Experimental and Applied Veterinary Research Journal
Volume 1, Issue No. 1, 2025

Detection of lead and cadmium pollution in Tigris River, water stations, and tap water in Baghdad Governorate

Zamn Saad AL-amary[1], Mohanad Falhi Hamood[1]

[1]*Public Health Department, College of Veterinary Medicine, University of Baghdad, Baghdad, Iraq.*

***Corresponding Author**
Zamn Saad AL-amary
zamnsaad456@gmail.com

Received: 7 August 2025
Accepted: 24 August 2025
Published: 28 December 2025

Abstract

Background: Heavy metals such as cadmium (Cd) and lead (Pb) are among the most hazardous environmental pollutants because of their toxic effects on humans and other living organisms, even at low concentrations. This study aimed to assess the levels of Cd and Pb contamination in different water sources across Baghdad Governorate, including river water, water treatment plants, and tap water. **Methodology:** This study was conducted between February 2023 and January 2024. A total of 1,296 water samples were collected from six locations, and Cd and Pb concentrations were determined. **Results:** Elevated concentrations of Cd and Pb were detected across all water sources. The highest mean of Pb concentration was recorded in river water (0.059 mg/L), followed by tap water (0.052 mg/L) and treated water (0.043 mg/L), all of which exceeded the WHO safety limit of 0.01 mg/L. Similarly, Cd concentrations were highest in river water (0.026 mg/L), followed by tap water (0.044 mg/L) and treated water (0.036 mg/L), surpassing the WHO guideline of 0.003 mg/L. Seasonal variations showed that Cd concentrations were the highest in summer, whereas Pb levels were the highest in spring. **Conclusions:** The prevalence of Cd and Pb contamination varied by water source and location. Cd pollution was nearly six times more likely to exceed permissible limits compared to Pb ($P < 0.0001$). Moreover, seasonal differences were evident, with Cd exceeding Pb in summer, while Pb surpassed Cd in spring.

Keywords: Lead, cadmium, water pollution, Baghdad Governorate, river water, water stations, tap water

CITE: AL-amary, Z. S. & Hamood, M. F. (2025). Detection of lead and cadmium pollution in Tigris River, water stations, and tap water in Baghdad Governorate. *Experimental and Applied Veterinary Research Journal, 1*(1).

Introduction

According to Ding *et al*., (2022) a metal is classified as heavy if its density is more than 5 g/cm3 (opaque) or light with less than 5 g/cm3. Heavy metals are persistent environmental pollutants due to their insoluble nature. Access to uncontaminated potable water is vital for maintaining a state of optimal health and well-being (Kruger, 2011). Many types of pollution have reduced the quality of the world's freshwater resources, while the demand for water continues to increase annually (du Plessis, 2023). Climate change would exacerbate these water problems via the effects of elevated temperatures and alterations in the water cycle (Mishra, 2023). These effects may result in more frequent and intense droughts, increased floods, and heightened toxicity of chemical pollutants in the environment (Bolan *et al*., 2023). In underdeveloped countries, the absence of adequate infrastructure for treating polluted water or ensuring access to clean drinking water exacerbates the impact of increasing pollution levels, leading to more severe consequences (Katekar & Deshmukh, 2021). However, various sources of water such as piped water, boreholes, protected wells and springs, rainwater, and packaged/delivered water are available (Oluwasanya *et al*., 2025). The prevalence of heavy metal contamination has increased in recent years because of the expanding industrial and urban areas in emerging regions (Wu *et al*., 2022).

Various industries, such as coal-fired power plants and mining together with waste recycling and solid waste disposal, release contaminated wastewater (Habib & Khan, 2021). Multiple factors contribute to the toxicity of an element, such as the species that come into touch with it, the elemental properties and biological role, and the duration of exposure to the metal (Jaishankar *et al*., 2014). The interconnectedness of organisms is evident in food webs and chains (Schmitz & Leroux, 2020). Recent high pollution levels stem from wars, industrial activities, and domestic and hospital wastewater discharged into the Tigris River, carrying chemicals, pesticides, and fertilizers (ALSalman & Dawood, 2023). Therefore, the aim of this study was detection of the pollution of water (river, stations, and tap water) in Baghdad governorate with heavy metals, particularly lead (Pb) and cadmium (Cd).

