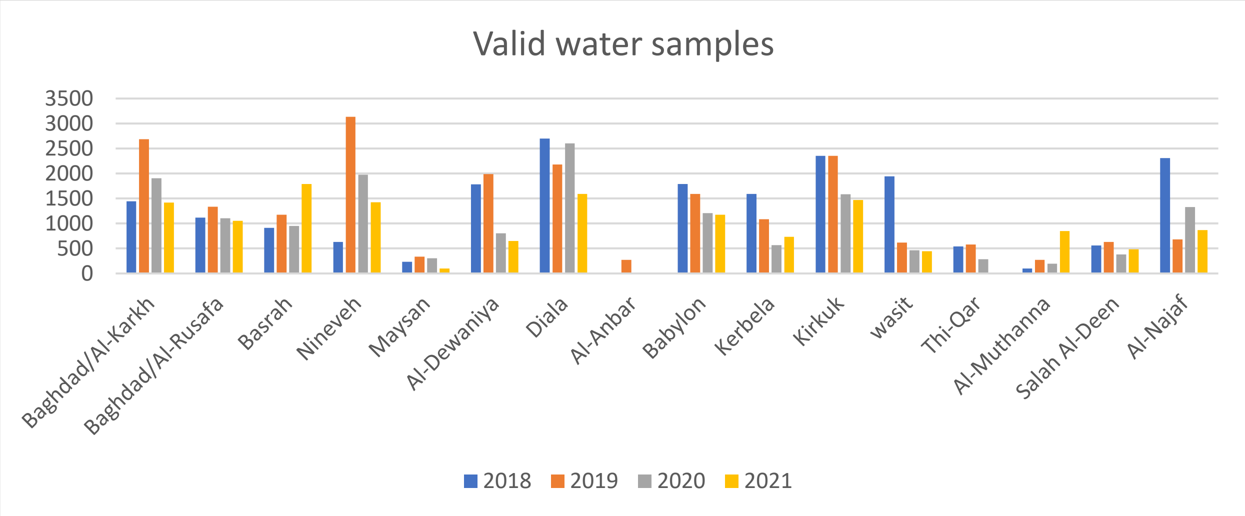

Figure 4 the distribution of water validation among Iraq governorates.

For the invalidation samples of drinking water, figure 5 show that main invalid water was in Baghdad/Al-Rusafa and Thi-Qar during 2018 and 2019. Followed by Babylon, Wasit, al-Muthanna, Kerbela, Salah Al-Deen, Al-Basrah, and Baghdad /Al-Karkh.

Compare to 2020 and 2021, Wasit was the main governorates with invalid water, Thi-Qar, Kerbela, Al-Muthanna, Maysan, Baghdad/Al-Rusafa and Baghdad/Al-Karkh respectively.
While Al_Anbar there was no data for the years 2018, 2020 and 2021 as shown in figure 5.

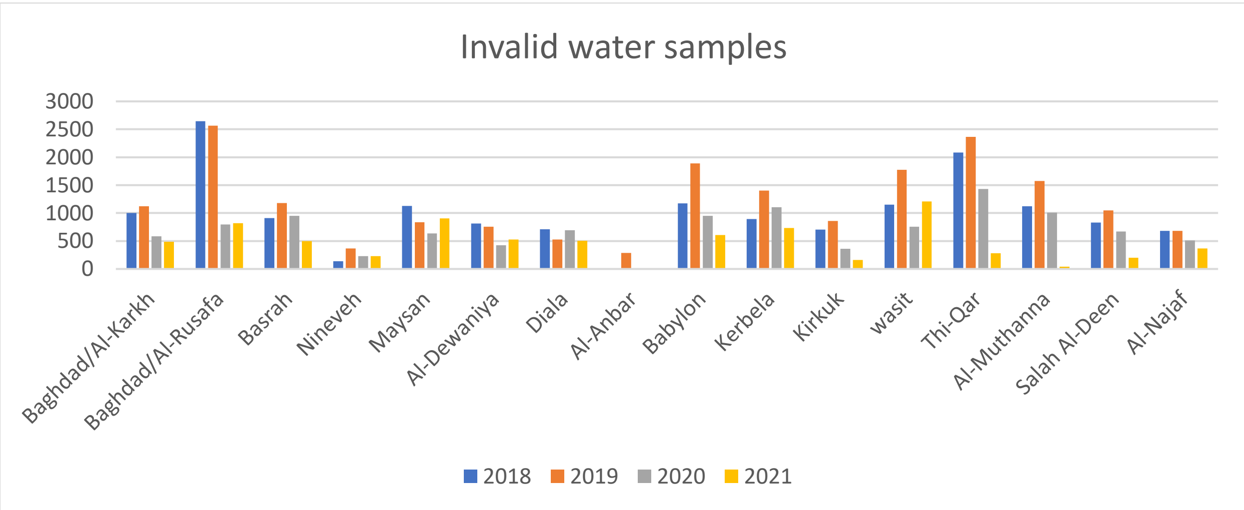

Figure 5 the distribution of water Invalidation among Iraq governorates.

