Journal of Current Research and Studies

Volume 03 Issue 03 May-June 2026
https://journalcurrentresearch.com/
ISSN:3048-9911

OPEN ACCESS

***Correspondence**
Nserd Ntonoba Mfam

Article Received
04/05/2026
Accepted
09/05/2026
Published
09/05/2026

Works Cited

Nserd Ntonoba Mfam, Abeje Ntonoba Mfam & Mary Mathew, (2026). Health Implications of Heavy Metals Pollution in Well-water at Automobile Workshops Areas in Makurdi Metropolis-benue State, Nigeria. *Journal of Current Research and Studies*, 3(3), 55-64.

Health Implications of Heavy Metals Pollution in Well-water at Automobile Workshops Areas in Makurdi Metropolis-benue State, Nigeria

Nserd Ntonoba Mfam[1], Abeje Ntonoba Mfam[2], & Mary Mathew[3]

[1, 3] Department of Epidemiology and Community Medicine, Federal University of Lafia, P.M.B 146, Nasarawa State - Nigeria.

[2]Department of Botany, Joseph Sarwuan Tarka University, P.M.B 2373, Benue State - Nigeria.

Abstract

This quantitative study determined the heavy metal concentration in well-water (Wells) located within selected automobile workshops in Benue State. The concentration of different metals including lead (Pb), cadmium (Cd), iron (Fe), copper (Cu), zinc (Zn), manganese (Mn), arsenic (As), mercury (Hg), chromium (Cr), nickel (Ni) and cobalt (Co) were analyzed following proper digestion method described in the AOAC. All the metal contents were compared with the established permissible limit provided by NESREA, US-EPA, and WHO, and as reported by different authors. The concentrations of Pb, Cd, Fe, Cu, Mn, Cr and Ni from the experimental sites were significantly above the permissible limits for drinking water. Across all well-water samples in the automobile workshops, Fe > Cu > Zn > Cr > Mn > Pb > Cd > As > Hg, while in the control sample, Zn > Cu > Mn > Cr > Fe > Pb > Cd. In conclusion, the heavy metal accumulation levels of well water selected from experimental sites were slightly higher than their corresponding control sample, with most elements significantly higher than their respective permissible limits. 60.0% of the 11 heavy metals analyzed from the experimental sites were found to be above their permissible limits, while 58.3% of heavy metals in the control sample were above the permissible limits.

Keywords:

Health Implications; Well-water; Heavy metals; Pollution; Automobile Workshop

1. Introduction

Heavy metal pollution in the biosphere is now one of the most serious environmental concerns due to its severe long-term implications on human health and the environment (Ali et al., 2019; Mfam et al., 2023). Consequently, identifying areas with higher concentrations of heavy metals is crucial to the development of guidelines, effective legislation, and regulations. (Ogbeide & Henry, 2024)

Heavy metals are non-biodegradable and may amass in the ecosystem reaching unsafe proportions for human health. (Florea et al., 2020). The most common routes of human exposure to heavy metals in industrial and residential areas

are dermal, inhalation, and oral ingestions (food, water) (Năstăsescu et al., 2020). These heavy metals can cause toxicity if their allowable levels are surpassed. (Abdel-Rahman et al., 2019; Emmanuel et al., 2022).

The public is becoming conscious of the presence of heavy metals which is on a steady increase in the environment. (Tchounwou et al., 2012). The awareness of the effects of these contaminants in our foods, drinking water, and air is very important (Onyedikachi et al., 2018). This is because the ingestion of substances contaminated with heavy metals decreases the bioavailability of some essential nutrients. (Saikat et al., 2022). It can also deplete immunological responses, lead to gastrointestinal cancer, intrauterine growth retardation, impaired psycho-social facilities, and many other health effects (Choudhury, 2015).

Nigeria as a country, is one of the largest consumers of fairly used cars. This in turn increases the burden and cost of repairs and maintenance of these vehicles. Automotive service and repair workshops are the largest small-quantity generators of hazardous waste (Komolafe et al., 2019). Automobile workshops are known to churnout different types of waste in their day-to-day activities. (Abidemi, 2011). These include used oil and fluids, used vehicle parts, asbestos from brake pads, and waste from solvents used for cleaning. (Riyad et al., 2015; Richard, 2004). The importance of these metals as environmental health hazards is readily evident from the fact that they ranked in the top 10 on the Agency for Toxic Substances and Disease Registry priority list of hazardous substances (ATSDR, 2015; Alissa & Ferns, 2011).