Materials and Methods

Water samples

This study was conducted during the period from February 2023 to January 2024. Totally, 1296 water samples were collected from the river Tigris, water treatment plants, and tap water from six areas: Central Al-Karkh water project/Tarmiya area, Central Al-Rusafa water project/canal highway, Abu-Graib central water project/Al-Zaidan area, Al-Qaqaa water project/Al-Yousifiya area, Al-Latifiya and part of Al-Mahmoudia, Nahrawan water project/Al-Nahrwan area, Al-Hussainiya water project/Al-Hussainiya District (Al-Zuhur water). Six water samples were taken from each location (river, water stations, and tap water). At the beginning, river water samples were collected at a distance of approximately 3 meters from the riverbank/cliff, while water treatment plant samples were collected from storage basins. Finally, tap water samples were collected after allowing the tap to flow for one minute, and then the water was stored in a clean and dry 1-liter plastic bottles. The samples were kept at the refrigerator before analysis, and then they were sent to the Science and Technology Laboratories – Baghdad, Iraq, for measuring heavy metal concentrations.

Lead concentration measurement

Pb concentrations were determined using a novAA® 300 Atomic Absorption Spectrophotometer (Analytik Jena, Germany) based on the principles of Flame Atomic Absorption Spectroscopy.

Cadmium concentration measurement

Cd concentrations were measured using Graphite Furnace Atomic Absorption Spectroscopy (as mentioned above), which provides high sensitivity and precision for trace metal analysis.

Heavy metals calibration

For both metals, calibrations were carried out using certified standard solutions, and the instrument performance was verified through the analysis of blanks and spiked recovery samples.

Statistical analysis

Data were statistically analyzed using SAS (Statistical Analysis System, version 9.1) to compare Pb and Cd concentrations across different water sources. Additionally, Reference Values Adviser (RVA) software (SAS Institute Inc., 2003) was employed to establish non-parametric reference intervals for the measured concentrations based on the method described by Geffré *et al*. (2011).

Results

Table 1 shows different sources of water. The data revealed that the highest mean concentration of Pb was in river water, followed by tap water, while station-treated water exhibited the lowest mean concentration.

Table 1: Pb concentrations in different water sources

pb	Tap water	Stations	River
No.	٤٣٢	٤٣٢	٤٣٢
Mean (mg/dI)	٠,٠٥٢	٠,٠٤٣	٠,٠٥٩
Median (mg/dI)	٠,٠٥٥	٠,٠٣٣	٠,٠٥٦
Standard (mg/dl)	٠,٠٢	٠,٠٢	٠,٠١٢
Lower limit (mg/dl)	٠,٠٠٩	٠,٠٢٢	٠,٠١٢
Upper limit (gm/dl)	٠,٠٩٥	٠,٠٨٥	٠,١٠٦
90% Lower limit	٠,٠١-٠,٠٠٦	٠,٠٢٢-٠,٠٢١	٠,٠٠١٤-٠,٠١٠
90% Upper limit	٠,٠٩٥-٠,٠٩٤	٠,٠٨٩-٠,٠٨٥	٠,١٠٩-٠,١٠٣
Method	Non-parametric	Non-parametric	STD

When compared to the reference values established by the World Health Organization (WHO) in 2017, which set the maximum permissible limit for Pb in drinking water at 0.01 mg/L (or 0.001 mg/dl), it was evident that all measured values in this study exceeded the international safety threshold. This is consistent with the findings reported in Baghdad by Al-Rakabi and Ramadan, (2017). This suggests a potential environmental pollution concern. The markedly elevated maximum Pb concentrations, particularly in river water (0.106 mg/dl) and tap water (0.095 mg/dl), point to potential ongoing pollution sources, which may include direct industrial discharges into rivers, deterioration of aging water distribution infrastructure, or leaching of industrial and agricultura1 waste contaminated with heavy metals. The findings align with the Iraqi Ministry of Environment study (2022) (Iraq, 2022). which recorded increasing concentrations of heavy metals, particularly Pb, in surface water sources attributable to inadequate water treatment facilities and deficient environmental regulatory compliance.

