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Contamination and risk assessment of heavy metals in water and fish obtained in Bunza River in Kebbi State, Nigeria

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Abstract

Background: Fish are consumed worldwide due to their nutritional and health benefits; however, heavy metal pollution is compromising their safety. This study aimed to determine heavy metal safety in water and fish, specifically tilapia (*Oreochromis niloticus*) and catfish (*Clarias gariepinus*), collected from Bunza River in Kebbi State, Nigeria.

Methods: Water and fish samples underwent analysis for zinc (Zn), cadmium (Cd), copper (Cu), and lead (Pb) using atomic absorption spectroscopy. The obtained values were then utilized to assess the associated health risks.

Results: The atomic absorption spectroscopy of fish revealed significant differences ($P < 0.05$) between heavy metal concentrations in the fish organs and FAO/WHO standards. It indicated non-tolerable concentrations of copper (1.77-5.24 mg kg^{-1}) and lead (1.85-4.53 mg kg^{-1}). The estimated daily intake (*EDI*) of Pb and Cd through fish consumption was above the recommended daily intake (*RDI*). However, the hazard quotient (*HQ*) and health risk index (*HI*) of all the heavy metals were within tolerable limits (< 1). On water samples, non-tolerable levels of the heavy metals and significant differences ($P < 0.05$) were observed when compared with the standards. The water samples had average concentrations of Cu (4.64 ± 0.62 mg kg^{-1}), Pb (1.78 ± 0.70 mg kg^{-1}), Cd (0.50 ± 0.02 mg kg^{-1}), and Zn (18.90 ± 3.08 mg kg^{-1}). The average daily ingestion (*ADI*) and *HQ* of the heavy metals through the consumption of the water were above the recommended limits.

Conclusion: Based on the results, the fish and water samples could cause heavy metal-related toxicity. There is a need for policies aimed at decontaminating the river.

Keywords: Atomic absorption spectroscopy, Catfish (*Clarias gariepinus*), Estimated daily intake, Health risk index, Heavy metals

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Introduction

Fish consumption is widespread globally, to the extent that it is currently competing with beef as a staple food (1). This is attributed to its numerous nutritional and health benefits (2). Fish contains vitamins, proteins, omega-3 fatty acids, and various minerals (3,4). Furthermore, fish play a crucial role in the global economy, with many individuals relying solely on the fisheries industry for their income (5,6). In Nigeria, approximately 1.5 million people are employed in the fisheries sector, contributing over 1.0% to the national gross domestic product (GDP) in 2020 and 2021 (7). From a health perspective, regular fish consumption promotes glucose homeostasis, thyroid health, body weight maintenance, muscle mass preservation, and reduces the risk of diabetes mellitus, aging-induced high blood pressure, cardiovascular diseases, and metabolic syndrome (8,9). Fish are also utilized in ethnomedicine to treat parasitic and infectious diseases, as well as to manage pregnancy, delivery, and post-delivery (10). In Nigeria, aside from the nutritional and economic benefits, fish are integral to traditional healings, festivals, rituals, ceremonies, and sacrifices (11,12).

Unfortunately, anthropogenic activities such as industrial, urban, and population growth are polluting water bodies and resources globally, jeopardizing the benefits of fish (13). Harmful compounds, particularly heavy metals such as chromium (Cr), lead (Pb), arsenic (As), cadmium (Cd), and copper (Cu), pollute water bodies and accumulate in aquatic organisms like fish, crabs, crayfish, mollusks, and prawns (14,15). Heavy metals in fish induce oxidative stress, weakening the immune system and causing tissue and organ damage, growth defects, and a reduction in reproductive ability (16). Through the consumption of fish, heavy metals present in the fish tissues directly transfer to the human body, causing toxic effects and potentially expediting various diseases (17). Heavy metals, known for their toxicity, persistence, biodegradability, and accumulative nature, have been implicated in mutagenic, cytotoxic, and carcinogenic effects (18-21). Consequently, there has been a growing interest in determining the risk of heavy metals in water bodies and resources worldwide, including fish. This is crucial to prevent or reduce heavy metal-related morbidity and mortality resulting from fish consumption.