In May 2010, in Northern Nigeria Zamfara State, many children were reported to have fallen sick, symptoms reported include; vomiting, abdominal pain, headaches, and seizures. Many of these children died. The cause was unknown and as such, a team from the CDC-Nigeria office in Abuja went in for investigation. Unsafe levels of lead were discovered in most of the homes and waters from the community wells. Children in the villages investigated were found to have dangerous levels of lead in their blood (CDC, 2016).

In this study, we assess the presence and concentration of heavy metals in Well-water in the two largest automobile workshops located in Makurdi - the capital of Benue State. The detected levels of the heavy metals in the selected Well-water will be compared with safety standards to determine their safety for food, medicine, or other purposes. Heavy metals under consideration include; arsenic (As), cadmium (Cd), copper (Cu), chromium (Cr), Cobalt (Co), Iron (Fe), lead (Pb), Manganese (Mn), Mercury (Hg), Nickel (Ni), and zinc (Zn).

2. Materials And Methods

Study Area

The study was conducted in Makurdi Local Government Area of Benue State Nigeria. Located in the Middle-belt region of Nigeria, it boasts of a population of about 6.1 million based on the 2022 census record. It occupies a total land area of 30,783 km2 and among the 11th largest state by land mass in the country. Benue State has its capital at Makurdi (City Population, 2024)

Selection of Sites

The study was carried out in Makurdi Local Government Area which is the largest urban and cosmopolitan city in the state (Fig. 1). Table 1 shows the longitude and latitudes of the experimental sites. Using purposive sampling, Automobile workshops in Makurdi with functional wells were selected for water sample collection. Four (4) automobile workshops sites in Makurdi were found to have functional wells, hence the study was limited to these sites namely – One (1) Automobile Workshop in North Bank Area and three (3) Automobile Workshop in New Garage Area.