The examination of standard deviation and value ranges (lower and upper limits) indicated significant internal variance within each group, this indicates heterogeneous or intermittent pollution, where certain water samples show significantly elevated contaminant levels compared to others, reflecting fluctuating pollution sources or episodic contamination events (de Bastos *et al*., 2021). The skewed distribution is evident in station water, as the median concentration (0.033 mg/dl) was lower than the mean (0.043 mg/dl), indicating that although most samples exhibited appropriate levels, a few high-concentration outliers substantially elevated over the mean. These findings are concerning from a public health standpoint. Multiple studies indicate that prolonged exposure to even minimal levels of Pb can lead to cumulative adverse consequences, including neurological impairments, renal failure, and cognitive abnormalities, particularly in children (Collin *et al*., 2022; Lanphear et al., 2005) emphasized that children were especially susceptible to Pb poisoning, even at concentrations beneath globally recognized thresholds (Champion *et al*., 2022). corroborates these findings, revealing that almost 72% of residential drinking water samples from diverse regions in Baghdad surpassed the WHO's Pb concentration thresholds. The authors ascribed this to declining infrastructure, including antiquated piping systems and insufficient water filtering, particularly in informal settlements and regions with deficient municipal services.

Table 2: Cd concentrations in different water sources

Cd	Tap water	Station	River
No.	432	432	432
Mean	0.031	0.035	0.047
Median	0.026	0.036	0.044
Lower limit	0.01	0.014	0.023
Upper limit	0.066	0.058	0.072
95%Lower limit	0.010-0.011	0.012-0.018	0.022-0.025
95%Upper limit	0.062-0.072	0.056-0.061	0.070-0.073
Method	Non-Parametric	Non-Parametric	Non-Parametric

Table 2 depicts the distribution of Cd levels. Cadmium concentrations were analyzed in three main water sources using the Reference Values Adviser (RVA) tool to establish non-parametric reference intervals based on empirical data distributions. The results showed that the highest mean of Cd concentration was in river water followed by station-treated water, and the lowest mean was in tap water. The reference intervals for Cd concentrations in river water indicated notable environmental pollution compared to other sources. The 95% confidence limits were relatively narrow within each source, reflecting relative stability in the data but also natural variability indicating intermittent or heterogeneous pollution. These findings suggest the presence of ongoing or episodic sources of Cd pollution, especially in river water, which may be exposed to industrial and agricultural discharges or deterioration of water infrastructure. Similar patterns of intermittent heavy metal pollution and associated human health risks have been documented in other regional studies (Mukherjee *et al*., 2020).

These results align with local studies in Iraq, such as the work by Al-Rakabi and Ramadan, (2017), which reported Cd concentrations in Baghdad's drinking water exceeding the permissible limits set by the WHO (2017), highlighting the urgent need for water quality monitoring and improved treatment processes. Globally, the WHO recommends that Cd levels in drinking water should not exceed 0.003 mg/L to minimize health risks (WHO, 2017). Exceeding these limits has been linked to toxic effects on the kidneys, bones, and respiratory system, underscoring the importance of addressing persistent pollution. These results align with those documented in earlier Iraqi investigations for instance (Ibadi *et al*., 2024) documented elevated Cd concentrations in the Tigris River attributed to discharges from metal plating industries and sewage effluents. While (Ahmed & Al-Baidhani, 2024) identified that surface waters in southern Baghdad surpassed national Cd thresholds, especially in proximity to untreated waste discharge sites. Cd is a hazardous heavy metal that bioaccumulates in the kidneys, liver, and bones, posing significant public health concerns. Prolonged exposure may result in nephrotoxicity, osteomalacia, and an elevated cancer risk (Kuna *et al*., 2024).

The WHO (2022) asserts that even minimal, prolonged exposure presents a considerable risk, particularly for communities dependent on contaminated drinking water supplies. The Central Organization for Standardization and Quality Control (COSQC) and the Ministry of Environment in Iraq have underscored the necessity for enhanced environmental laws and the surveillance of heavy metals in aquatic systems. Nonetheless, the results of this study reveal deficiencies in enforcement and treatment efficacy, especially in regions devoid of contemporary water purification systems

Table 3 shows that Pb concentration in the river and tap water were significantly ($P<0.05$) higher compared with its concentration in water stations

Table 3: Pb concentrations in various sources of water

Source of water	Tap water	Station	River	LSD
No. sample	432	432	432	
Pb (mg/L)	0.05±0.002a	0.04±0.002b	0.05±0.002[a]	0.008

Means with a different letter are significantly different (P<0.05)

Table 4 shows that Cd concentration in the river and tap water were significantly ($P<0.05$) higher compared to its concentration in water stations

