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# Assessment of Water use Trends, Usage Frequency, and Heavy Metals Contamination in Elemi and Ogbese Rivers in Ado-Ekiti, Ekiti State

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**Abstract**
*Heavy metal levels in Elemi and Ogbese Rivers surpass WHO standards, endangering community health. Limited awareness, linked to education gaps, increases exposure risks. Urgent action is needed to improve water safety and public health awareness. Hence, this study investigated water usage trends and heavy metal contamination in Elemi and Ogbese Rivers in Ado-Ekiti, Nigeria. Data on demographic characteristics were collected through a guided questionnaire administered to 150 adults each, aged 18-55, from the two communities. Metals (Hg, Cr, Pb, Zn, Co, Cd) analyses in the water samples were carried out using Atomic Absorption Spectroscopy AAS. Statistical analysis was performed with IBM SPSS 29 with significance at $p<0.05$. The study revealed significant differences in educational levels and employment status between the two communities, with Elemi having higher frequencies than Ogbese in both parameters. The frequency of water usage showed that Ogbese consumed a higher daily water intake (12%) than Elemi (6%), a marker for a potentially increased susceptibility to contaminant contact through frequent water use. Education and occupation significantly influenced water usage in both rivers, while gender significantly influenced water usage in the Ogbese River only. There was higher awareness of heavy metal pollution in Elemi (36.0%) compared to Ogbese (10.0%). However, awareness of heavy metal pollution and effluent discharge is significantly correlated to education. Mean metal concentrations in Ogbese River and Elemi River were higher than the WHO recommended values, indicating a possible health hazard for communities that rely on these rivers. Low community awareness of heavy metal contamination poses significant public health risks, as river concentrations exceed WHO standards. Educational disparities affect awareness and water usage behaviours, emphasising the need for targeted interventions. Regulatory measures are necessary to control effluent discharge into rivers, Ongoing environmental monitoring is crucial for sustained protection. Community engagement remains key to safeguarding public health and ecosystems.*
**Keywords:** *Environmental pollution, Public health, Community awareness, heavy metals, Water usage.*

## INTRODUCTION

The proliferation of heavy metal ions, which have hazardous qualities, in water bodies has arisen as a major global concern in recent years. Major sources of heavy metal contamination include industrial discharges, agricultural runoff, and waste management (Alengebawy *et al*., 2021; Afzaal *et al*., 2022). Agricultural activities contribute to pollution through the use of fertilisers, pesticides, and sewage sludge containing heavy metals (Srivastava *et al*., 2017). Heavy metals such as lead (Pb), cadmium (Cd), mercury (Hg), arsenic (As), and chromium (Cr) are commonly found in the environment as a result of human activities and inappropriate waste management (Singh *et al*., 2023). Heavy metals' toxicity, non-biodegradability, biological accumulation, and carcinogenic nature, which endangers both the aquatic ecosystem and human health, make their global presence in water a major environmental problem. This widespread problem of heavy metal contamination in water poses a substantial threat to environmental sustainability and public health (Pandit *et al*., 2023). Therefore, it is crucial to reduce heavy metals in water to mitigate their detrimental impacts on the environment.

Contamination accumulates in water and biota, and brings about contact and harmful consequences in humans. Long-term exposure to heavy metals brings about a range of ailments, such as neurological impairment, kidney impairment, and forms of cancer (Lentini *et al*., 2017). Therefore, there is a need for continuous assessment of water bodies, and proper regulatory actions are initiated in order to combat metal pollution in our aquatic resources.

The Elemi and Ogbese Rivers play significant roles in the lives of the communities living around the rivers in that they are useful for farming, fishing, irrigation, washing, bathing, recreation, and cooking. The anthropogenic activities around the rivers constitute potential sources of heavy metals to the rivers, which in the long run may affect human and aquatic ecosystems as a result of the bioaccumulation and toxicity of the heavy metals.

Although Elemi and Ogbese Rivers are vital to the surrounding communities, limited research has been conducted on water usage patterns and heavy metal contamination in these rivers. Understanding water usage trends and evaluating heavy metal concentrations is essential for informing effective public health interventions and safeguarding the quality of these critical water sources. Therefore, this study aimed to assess water usage behaviours in the communities and determine the concentrations of heavy metals in Elemi and Ogbese Rivers.