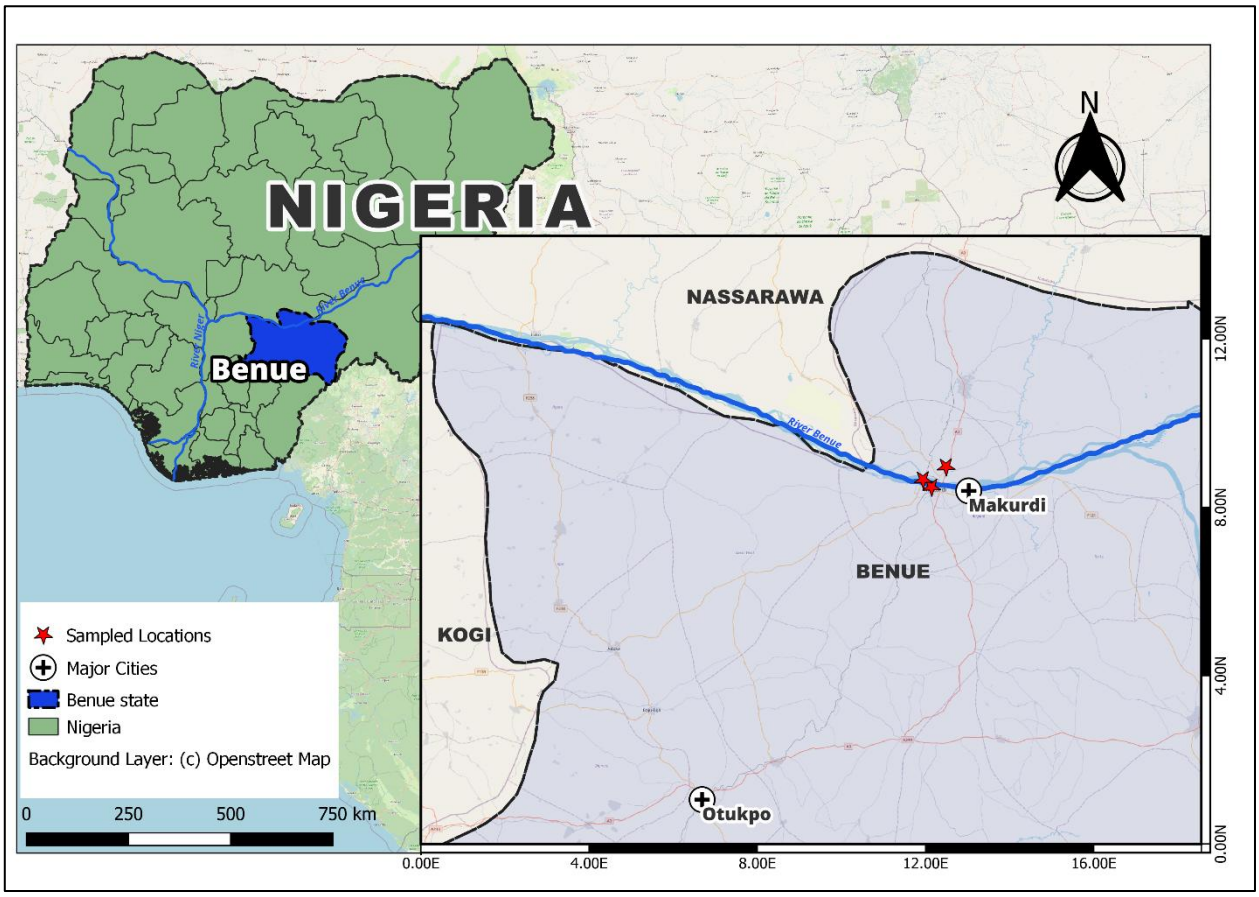

Figure 1: Map of Nigeria showing Benue State and study locations.

Source: Authors illustrations based on data from OpenStreetMap and Global Administrative Areas (GADM, 2022).

Table 1: Longitude and Latitude of Experimental Sites.

Location	Address	Latitude	Longitude
Makurdi	Automobile Workshop in North Bank	7.770421	8.55783
Makurdi	Automobile Workshop in New Garage 1	7.743646	8.51722
Makurdi	Automobile Workshop in New Garage 2	7.743765	8.51732
Makurdi	Automobile Workshop in New Garage 3	7.748064	8.51697

Sample Collection and Preparation for Elemental Analysis

The samples were collected in bottles. The bottles were pre washed, properly rinsed and left to dry. All samples were labelled appropriately and transported to the laboratory for elemental analysis. Plates 1-4 shows pictures of some of the sites from which samples were collected.

The control sample was taken from a private well in residential area (a kilometer away from the nearest Automobile workshop.)

Plate 1: A functional well in Automobile workshop in G.R.A 1, Makurdi showing abandoned vehicles and scraps.

Plate 2: A functional well in Automobile workshop in G.R.A 2, Makurdi showing abandoned vehicles wind screens and other scraps.

Plate 3: Automobile workshop in New Garage 3, Makurdi showing piles of decaying vehicle parts surrounding a functional well.

Plate 4: Automobile workshop at New Garage 3, Makurdi showing a functional well surrounded by vehicle scraps. Locals are reported to sometimes fetch this water for domestic use.

Laboratory Analysis

Sample digestion was done according to the method described by Association of Official Analytical Chemists (AOAC, 2015). Heavy metal concentrations were determined using Perk-Elmer Analyst AAS (Atomic Absorption Spectrophotometer).

3. Results and Discussion

Concentrations of Heavy Metals in Well water from Automobile Workshops in Makurdi.

Table 2 shows the concentrations of heavy metals in Well-water from Automobile workshops sites in Makurdi-Benue State. The concentrations of Pb, Cd, Fe, Cu, Mn, Cr and Ni from the four experimental sites were significantly above the permissible limits for drinking water. Total concentration of heavy metals in Well-water New Garage I (21.45mg/L) and Well-water New Garage II (20.94mg/L) were the highest concentrations of heavy metals across all samples (twice the total concentration of heavy metals in the control sample (10.09mg/L). Heavy metal contamination was highest in Well-water New Garage I (WWNG1), followed by Well-water New Garage II (WWNG2), Well-water New Garage III (WWNG3) and Well-water Northbank (WWNB). Across all well-water samples in the automobile workshops, Fe > Cu > Zn > Cr > Mn > Pb > Cd > As > Hg, while in the control sample, Zn > Cu > Mn > Cr > Fe > Pb > Cd. Mercury was not detected in WWNG3, WWNB and Control A while Arsenic was not detected in Control A sample alone.