Table 4: Cd concentrations in different sources of water

Source of water	Tap water	Station	River	LSD
No. sample	432	432	432	
Cd (mg/L)	0.036±0.0007a	0.035±0.0005b	0.047±0.0005a	0.0014

Means with a different letter are significantly different (P<0.05)

Tables 3 and 4 show a significant increase in the concentration of Pb and Cd in the river and tap water, as mentioned above. The variation in the river may be caused by pollution from environmental and human activities. The variation in contaminant levels may be attributed to pollution associated with river water, originating from multiple anthropogenic sources, these include the discharge of untreated or partially treated industrial effluents containing heavy metals and chemicals into the river (Daripa *et al*., 2023), as well as domestic sewage, which carries organic matter, pathogens, detergents, and trace metals (Islam & Tanaka, 2004). Agricultural runoff from excessive fertilizer and pesticide use further contributes to the occurrence of nitrates, phosphates, and pesticide residues in river systems (Wu *et al*., 2015). Hospital and medical facility wastewater represent another source, introducing pharmaceuticals, disinfectants, and pathogens into the river (Verlicchi *et al*., 2015).

Additionally, the impacts of war and conflict can lead to destruction of infrastructure and the uncontrolled release of various pollutants into water bodies (Al-Ansari *et al*., 2012). Pb and Cd can also enter the river through atmospheric deposition. Emissions from vehicles, industrial processes, and waste incineration can release these metals into the air, where they can be transported and deposited into the river via precipitation (Issa *et al*., 2020; Aljanabi *et al*., 2022). Agricultural practices involving the use of fertilizers and pesticides represent a potential source of heavy metal contamination (Rashid *et al*., 2023). Phosphate fertilizers, which may contain Cd impurities, can leach into rivers through runoff especially during heavy rains (McDowell, 2022). These findings are consistent with those reported by Daripa *et al*. (2023) as well as AlSalman and Dawood, (2023). Tap water contamination is often linked to household plumbing materials containing Pb (Hatam, 2023). PVC pipes and soldered joints can leach Pb into drinking water, especially under acidic conditions or low mineral content, which accelerates with corrosion (AlSalman & Dawood, 2023). Both Pb and Cd can enter the water supply through these materials, leading to elevated heavy metal concentrations (Swaringen *et al*., 2022; WHO, 2022; Stefan *et al*., 2023).

Table 5 shows that Pb concentrations in summer are significantly ($P<0.05$) higher compared with other seasons.

Table 5: Lead acetate concentrations in water samples in all seasons

Season	Winter	Spring	Summer	Autumn	LSD
No. sample	324	324	324	324	
Pb (mg/L)	0.03±0.002c	0.03±0.001c	0.07±0.003a	0.06±0.002b	0.009

Means with a different letter are significantly different (P<0.05)

Increased Pb concentration in water sources during summer may be due to increased water evaporation. In summer, high temperatures lead to increased evaporation of water, which can concentrate any pollutants in the remaining water. This can result in a higher Pb concentrations during the warmer months (Mulla *et al.,* 2023). During summer, water flow in rivers can decrease due to low rainfall and high evaporation, and reduced water flow means that contaminants like Pb can become more concentrated as the volume of water decreases. In addition, pollution from human activities, such as increased river traffic, industrial discharge, or improper disposal of waste may increase during the summer months (Pandey & Kumari, 2023).

Table 6 shows that Cd concentration in spring was significantly (P<0.05) higher compared with other seasons.

Table 6: Comparison among means of Cd according to the season

Season	Winter	Spring	Summer	Autumn	LSD
No. sample	324	324	324	324	
Cd (mg/L)	0.033±0.0008c	0.046±0.0007a	0.033±0.0007c	0.039±0.0008b	0.0016

Means with a different letter are significantly different (P<0.05)

Increased Cd concentration during spring compared to other seasons may be because these areas have high Cd pollution owing to the use of fertilizers, pesticides, and industrial waste, which can be washed into the river during spring, increasing the concentration of Cd in water (Al Bomola, 2011). Similarly, this phenomenon can be explained by high Cd pollution in agricultural and industrial areas due to the extensive use of phosphate fertilizers containing Cd impurities, pesticides, and industrial waste discharge. During spring, rainfall and runoff can wash these pollutants into rivers, resulting in elevated Cd levels in water. This explanation was supported by (Gunes, 2022). who reported elevated Cd levels in river and waterway samples from agricultural regions in Iraq due to fertilizer and pesticide use. Additionally, the Iraqi Ministry of Water Resources (Iraq, 2022) highlighted the adverse effects of industrial waste on surface water quality, particularly during rainy seasons (Algamal *et al*., 2025) In some cases, industries may discharge more pollutants into water systems in spring due to changes in production schedules or the handling of waste products after the winter months (Hameed, 2024).