## MATERIALS AND METHODS

### *Collection of Data for demographic characteristics and water consumption frequency*

One hundred and fifty structured questionnaires showing demographic characteristics and water consumption frequency of the population were administered to the communities (Ogbese and Elemi). The study was carried out during the rainy season (August to October).

Ethical clearance was obtained from the ethical review board (College of Science, ABUAD) before the commencement of data collection and was assigned the number: CSREC/M-15/24. Informed consent was obtained from all study participants after enlightening them on the purpose of the research.

### *Water Sample Collection and Metal Analysis in Water*

One litre of water was collected from the downstream of the river Elemi and the Ogbese River in an acidified bottle. The collected water samples were filtered using a Whatman no.1 (0.45 mm) filter paper. Five millilitres of concentrated $H_2SO_4$ was added to a 100 ml water sample in a conical flask and heated for about two hours at 105°C until the volume reached 25 ml. The sample was then transferred to a 100 ml volumetric flask. Deionised $H_2O$ was gradually added to the flask until it reached 100 mL of volume of the sample. The sample solution was kept in a well cleaned analytical bottle with label until metal analysis (Pandiyan *et al.,* 2020*;* Adebayo, 2017).

The metal concentrations in water were determined using an Atomic Absorption Spectrometer Buck Scientific model 211 VGP, following APHA 20th Edition 3111B, 3111D, ASTM D3561, and ASTM D5198 standards.

The equipment was calibrated with working standards of a definite concentration in a view to get a calibration curve. The concentration of metal in samples was measured by aspirating samples in a digested state directly into a flame. The following metals were analysed in water: Metals analyzed were Cadmium (Cd), Cobalt (Co), Chromium (Cr), Mercury (Hg), Lead (Pb), Zinc (Zn).

Pearson Chi-square test was used to determine the association between factors using IBM SPSS Version 29.0.2.0 (20). P-values ≤ 0.05 were regarded as statistically significant.

## RESULTS

### *Sociodemographic Distribution of Respondents*

The respondents' age ranges from 18 – 60 years in both communities, with a mean of 34.5 years in Elemi and 34.1 years in Ogbese, a modal age range of 25 – 35 years respectively in both communities. The majority of the respondents are female (52% in Elemi and 50% in Ogbese). 75.4% and 49.3% were educated in Elemi and Ogbese, respectively. Also, occupation ranges from students to traders in both communities (Table 1). The relationship between awareness of heavy metals and effluent discharge and the educational levels of respondents were statistically significant ($p < 0.05$) (Table 3).

**Table 1:** Descriptive analysis of respondents from Elemi and Ogbese rivers

| Demographic Variable | Category | Elemi (n = 150) | % | Ogbese (n = 150) | % |
|---|---|---|---|---|---|
| Age (Years) | 18-24 | 37 | 24.7% | 34 | 22.7% |
| | 25-35 | 44 | 29.3% | 52 | 34.7% |
| | 36-44 | 39 | 26.0% | 43 | 28.7% |
| | 45-54 | 28 | 18.7% | 14 | 9.3% |
| | 55 or older | 2 | 1.3% | 7 | 4.7% |
| | Total | 150 | 100% | 150 | 100% |
| Gender | Male | 72 | 48.0% | 65 | 43.3% |
| | Female | 78 | 52.0% | 75 | 50.0% |
| | Prefer not to say | 0 | 0.0% | 10 | 6.7% |
| | Total | 150 | 100% | 150 | 100% |
| Education Level | No formal education | 1 | 0.6% | 34 | 22.7% |
| | Primary School | 7 | 4.7% | 9 | 6.3% |
| | Secondary School | 27 | 18.0% | 19 | 12.7% |
| | Vocational Training | 36 | 24.0% | 42 | 28.0% |
| | Bachelor's Degree | 57 | 38.0% | 32 | 22.3% |
| | Master's Degree | 22 | 14.7% | 12 | 8.0% |
| | Total | 150 | 100% | 150 | 100% |
| Occupation | Student | 36 | 24.0% | 42 | 28.0% |
| | Employed | 76 | 50.7% | 19 | 12.7% |
| | Self-employed | 7 | 4.7% | 54 | 36.0% |
| | Unemployed | 18 | 12.0% | 5 | 3.3% |
| | Entrepreneur | 1 | 0.7% | 12 | 8.0% |
| | Trader | 25 | 16.7% | 5 | 3.3% |
| | Total | 150 | 100% | 150 | 100% |