Table 2. Concentrations of Heavy Metals in Well-water from Automobile Workshops and Residential sites in Makurdi.

Element	Well Water-NG 1 (mg/l)	Well Water-NG 2 (mg/l)	Well Water-NG 3 (mg/l)	Well Water-N/Bank (mg/l)	Control A (mg/l)	Control B (mg/l)	Control C (mg/l)	Control D (mg/l)	NESREA Pm-limits (mg/l)	US EPA Pm-limits (mg/l)	WHO Pm-limits (mg/l)
Pb	1.24	1.30	0.21	0.18	0.013	1.24	1.18	1.41	NS	0.05	0.05
Cd	1.21	1.25	0.19	0.15	0.01	1.19	1.16	1.30	0.003	0.005	0.003
Fe	7.13	6.56	0.66	0.63	0.67	6.90	7.10	7.40	0.30	0.30	0.30
Cu	3.61	3.58	3.10	2.83	2.28	3.50	3.30	3.65	NS	1.30	1.50
Zn	4.54	4.50	4.30	4.26	4.21	4.57	4.50	4.61	3.0	5.00	5.00
Mn	1.68	1.72	1.64	1.60	1.56	1.70	1.82	2.00	0.20	0.05	0.40
As	0.06	0.07	0.01	0.003	ND	0.08	0.05	0.10	0.01	0.05	0.01
Hg	0.016	0.02	ND	ND	ND	0.018	0.014	0.021	0.001	0.002	0.006
Cr	1.97	1.94	1.41	1.39	1.35	1.98	1.93	2.12	0.05	0.05	0.05
Ni	1.88	1.85	0.28	0.31	0.26	1.90	1.80	1.96	NS	0.02	0.10
Co	0.18	0.21	0.05	0.05	0.043	0.23	0.19	0.27	NS	0.05	0.01
Total Conc.	23.52	23.00	11.84	11.40	10.39	23.31	23.04	24.84			
No. of heavy metals above Pm-limits out of 11	10	10	9	7	6	10	9	10			