Conclusions

Water contamination by Pb and Cd is influenced by both the source and geographic location of the samples. Spatial variations indicate that certain areas are more prone to heavy metal pollution, while temporal differences reveal seasonal fluctuations, with Cd concentrations exceeding Pb in summer and Pb surpassing Cd in spring. Importantly, human exposure to Cd poses a significantly higher risk, being approximately six times more likely to exceed permissible limits than Pb (P<0.0001). These findings underscore the need for continuous monitoring and targeted mitigation strategies to safeguard public health and manage environmental risks associated with heavy metal contamination in water sources.

Acknowledgments

Sincere appreciation is extended to the Public Health Department, College of Veterinary Medicine, University of Baghdad, for providing laboratory facilities and general support during the research. The authors also acknowledge Prof. Dr. Zainab Razzaq Zghair for her kind assistance and technical support during the practical phase of the work

Authors' Contributions

ZSA: sample collection, laboratory work, data analysis, manuscript drafting. MFH: supervision, study design, data interpretation, manuscript revision.

Conflicts of Interest

The author(s) declares no conflicts of interest.

References

Al Bomola, A. (2011). Temporal and spatial changes in water quality of the Euphrates river-Iraq. TVVR11/5013. Master's Thesis, Lund University, Lund. https://lup.lub.lu.se/luur/download?func=downloadFile&recordOId=2341931&fileOId=2341934

Ahmed, A. M., & Al-Baidhani, J. H. (2024). Monthly accumulative effect of wastewater discharged from the medical city on the water quality of Tigris River in Baghdad City, Iraq. *Caspian Journal of Environmental Sciences*, 1-7.

Al Salman, M. R. M., & Dawood, T. N. (2023). Lead, cadmium and mercury concentrations in the tap, river and well water with different treatment from regions along Tigris River. *Social Science Journal*, 13(2),2949–2957. https://resmilitaris.net/uploads/paper/6bc05335fb79cf5e6a23c4c70c15a6e0.pdf

Al-Ansari, N., Knutsson, S., & Ali, A. (2012). Restoring the Garden of Eden, Iraq. *Journal of Earth Sciences and Geotechnical Engineering* 2 (1), pp. 53–88. https://www.scienpress.com/Upload/GEO/Vol%202_1_4.pdf

Algamal, Z. Y., Shehab, Z. N., & Faisal, R. M. (2025). Spatiotemporal variation analysis of Tigris River water quality in Mosul, Iraq during 2020–2023 based on environmetric techniques. *Environmental Earth Sciences*, 84(2), 69.https://doi.org/10.1007/s12665-024-12086-z

Aljanabi, Z. Z., Hassan, F. M., & Al-Obaidy, A. H. M. J. (2022). Heavy metals pollution profiles in the Tigris River within Baghdad city. *IOP Conference Series: Earth and Environmental Science*, *1088*(1), 012008. https://doi.org/10.1088/1755-1315/1088/1/012008

Alrakabi, M. H., & Ramadan, E. S. (2017). Determination of Heavy elements in Drinking Water from Different Regions of Baghdad City (Iraq) Using EDXRF Spectrometer. *Al-Mustansiriyah Journal of Science*, *28*(1), 142-148. https://doi.org/10.23851/mjs.v28i1.324

Bolan, N., Sarmah, A. K., Bordoloi, S., Bolan, S., Padhye, L. P., Van Zwieten, L., ... & Siddique, K. H. (2023). Soil acidification and the liming potential of biochar. *Environmental Pollution*, *317*, 120632. https://doi.org/10.1016/j.envpol.2022.120632

Champion, W. M., Khaliq, M., & Mihelcic, J. R. (2022). Advancing knowledge to reduce lead exposure of children in data-poor low-and middle-income countries. *Environmental Science & Technology Letters*, *9*(11), 879-888. https://pubs.acs.org/doi/10.1021/acs.estlett.2c00656

Collin, M. S., Venkatraman, S. K., Vijayakumar, N., Kanimozhi, V., Arbaaz, S. M., Stacey, R. S.,... & Swamiappan, S. (2022). Bioaccumulation of lead (Pb) and its effects on human: A review. *Journal of Hazardous Materials Advances*, *7*, 100094 https://doi.org/10.1016/j.hazadv.2022.100094