**Table 2:** Association between Age Occupation, Gender and Education to Water usage in Elemi and Ogbese

| Demographic Indices | Pearson Chi Square | |
|---|---|---|
| | Elemi | Ogbese |
| Age | $\chi^2 = 17.476$ | $\chi^2 = 15.641$ |
| | P = 0.355 | P = 0.478 |
| Occupation | $\chi^2 = 60.970$ | $\chi^2 = 39.378$ |
| | P =0.001* | P =0.006* |
| Gender | $\chi^2 = 4.957$ | $\chi^2 = 35.120$ |
| | P =0.292 | P =0.029* |
| Education | $\chi^2 = 31.905$ | $\chi^2 = 51.053$ |
| | P =0.044 | P =0.001* |

**Table 3:** Association between awareness of Heavy metal and Effluent discharge in Elemi and Ogbese with level of Education

| Parameter | Pearson Chi-Square | |
|---|---|---|
| | Elemi | Ogbese |
| Heavy Metal | $\chi^2 = 31.142$ | $\chi^2 = 31.851$ |
| | P = 0.008 | P = 0.001 |
| Effluent | $\chi^2 = 22.995$ | $\chi^2 = 26.924$ |
| | P = 0.011 | P = 0.029 |

**Table 4:** Heavy metals level in Ogbese and Elemi river

| Characteristics | | Elemi | Ogbese | |
|---|---|---|---|---|
| Water | | | | |
| | Never | 67(44.7) | 51(34.0) | |
| | Rarely | 50(33.3) | 42(28.0) | |
| | Monthly | 10(6.7) | 25(16.7) | $X^2 = 28.013$ |
| | Weekly | 14(9.3) | 14(9.3) | P = 0.032 |
| | Daily | 9(6.0) | 18(12) | |

### *Water Sample*

Heavy metals presence in Ogbese River, Cd, Cr, Hg and Pb are 0.036mg/L, 0.190 mg/L, 0.298mg/L and 0.195mg/L respectively during the sampling period, while Elemi River had the values of Cd, Cr, Hg and Pb to be 0.067mg/L, 0.211mg/L, 0.328mg/L and 0.172mg/L respectively during the sampling period. The trend of metal concentrations in Ogbese River is Zn > Hg > Pb > Cr > Cd > Co, while in Elemi River, the trend is Zn > Hg > Cr > Pb > Cd > Co. However, there was no statistical difference between the Rivers (Table 4).

**Table 4:** Heavy metals level in ogbese and elemi river

| Month | | Heavy Metals | | | | | |
|---|---|---|---|---|---|---|---|
| | | Cd(mg/L) | Co(mg/L) | Cr(mg/L) | Hg(mg/L) | Pb(mg/L) | Zn(mg/L) |
| August | Ogbese | 0.019 ± 0.001 | 0.036 ± 0.002 | 0.162 ± 0.010 | 0.261 ± 0.020 | 0.195 ± 0.001 | 0.522 ± 0.003 |
| | Elemi | 0.046 ± 0.000 | 0.022 ± 0.001 | 0.212 ± 0.020 | 0.342 ± 0.033 | 0.145 ± 0.010 | 0.351 ± 0.020 |
| September | Ogbese | 0.054 ± 0.002 | 0.042 ± 0.001 | 0.215 ± 0.020 | 0.319 ± 0.020 | 0.267 ± 0.002 | 0.578 ± 0.005 |
| | Elemi | 0.091 ± 0.002 | 0.067 ± 0.003 | 0.281 ± 0.002 | 0.392 ± 0.003 | 0.213 ± 0.020 | 0.431 ± 0.040 |
| October | Ogbese | 0.036 ± 0.001 | 0.018 ± 0.001 | 0.192 ± 0.010 | 0.314 ± 0.030 | 0.124 ± 0.001 | 0.291 ± 0.020 |
| | Elemi | 0.064 ± 0.002 | 0.046 ± 0.002 | 0.141 ± 0.010 | 0.25 ± 0.002 | 0.16 ± 0.010 | 0.451 ± 0.002 |
| Mean monthly values | Ogbese | 0.036 ± 0.000 | 0.032 ± 0.001 | 0.190 ± 0.010 | 0.298 ± 0.022 | 0.195 ± 0.011 | 0.463 ± 0.004 |
| Mean monthly values | Elemi | 0.067 ± 0.003 | 0.045 ± 0.002 | 0.211 ± 0.020 | 0.328 ± 0.030 | 0.172 ± 0.010 | 0.411 ± 0.033 |
| | NAFDAC | 0.003 | 0.07 | 0.05 | 0.006 | 0.01 | 5 |
| | WHO | 0.003 | 0.07 | 0.05 | 0.006 | 0.01 | 3.0 |
| | | Elemi > Ogbese | Elemi > Ogbese | Similar | Elemi > Ogbese | Ogbese > Elemi | Ogbese > Elemi |