However, the differences in the validation of drinking water during the years 2018 to 2021 among the Iraq governorates, table 1 reveals that there were no statistically significant differences for the valid drinking water samples with the four years survey as p value was more than 0.05, also for the invalid drinking water samples collected was insignificantly associated with the years as p value was 0.672.

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Table 1 the association of the drinking water validation with the years of samples collection.

Tab Water samples	2018	2019	2020	2021	P value
Valid	2249.7±4436.3	2561.2±5048.8	1732.1±3433.1	1451.4±2627.4	0.849
invalid	1879.8±3679.2	2270.0±4449.0	1308.12±2551.4	964.65±2153.5	0.672
Total	4098.7±8050.8	4837.1±9399.9	3032.0±5922.1	2416.1±4740.9	0.770

DISCUSSION:

A study was conducted in Iraq to assess the implementation of the water auditing plan in 1241 primary health care centers during the period 2018 to 2021. The results showed that despite the challenges posed by the coronavirus lockdown, the primary health care centers in Iraq were able to maintain a high level of compliance with the water audit plan. This is a testament to the commitment of the healthcare providers and the government to ensuring the safety and quality of drinking water in the country. This result is in line with studies conducted by Roy et al., 2021, in Bangladesh; Nel et al., 2022, in South Africa; and Arora et al., 2023, in India [15-17].

A recent study of the water quality at primary health centers revealed that just over half of the samples collected between 2018 and 2021 were suitable for drinking. The study collected 116,408 water samples and found that 54.5% were considered safe for consumption, while the remaining 45.5% were deemed invalid. This was higher that the result of studies conducted in Nepal by Pant et al. in 2021 and in Iran by Haghnazar et al. in 2022, and the reason for that might be due to the ignorance of maintenance of the treatment projects and the distribution network especially after the increase in the construction of overrun and unauthorized houses in Baghdad and their unofficial connection to the drinking water network. However, all the studies suggesting that water quality continues to be a concern in many regions. To ensure safe and clean drinking water, ongoing monitoring and improvement efforts are needed to safeguard pubhlic health [18, 19].

The maximum number of water samples collected during the study was in 2019, with a total of 41,116 samples, or 35.3% of the total samples. Out of these, 52.9% were considered safe for drinking, with 21,771 samples deemed valid, while the remaining 47.1% were considered invalid. On the other hand, the lowest number of water samples collected was in 2021, with only 14,371 samples, or 12.3% of the total. Out of these, 54.8% were considered safe for drinking, with 7869 samples deemed valid, and 45.2% were deemed invalid. And this backdown in the samples size during 2021 compare to 2019 might be due to the lack of funds required to follow up and monitor the quality of drinking water, and transfer funds of many health programs to the efforts of control of the Coronavirus pandemic, in addition to reducing in the number of visits to water treatment complexes in the years 2020 and 2021 compared to before Coronavirus pandemic because of the social distance policy. This data highlights the need for continued monitoring of water quality to ensure that safe and clean drinking water is available to the public even during disasters or pandemics. And this finding was going on with the result mentioned in the studies done by Latchmore et al., 2022, in Canada, and Abia et al., 2023, in South Africa [20, 21].

According to the drinking water auditing plan, our study shows a marked variation in the application of the plan over the years. In 2019, 79.5% of the primary health care centers implemented the auditing plan and collected water samples, which was an increase of 4.4% from 2018 (75.1%). However, the implementation of the plan declined in 2020 to 69.8%. In 2021, there was a more drop in the implementation of the government's plan, reaching 50.9%. This drop is likely due to the COVID-19 lockdown has led to reductions in certain public health services. The lockdown measures and the focus on responding to the pandemic have placed additional stress on health systems, and many non-emergency services, such as routine check-ups [22,23].

It is likely that the decrease in water validation in some directorates in Iraq from 2018 to 2021 was due to factors such as drought, mismanagement, and increased demand due to population growth [24]. However, the COVID-19 pandemic and associated lockdowns may have also had an impact, as they disrupted supply chains and led to decreased investment in infrastructure and maintenance [25]. Despite this, some directorates, such as Al-Muthana and Al-Basrah, had an increase in water validation in 2021, which may be due to increased investment in water infrastructure and improved management practices [26].

In 2018 and 2019, the directorates with the highest levels of invalid drinking water were Baghdad/Al-Rusafa and Thi-Qar. While, in 2020 and

2021, Wasit was the main directorate with invalid drinking water. Al_Anbar has no data for the years 2018, 2020 and 2021 collected their due to the security situation in the governorate. The changing in the directorates drinking water invalidation might be due to the COVID-19 lockdown could have affected the water validation process and contributed to the increase in invalid water in these governorates. The lockdown measures may have disrupted the usual water supply and distribution systems, leading to a decrease in the quality of drinking water [27]. Additionally, the pandemic could have diverted resources and attention away from maintaining and improving the water supply infrastructure, leading to a decline in the overall water quality [28].

However, the COVID-19 lockdown may have had effect on the overall validation of drinking water in Iraq. The p-values suggest that the differences in the validation of drinking water among the governorates were not significantly impacted by the pandemic.

CONCLUSION:

The drinking water treatment system in Iraq is not up to the standard required for drinking water. Despite the difference in the proportions of validity and invalidity water over the study years, it found that these differences are not statistically significant.

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