Daripa, A., Malav, L. C., Yadav, D. K., & Chattaraj, S. (2023). Metal contamination in water resources due to various anthropogenic activities. In *Metals in Water* (pp. 111–127). *Elsevier*. https://doi.org/10.1016/B978-0-323-95919-3.00022-7

de Bastos, F., Reichert, J. M., Minella, J. P. G., & Rodrigues, M. F. (2021). Strategies for identifying pollution sources in a headwater catchment based on multi-scale water quality monitoring. *Environmental Monitoring and Assessment*, *193*(4), 169.https://doi.org/10.1007/s10661-021-08930-5

Ding, C., Chen, J., Zhu, F., Chai, L., Lin, Z., Zhang, K., & Shi, Y. (2022). Biological toxicity of heavy metal(loid)s in natural environments: From microbes to humans. *Frontiers in Environmental Science*, *10,* 920957. https://doi.org/10.3389/fenvs.2022.920957

du Plessis, A. (2023). Water resources from a global perspective. In: *South Africa's Water Predicament*: *Freshwater's Unceasing Decline* (pp. 1–25). *Springer International Springer Cham* https://doi.org/10.1007/978-3-031-24019-5

du Plessis, A. (2023). Water Resources from a Global Perspective. In: South Africa's Water Predicament. Water Science and Technology Library, vol 101. Springer, Cham. https://doi.org/10.1007/978-3-031-24019-5_1

Geffré, A., Concordet, D., Braun, J. P., & Trumel, C. (2011). Reference Value Advisor: A new freeware set of macroinstructions to calculate reference intervals with Microsoft Excel. *Veterinary Clinical Pathology*, *40*(1), 107–112. https://doi.org/10.1111/j.1939-165X.2011.00287.x

Gunes, G. (2022). The change of metal pollution in the water and sediment of the Bartın River in rainy and dry seasons. *Environmental Engineering Research*, *27*(2).https://doi.org/10.4491/eer.2020.701

Habib, M. A., & Khan, R. (2021). Environmental impacts of coalmining and coal-fired power-plant activities in a developing country with global context. In *Spatial Modeling and Assessment of Environmental*

Contaminants: *Environmental Challenges and Solutions* (pp.421-493). *Springer*, *Cham*. https://doi.org/10.1007/978-3-030-63422-3_24

Hameed, A. A. S. (2024). Pollution of water's direct effect in Iraq on the public health & safety. *Journal of Al-Farabi for Engineering Sciences*, *2*(2), 12. https://doi.org/10.59746/jfes.v2i2.78

Hatam, F., Blokker, M., Doré, E., & Prévost, M. (2023). Reduction in water consumption in premise plumbing systems: Impacts on lead concentration under different water qualities. *Science of The Total Environment*, *879*, 162975. https://doi.org/10.1016/j.scitotenv.2023.162975

Ibadi, E. A., Awad, H. K., & Hussain, L. I. (2024). Environmental toxins and their organ-specific effects: A comprehensive review of human exposure and accumulation. *Journal of agricultural, environmental & Veterinary Sciences*, *8*(2), 10-24 https://doi.org/10.26389/AJSRP.E250424

Iraq, I. O. M. (2022). Migration, environment, and climate change in Iraq. *International Organization for Migration* (IOM). https://environmentalmigration.iom.int/sites/g/files/tmzbdl1411/files/documents/Migration%2C%20Environment%20and%20Climate%20Change%20in%20Iraq.pdf

Islam, M. S., & Tanaka, M. (2004). Impacts of pollution on coastal and marine ecosystems including coastal and marine fisheries and approach for management: A review and synthesis. *Marine Pollution Bulletin*, *48*(7–8), 624–649. https://doi.org/10.1016/j.marpolbul.2003.12.004

Issa, M. J., Al-Obaidi, B. S., & Muslim, R. I. (2020). Evaluation of some trace elements pollution in sediments of the Tigris River in Wasit governorate, Iraq. *Baghdad Science Journal*, *17*(1), 9–22. https://doi.org/10.21123/bsj.2020.17.1.0009

Jaishankar, M., Tseten, T., Anbalagan, N., Mathew, B. B., & Beeregowda, K. N. (2014). Toxicity, mechanism and health effects of some heavy metals. *Interdisciplinary Toxicology*, *7*(2), 60–72. https://doi.org/10.2478/intox-2014-0009