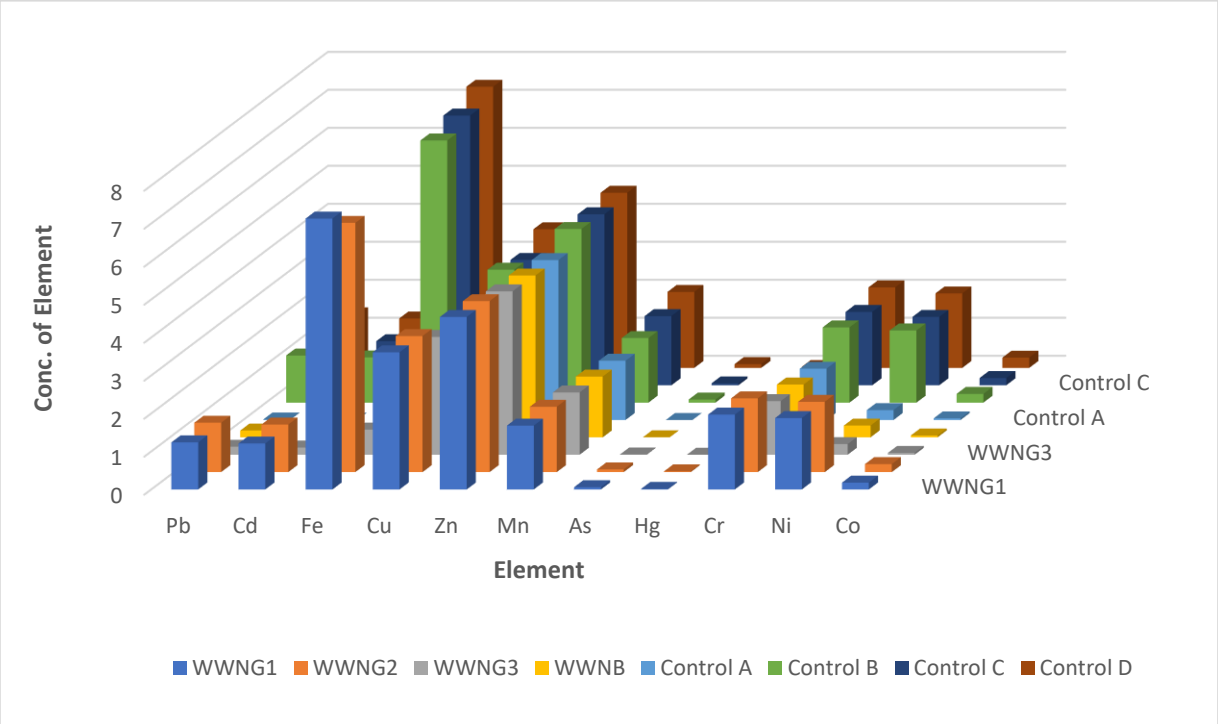

Figure 2. 3D Column showing 11 heavy metal concentrations across 8 analyzed samples in Makurdi.

4. Discussion

The elevated levels of heavy metals detected in well-water samples from automobile workshops can be traced to the activities of automobile workshop operators such as indiscriminate dumping of automobile scraps, engine oil, hydraulic oil and many other wastes which may have been released into the soils. The heavy metals subsequently seep into ground water around these workshops, leading to ground water contamination. The concentration of Pb across the automobile workshop wells was many times more than the WHO and US-EPA permissible limits, with WWNG1 being 24 times more than the permissible limits. This findings agree with Udongwo et al. (2022) and contrary to Usman et al. (2013) who reported lead with concentrations below WHO and NESREA permissible limits in automobile workshops. Possible sources of lead in water include motor batteries and other lead containing materials used by automobile workshop operators. Effects of lead levels above permissible limits can potentially affect children's brain development, resulting in reduced intelligence quotient (IQ), anaemia, hypertension, renal impairment, immune-toxicity and toxicity to the reproductive organs. The neurological and behavioural effects of lead are believed to be irreversible (CDC 2022 and WHO, 2023).

Cadmium (Cd), Iron (Fe), copper (Cu), chromium (Cr) and nickel (Ni) were detected above the NESREA, WHO and US-EPA permissible limits in all the well water samples. Cadmium can be released into the soil and subsequently ground water from Zinc smelting, waste batteries, paint sludge, incinerations & fuel combustion (Rashmi and Pratima, 2013). Usman et al. (2013) and Ibrahim et al. (2019) in their work, also reported cadmium concentration above WHO permissible limits. Cadmium can be released from steel, batteries and magnets (Carney, 2022). Iron content of the water may be as a result of waste generated which includes solvent, hydraulic fluid, spent lubricants most of which are dumped into the soil directly and are leached into underground water. Usman et al. (2013) recorded iron below WHO permissible limits. Adelekan and Abegunde (2011) also recorded copper concentrations above WHO permissible limits. Usman et al. (2013) recorded nickel below permissible limits. Zinc, although having the highest recorded concentration of all heavy metals analyzed, is below WHO and US-EPA permissible limits. This agrees with Ibrahim et al. (2019) who recorded zinc as having the highest heavy metal concentration in well water samples studied. Usman et al. (2013) also reported zinc with the highest concentration of all heavy metals analyzed in well water samples and exceeding WHO permissible limits. Arsenic was found to be below permissible in all water samples analyzed. Arsenic can be released into ground water via smelting operations, thermal power plants, and fuel spillage. Long-term exposure to arsenic from drinking-water and food can cause cancer and skin lesions. In utero and early childhood exposure has been linked to negative impacts on cognitive development and increased deaths in young adults (WHO, 2024) . Hence, exposure to it via drinking water or any other source pose a serious health threat to humans (Podgorski, 2020). Mercury (Hg) was detected in WWNG1 (0.016mg/L) and WWNG2 (0.02mg/L) but was not detected in WWNG3, WWNB and the Control sample. Usman et al. (2013) in his studies reported the presence of mercury but in very low concentrations and below WHO permissible limits. Cobalt was found below permissible limits. The disagrees with Udong et al. who in a 2022 study of Heavy Metal Contamination in Boreholes around Mechanic Workshops in Uyo Metropolis, Akwa Ibom State, reported cobalt above standard permissible limits). With the exception of a few elements in Control A, most of the elements in Control samples B, C and D where seen to have high heavy metal concentration levels as most of the automobile workshops. Generally, well water samples from Automobile workshops and Control samples were seen to have heavy metal concentrations that exceed the permissible limits. Higher heavy metal concentrations in well water located in automobile workshops than in those taken in residential areas has been reported (Gyanggyang & Gbaa, 2024). However, studies on water-bodies located away from automobile workshops such as rivers in Makurdi reveal high concentrations of heavy metals such as Cd, Cr and Pb. (Eneji et al., 2012). In this study, Iron (Fe) levels were significantly higher than permissible limits in all experimental and control site samples (range of 0.63-7.40mg/l). Forty percent (40%) of wells exhibit elevated iron concentrations above the WHO limits for drinking water. The presence of iron in residential wells may be traced to the local environment of the wells with respect to geology, dissolution of iron minerals from rocks and soil, precipitation and run offs. (Mile et al., 2012). Piwuna and Daku reported elevated residential well-water concentrations of As (mean: 28.10 mg/kg), Cd (25.68 mg/kg), Se (6.75