Values expressed as mean ± SEM (n=5),
ns = no significant difference

## DISCUSSION

### *Demographic Characteristics and Water Usage*

The findings affirm that water is universally required across all occupational groups, aligning with the widely accepted saying that "water is life". People in Nigeria still rely on river water rather than portable water. This aligns with previous studies by Omole *et al*. (2010); Ngene *et al*. (2021) who reported that water is a vital requirement for human existence.. Similarly, Kola-Olusanya *et al*. (2023) reported that a large portion of the water required for household, agricultural, and industrial operations is supplied by Rivers, lakes, and other surface water resources. The significant relationship between gender and water usage in Ogbese could be linked to the fact that Ogbese is a local settlement and most of the people living around the area are predominantly farmers (male and female) who depend solely on the water from this river, it can also be linked to accessibility to clean portable water. This finding aligns with the report of Bennett *et al*. (2008) that fresh water is a finite and sensitive resource, vital to maintain life, development and the environment. This study highlights the critical role of education in shaping water usage behaviours, suggesting that higher levels of education are closely linked to more informed choices of water sources, as well as more responsible practices in water use and management. This is in agreement with the previous study by Muhamad & Ingo (2024), who reported that water education is learning about the origin, uses, and correct management of water to ensure its safety for both human use and the environment.

Also, the level of literacy impacts the awareness level of heavy metal pollution by people dwelling in both communities, indicating that individuals with higher education are more likely to be informed about heavy metal contamination. This is in contrast to the previous study by Kola-Olusanya *et al*. (2023) who asserted that education does not improve the level of awareness and attitude toward water pollution prevention and conservation in Nigeria. The significant negative relationship observed between effluent discharge and education levels suggests that individuals with higher education are more aware of the harmful impacts of effluent discharge on human health and the environment, and are therefore less likely to engage in practices that contribute to river pollution. This is in alignment with a previous study by Yordanova *et al.* (2022), who recommended education against effluent discharge as a measure to prioritize pollution prevention and protect the quality of natural and drinking water.

The level of cadmium (Cd), chromium (Cr), cobalt (Co) and mercury (Hg) concentration at the time of this study was higher than the WHO (2011) permissible limits in Ogbese and Elemi rivers. Similar reports of heavy metals with higher concentrations than the recommended values have been reported by other researchers in water bodies in Ekiti State and the Southwest, Nigeria (Adesiyan *et al*., 2018; Olagbemide and Owolabi, 2023). These higher values may be due to anthropogenic activities such as farming and its accompanying operations since agriculture provides employment for more than 75% of the populace in Ekiti State (Kolawole *et al*., 2017). Elevated heavy metal levels in both rivers indicate that the water in the Rivers may not be suitable for human consumption.

This study highlights the relationship between demographic factors and water usage, awareness of heavy metals and effluent discharge with education. a significant association was observed between demographic variables (occupation and education) and water usage at both communities, except for gender, which was only significant for water usage in Ogbese. Awareness of heavy metal and effluent discharge in both rivers was significantly associated with the level of education. The observed level of heavy metals present in Elemi and Ogbese Rivers in Ekiti State, Nigeria was higher than WHO (2011) permissible level. This necessitates a definite positive strategy to be employed to safeguard against further deterioration of these aquatic resources as well as the protection of the health of the users.

## RECOMMENDATION

i. Continuous monitoring of heavy metal levels in the Ogbese and Elemi rivers is required.
ii. Prioritize educational programs to improve public health and wellness.
iii. Provide alternative water sources for those living near the Ogbese River.
iv. Implement environmental remediation strategies like phytoremediation and waste management to reduce heavy metal pollution.

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