Katekar, V. P., & Deshmukh, S. S. (2021). Energy-drinking water-health nexus in developing countries. In Energy and Environmental Security in Developing Countries (pp. 411–445). *Springer*, *Cham*. https://doi.org/10.1007/978-3-030-63654-8_17

Khan, S., & Adeel, M. (2018). Assessment of heavy metal pollution and human health risk in drinking water sources: A case study from Pakistan. *Environmental Science & Pollution Research*, *25*(2), 1360–1372. https://doi.org/10.1007/s11356-017-0581-7

Kruger, S. N. (2011). A blue revolution: The global crisis of water quality and accessibility. *ESSAI*, *9*(1), 22. https://dc.cod.edu/essai/vol9/iss1/22

Kuna, G., Gullipalli, S., & Chintada, V. (2024). Health risks associated with cadmium toxicity. In *Cadmium Toxicity in Water*: *Challenges and Solutions* (pp. 47-60). Cham: Springer Nature Switzerland. https://doi.org/10.1007/978-3-031-54005-9_3

Lanphear, B. P., Hornung, R., Khoury, J., Yolton, K., Baghurst, P., Bellinger, D. C., ... & Roberts, R. (2005). Low-level environmental lead exposure and children's intellectual function: An international pooled analysis. *Environmental Health Perspectives*, *113*(7), 894–899. https://doi.org/10.1289/ehp.7688

McDowell, R. W. (2022). Assessing the leaching of cadmium in an irrigated and grazed pasture soil. *Environmental Pollution*, *292*(Part B), 118430. https://doi.org/10.1016/j.envpol.2021.118430

Mishra, R. K. (2023). Fresh Water availability and It's Global challenge. *Journal of Marine Science & Research*, *2*(1), 01–03. https://doi.org/10.58489/2836-5933/004

Mukherjee, I., Singh, U. K., Singh, R. P., Kumari, D., Jha, P. K., & Mehta, P. (2020). Characterization of heavy metal pollution in an anthropogenically and geologically influenced semi-arid region of east India and assessment of ecological and human health risks. *Science of the Total Environment*, *705*. https://doi.org/10.1016/j.scitotenv.2019.135801

Mulla, S., Ahmed, R., Singh, K. K., Singh, S. K., Deshmukh, N., & Inamdar, F. K. (2023). Climate change effect on climate parameters like temperature, rainfall and water resources sectors in India. *Climate Change Impacts in India* (pp. 9–59). https://doi.org/10.1007/978-3-031-42056-6_2

Oluwasanya, G., Omoniyi, A., Qadir, M., & Madani, K. (2025). Characterizing the gendered health burdens of poor water quality in the Global South. *Human and Ecological Risk Assessment*: *An International Journal*, 1–26. https://doi.org/10.1080/10807039.2025.2535630

Pandey, S., & Kumari, N. (2023). Impact assessment of heavy metal pollution in surface water bodies. *Metals in Water* (pp. 129–154). Elsevier. https://doi.org/10.1016/B978-0-323-95919-3.00004-5

SAS Institute Inc. (2003). SAS® 9.1 Language Reference: Concepts. Cary, NC: SAS Institute Inc. Retrieved from https://support.sas.com/documentation/onlinedoc/91pdf/sasdoc_91/base_langref_6972.pdf .

Schmitz, O. J., & Leroux, S. J. (2020). Food webs and ecosystems: Linking species interactions to the carbon cycle. *Annual Review of Ecology, Evolution, & Systematics*, *51*(1), 271–295. https://doi.org/10.1146/annurev-ecolsys-011720-104730

Rashid, A., Schutte, B. J., Ulery, A., Deyholos, M. K., Sanogo, S., Lehnhoff, E. A., & Beck, L. (2023). Heavy metal contamination in agricultural soil: environmental pollutants affecting crop health. *Agronomy*, *13*(6), 1521. https://doi.org/10.3390/agronomy13061521

Stefan, D. S., Bosomoiu, M. & Teodorescu, G. (2023). The behavior of polymeric pipes in drinking water distribution system—Comparison with other pipe materials. *Polymers*, *15*(19), 3872. https://doi.org/10.3390/polym15193872