mg/kg), and Pb (16.93 mg/kg), mostly exceeding guideline limits set by the World

Health Organization (Piwuna & Daku, 2025). Cobalt is a very rare element, with only trace amounts in the Earth's crust (Barceloux, 1999) and may be the reason for its detection in very low levels. Elevated levels of these metals in Automobile workshops, relative to control samples, are likely due to activities at the workshops that release these metals into the environment. However, the geological peculiarities of Makurdi and environs significantly contribute to the high heavy metal concentrations in both Experimental and Control samples can be attributed to ((Piwuna & Daku, 2025).

5. Conclusion

Our study provides evidence that automobile workshops in the examined region have significant heavy metal contamination. 60.0% of the 11 heavy metals analyzed from the experimental sites were found to be above their permissible limits, while 58.3% of heavy metals in the control sample were also above the permissible limits. The uptake of these heavy metals by human beings and their subsequent bioaccumulation in human tissues, as well as their biomagnification through the food chain, raises substantial concerns for both human health and the broader environment. We hereby recommend the following:

1. Consumption of Well-water located within Automobile workshops for drinking and cooking purposes should be discouraged due to the posited heavy metal contamination in these wells.
2. It is safe to advice that wells meant for private and domestic consumption be sited a distance away from automobile workshops, especially for residential areas with a topographic gradient that favours seepage pressure and runoffs from automobile workshops.
3. Further studies should be carried out in more wells located in both residential areas and automobile workshops to throw more light on the findings of this study. Due to the rich deposits of some minerals in the soil as revealed in the control sample, studies should be carried out to ascertain the natural water and soil concentrations of heavy metals within Benue state and possibly the Middle-belt region of Nigeria. This is pivotal to the development of safety guidelines, legislation and regulations regarding water consumption within the region.

ACKNOWLEDGMENTS:

We acknowledge the technical support of Amali A. Amali, Institute for Technology and Resources Management in the Tropics and Subtropics, Technische Hochschule Koln – Cologne University of Applied Sciences, Germany.

GRANT SUPPORT DETAILS

The present research did not receive any financial support.

CONFLICT OF INTEREST

The authors declare that there is not any conflict of interests regarding the publication of this manuscript. In addition, the ethical issues, including plagiarism, informed consent, misconduct, data fabrication and/ or falsification, double publication and/or submission, and redundancy has been completely observed by the authors.

LIFE SCIENCE REPORTING

No life science threat was practiced in this research.

References

1) Abidemi, Olayiwola. (2011). Levels of Pb, Fe, Cd and Co in Soils of Automobile Workshop in Osun State, Nigeria. Journal of Applied Science Environ. Management, 15(2), 279 – 282.
2) Adelekan, B. A. & Abegunde K. D. (2011). Heavy metals contamination of soil and groundwater at automobile mechanic villages in Ibadan, Nigeria. International Journal of the Physical Sciences, 6(5), 1045-1058.