In Nigeria, the Bunza River in Kebbi State is a hub of activities, with intense fishing taking place year-round. Some fish are consumed or sold locally to bridge nutritional gaps, while others are sold to people from other towns in the state, and also, to other states in the country. Fishing on the river provides a livelihood for some inhabitants, and water from the river is used for drinking and domestic purposes. However, farming, bathing, washing, and open waste dumping and defecation occur in and around the river, posing a potential threat to its pollution and contamination of aquatic organisms. Surprisingly, literature searches reveal that the safety of fish and water from the river has not been assessed recently. This assessment becomes even more crucial in light of earlier studies by Anthony et al (22), Zanna et al (23), and Yahaya et al (24), all of whom reported heavy metal pollution in some other rivers in Kebbi State. Notably, these studies did not evaluate the associated health risks of heavy metals in the rivers, which could have contributed to raising public awareness in Kebbi State. Moreover, the Bunza River discharges directly into the Niger River, providing numerous ecosystem services to several states across Nigeria. Therefore, the contamination of Bunza River, if not monitored and controlled, may have a cascading effect across the country. Therefore, this study aimed to assess the heavy metal safety of fish and water samples obtained from the Bunza River in Kebbi State, Nigeria.

Materials and Methods

Description of the study area

River Bunza is located in Bunza town in the Bunza Local Government Area of Kebbi State, Nigeria (Figure 1). Kebbi State is located between latitude 11.4942° N and longitude 4.2333° E in the northwest region of the country (25). The state lies between Niger State (its southern border) and Sokoto State (its northern border) and has Zamfara in its eastern part. The state is populated mainly by Hausa, Fulani, Zuru, Yoruba, Igbo, and other ethnic nationalities. Kebbi State experiences tropical weather conditions such as wetness, coldness, and harmattan. It has a few months of rain, from June to September. The temperature could fall below 20 ºC during harmattan and could be as high as 45 ºC during hot weather (26). The vegetation is Sudan savannah grassland, shrubs, and umbrella-shaped trees. The indigenous people of Kebbi are predominantly farmers and engage in cereal cropping, animal rearing, and fishing.

Bunza River is the only source of surface water in Bunza town, and therefore, is the only river that supplies groundwater in the area. The river is the continuation of the Rima River, which has its watershed in Sokoto State and drains through Bunza town into the Niger River. The water courses of the river are dotted with human settlements, as well as anthropogenic activities such as farming, fishing, artisanal works, and selling of commodities. Municipal waste and urban runoff discharge directly into the river at several points. There is no doubt that these activities will pollute the water in the river and contaminate fish and groundwater in the town. Consequently, water and fish samples were obtained at selected locations on the river to determine their suitability for consumption.

Sample collection

Fish and water samples were collected from 10 different sampling points, as illustrated in Figure 1, using stratified sampling methods that focused on hotspots of fishing activities along the river. Three samples, each of mature tilapia fish (*Oreochromis niloticus*) and catfish (*Clarias gariepinus*) were collected randomly from each sampling point in the river and transferred immediately into an icebox. Similarly, three water samples were obtained randomly from each sampling point into clean 1000 ml polyethylene terephthalate plastic bottles and sealed immediately. The containers were put in black polyethylene bags, tied properly, and conveyed to the laboratory where they were refrigerated at 4 °C.

Preparation of fish samples

The refrigerated fish samples were allowed to unfreeze, and then, washed thoroughly with ultrapure water to remove impurities. The fish were dried by placing them in foil papers, after which they were dissected to obtain the intestines and skin. The organs were dried at 60 °C in an oven until a constant weight was obtained, after which a mortar and pestle were used to pulverize them into powder. The ground samples were kept in a desiccator awaiting further analysis.

Heavy metal analysis

Heavy metals were analyzed as described by Yahaya et al (27). One gram was measured from each powder sample