Swaringen, B. F., Gawlik, E., Kamenov, G. D., McTigue, N. E., Cornwell, D. A., & Bonzongo, J. C. J. (2022). Children's exposure to environmental lead: A review of potential sources, blood levels, and methods used to reduce exposure. *Environmental Research*, *204*, 112025. https://doi.org/10.1016/j.envres.2021.112025

Verlicchi, P., Al Aukidy, M. & Zambello, E. (2015). What have we learned from worldwide experiences on the management and treatment of hospital effluent. An overview and a discussion on perspectives. *Science of the Total Environment*, *514*, 467–491. https://doi.org/10.1016/j.scitotenv.2015.02.020

World Health Organization. (2017). Guidelines for drinking-water quality (4th ed., incorporating the 1st addendum (pp. 631). https://www.who.int/publications/i/item/9789241549950

World Health Organization. (2022). Lead in drinking water: Health risks, monitoring and corrective actions: Technical brief. (pp.26). https://iris.who.int/server/api/core/bitstreams/83ed089d-b086-4ea1-9a9a-88efaf280415/content

Wu, L., Qi, T., Li, D., Yang, H., Liu, G., Ma, X. Y., & Gao, J. E. (2015). Current status, problems and control strategies of water resources pollution in China. *Water Policy*, *17*(3), 423-440. https://doi.org/10.2166/wp.2014.018

الكشف عن تلوث الرصاص والكادميوم في مياه نهر دجلة، محطات المياه، ومياه الحنفية في محافظة بغداد

زمن سعد العامري[١]، مهند فلحي حمود[٢]

[١،٢] فرع الصحة العامة، كلية الطب البيطري، جامعة بغداد، بغداد، العراق

المستخلص

الخلفية: تُعدُّ المعادن الثقيلة مثل الكادميوم (Cd) والرصاص (Pb) من أخطر الملوثات البيئية نظرًا لتأثيراتها السامة على البشر والكائنات الحية الأخرى، حتى عند التراكيز المنخفضة. هدفت هذه الدراسة، التي أجريت من شباط ٢٠٢٣ إلى كانون الثاني ٢٠٢٤، إلى تقييم مستويات تلوث المياه بالمعادن الثقيلة تحديدًا الكادميوم والرصاص - في مصادر مياه محافظة بغداد بما يشمل مياه الأنهار، ومحطات معالجة المياه، ومياه الصنبور. **المنهجية:** أُجريت هذه الدراسة بين شباط (فبراير) ٢٠٢٣ وكانون الثاني (يناير) ٢٠٢٤. تم جمع ١,٢٩٦ عينة مياه من ستة مواقع، وتم تحديد تراكيز الكادميوم والرصاص فيها. **النتائج:** كشفت البيانات البيئية عن ارتفاع مستويات الكادميوم والرصاص في المصادر المائية المحلية. سجلت مياه الأنهار أعلى متوسط لتركيز الرصاص ٠,٠٥٩) ملغم/ديسيلتر) تليها مياه الصنبور ٠,٠٥٢) ملغم/ديسيلتر) ثم المياه المعالجة من المحطات ٠,٠٤٣) ملغم/ديسيلتر). تجاوزت جميع القيم الحد الآمن لمنظمة الصحة العالمية البالغ ٠,٠١ ملغم/لتر. أما تراكيز الكادميوم فقد اتبعت نمطًا مشابهًا، سجلت مياه الأنهار أعلى متوسط تركيز ٠,٠٢٦) ملغم/ديسيلتر) تليها مياه الصنبور (٠,٠٤٤) ملغم/ديسيلتر)، ثم المياه المعالجة ٠,٠٣٦) ملغم/ديسيلتر) متجاوزةً جميعها الإرشاد العالمي لمنظمة الصحة العالمية ٠,٠٠٣) ملغم/لتر. **الاستنتاجات:** تشير هذه النتائج إلى وجود تلوث واسع النطاق، يُعزى على الأرجح إلى التصريفات الصناعية، والمياه الزراعية المسكوبة، وتدهور البنية التحتية. كما أظهرت التغيرات الموسمية أن مستويات الكادميوم بلغت ذروتها في الصيف ربما بسبب التبخر وانخفاض تدفق المياه، بينما سجلت مستويات الرصاص أعلى قيمها في الربيع.

الكلمات المفتاحية: الرصاص، الكادميوم، التلوث، مصادر المياه، محافظة بغداد، مياه النهر، محطات المعالجة، ماء الحنفية