3) Ali, H., Khan, E., & Ilahi, I. (2019). Environmental Chemistry and Ecotoxicology of Hazardous Heavy Metals: Environmental Persistence, Toxicity, and Bioaccumulation. Journal of Chemistry, (4), 1-14. https://doi.org/10.1155/2019/6730305
4) Alissa, E. M., & Ferns, G. A. (2011). Heavy metal poisoning and cardiovascular disease. Journal of toxicology, 2011:870125. https://doi.org/10.1155/2011/870125
5) AOAC. (2015). Official Methods of Analysis Association. Association of Official Analytical Chemists, (18th Edition), AOAC, Arlington, 806-814.
6) ATSDR (2015). Cercla Priority List of Harzardous Substances. Retrieved from https://www.atsdr.cdc.gov/spl/index.html
7) Barceloux D. G. (1999). Cobalt. Journal of toxicology. Clinical toxicology, 37(2), 201–206.
8) CDC (2016). Lead poisoning Investigation in Northern Nigeria. Retrieved from https://www.cdc.gov/onehealth/in-action/lead-poisoning
9) CDC (2022). National report on human exposure to environmental chemicals. Updated March 2022. Retrieved from https://www.cdc.gov/exposurereport/.
10) City Population (2023). Benue-State in Nigeria. Retrieved from https://www.citypopulation.de/en/nigeria/admin/NGA007__benue/ (accessed Dec 11, 2023).
11) Carney D. (2022). How the Auto Industry Will Get Enough Cobalt for the EV Revolution. Retrieved from https://www.designnews.com/automotive-engineering/how-auto-industry-will-get-enough-cobalt-ev-revolution.
12) Choudhury, Tasrina. (2015). Heavy Metals Contamination in Vegetables and its Growing Soil. Environmental Analytical Chemistry. 2, 10.4172/2380-2391.1000142.
13) Emmanuel, U. C., Chukwudi, M. I., Monday, S. S., & Anthony, A. I. (2022). Human health risk assessment of heavy metals in drinking water sources in three senatorial districts of Anambra State, Nigeria. Toxicology reports, 9, 869–875. https://doi.org/10.1016/j.toxrep.2022.04.011
14) Eneji, I. S., Sha'Ato, R., & Annune, P. A. (2012). An assessment of heavy metals loading in River Benue in the Makurdi metropolitan area in Central Nigeria. Environmental monitoring and assessment, 184(1), 201–207. https://doi.org/10.1007/s10661-011-1959-0
15) Florea, Alexandru. (2020). Investigation of pesticide residues and heavy metals content in various peppermint samples. farmacia. 68:704-709. 10.31925/farmacia.2020.4.16.
16) GADM (2022). Database of Global Administrative Areas, version 4.1. [online] URL: www.gadm.org (last accessed 02 October 2023).
17) Gyanggyang, M. I., & Gbaa, S. (2024). Heavy Metal Concentration in Groundwater in Some Selected Automobile Mechanic Villages in Makurdi, Nigeria. International Journal of Research Publication and Reviews, 5(1), 2211–2221. https://doi.org/10.55248/gengpi.5.0124.0243
18) Ibrahim, D., Abdullahii, S. U., Adamu, I. U., Dazi, L. L., Salihu, A. I., & Simon, I.A (2019). Heavy Metal Contamination of Soil And Ground Water At Automobile Mechanic Workshops In Borno State, Nigeria. Nigerian Research Journal of Chemical Sciences, 7:197-213.
19) Komolafe, O.Y., Banjo, A.A. & Arijeniwa, O.C (2019). Assessment of Heavy Metal Concentration in Soil and Water Samples from Automobile Mechanic Workshops in Owo, Ondo State, Nigeria. International Journal of Interdisciplinary Innovative Research and Development, 4(1) 2019.
20) Mfam A. N., Aguoru C. U., Ogbonna I. O., Okoh T., Olasan J. O. & Mfam N. N. (2023). Heavy metal contamination in soils at Automobile Workshops in Benue State, Nigeria. International Journal of Recent Research in Life Sciences. 10(4):9-18.
21) Mile, I.I., Dagba, B.I., Jande, J.A. (2012). Iron Contamination of Shallow Wells in Makurdi Urban Area, Benue State, Nigeria. Pakistan Journal of Chemistry, 2(2), 68-70. https://doi.org/10.15228/2012.v02.i02.p03
22) Năstăsescu, V., Magdalena, M., Goumenou, M., Anca Oana, D., Renieri, E., Udeanu, D., Oprea, E., Arsene, A., Dinu-Pîrvu, C., & Ghica, M. (2020). Heavy metal and pesticide levels in dairy products: Evaluation of human health risk. Food and Chemical Toxicology. 146. 111844. 10.1016/j.fct.2020.111844.
23) Ogbeide O.,& Henry, B.(2024). Addressing Heavy Metal Pollution in Nigeria: Evaluating Policies, Assessing Impacts, and Enhancing Remediation Strategies. J. Appl. Sci. Environ. Manage. Vol. 28 (4) 1007-1051.

24) Onyedikachi, U., Belonwu, C.,& Wegwu, M. (2019). Health Risk Assessment of Chromium, Manganese and Arsenic through the Consumption of Food from Industrial Areas in South Eastern States of Nigeria. Annual Research & Review in Biology, 31(6), 1-20. https://doi.org.10.9734/arrb/2019/v31i630067
25) Piwuna R.M & Daku S. S. (2025). Assessing Heavy Metal Contamination in Parts of Middle Benue Trough, Central Nigeria: Implications for Public Health and Environmental Safety. Journal of Pure and Applied Sciences (Science Forum), 25(2), 16-36.
26) Podgorski, J., & Berg, M. (2020). Global threat of arsenic in groundwater. Science (New York, N.Y.), 368(6493), 845–850. https://doi.org/10.1126/science.aba1510
27) Rashmi V. & Pratima D. (2013). Heavy metal water pollution - A case study. Journal of Recent Research in Science and Technology, 5(5): 98-99. ISSN: 2076-5061.
28) Richard A. L. (2004). Asbestos in Brakes Exposure and Risk of Disease. American Journal of Industrial Medicine 45: 229-237.
29) Riyad Al-Anbari, Abdul Hameed M.J. AI Obaidy, Fatima H. Abd Ali (2015). Pollution Loads and Ecological Risk Assessment of Heavy Metals in the Urban Soil Affected by Various anthropogenic Activities. International Journal of Advanced Research, 3(2), 104-110.
30) Saikat M., Arka J. C., Abu M. T., Talha B. E., Firzan N., Ameer K., Abubakr M. I., Mayeen U. K., Hamid O., Fahad A. Alhumaydhi, J. S. (2022). Impact of heavy metals on the environment and human health: Novel therapeutic insights to counter the toxicity.Journal of King Saud University - Science, 34 (3); 101865.
31) Tchounwou, P.B., Yedjou, C.G., Patlolla, A.K.,& Sutton, D.J. (2012). Heavy Metal Toxicity and the Environment. In: Luch, A. (eds) Molecular, Clinical and Environmental Toxicology. Experientia Supplementum, vol 101. Springer, Basel. https://doi.org/10.1007/978-3-7643-8340-4_6
32) Usman, A. A., Odoma, A. N., & Ozulu, G. U. (2013). Heavy Metals Concentration in Ground Water caused by Automobile Workshop Activities and its Health Implication on the Inhabitants of Makurdi Metropolis, Nigeria. International Journal of Health and Medical Information, 2(2), 36-46.
33) Udongwo A. M., & Sambo D. D. (2022). Assessment of Heavy Metal Contamination in boreholes around Mechanic Workshops in Uyo metropolis, Akwa Ibom State, Nigeria. J. Chem. Soc. Nigeria, 47(4), 931 – 942.
34) WHO (2023). Lead poisoning. Retrieved from http://www.who.int.
35) WHO (2024). Arsenic. Retrieved from https://www.who.int/news-room/fact-sheets/detail/arsenic#:~:text=Long%2Dterm%20exposure%20to%20arsenic,increased%20deaths%20in%20young%20adults.