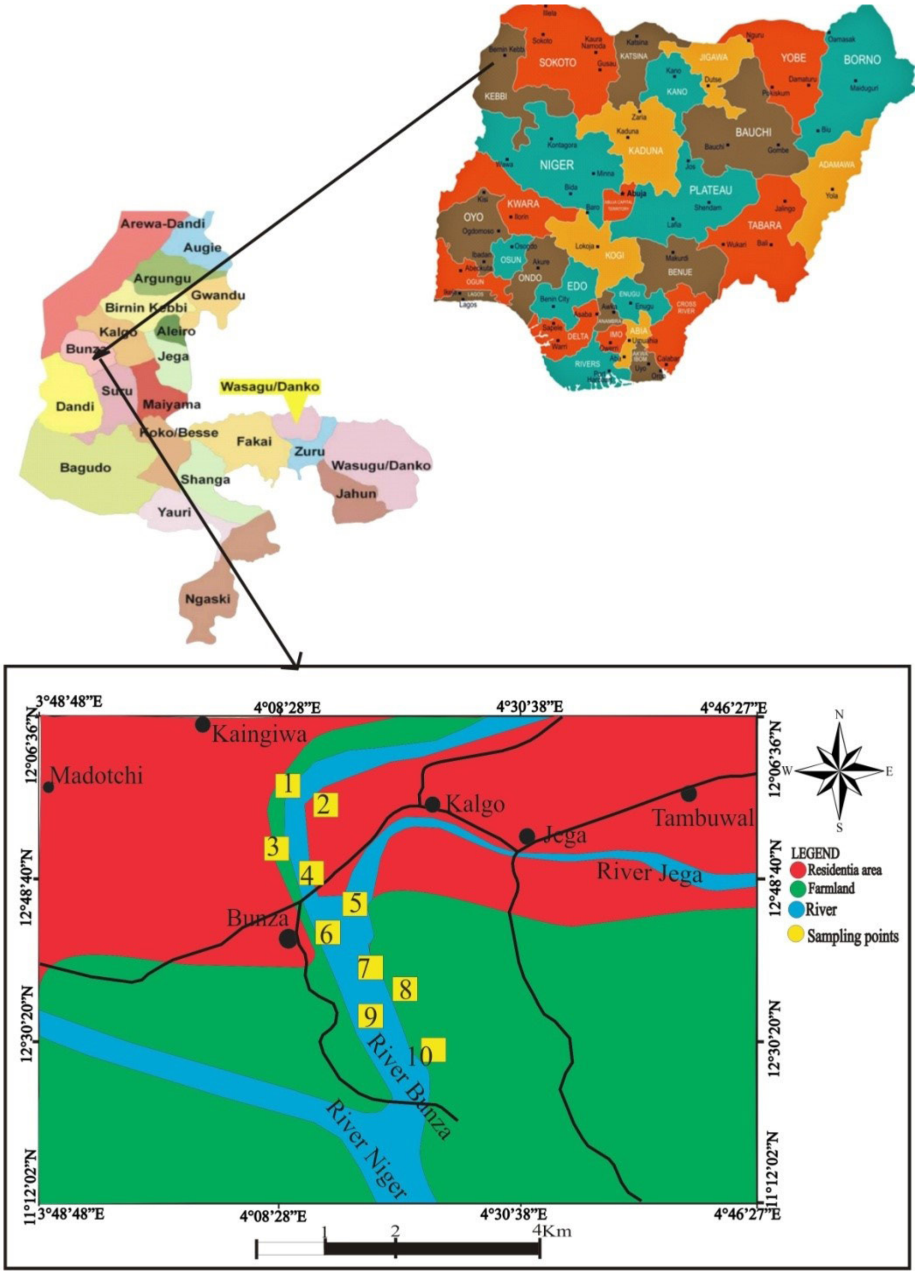

Figure 1. Map of the study area

of the fish and poured into a digestion flask that had been previously filled with concentrated nitric acid (1 part) and sulphuric acid (3 parts). The flask was heated while repeatedly adding 3⁄4 drops of hydrogen peroxide to suppress nitrous vapors and speed up the digestion by raising the temperature (27). The sample was completely digested at 150°C, then, was left to cool. The digest was poured into a 50-mL volumetric flask, and the content was raised to the meniscus with ultrapure water. A 0.45 mm pore-size acid-resistant filter paper was then used to filter the digest into clean glass vials. The levels of Cd, Pb, Cu, and zinc (Zn) in the samples were then obtained using a PG atomic absorption spectrophotometer (model: AA990).

The water samples were analyzed in the same manner as described for the fish. However, the digestion was done by mixing 5 ml of each sample with 25 mL aqua-regia solution, and then, heated at 120 °C for 3 hours (24). The digest was filtered into a 100 mL beaker as described for fish, allowed to cool, and then, analyzed.

Quality control and assurance

Analytical-grade chemicals and reagents were procured for the study. The contamination of the chemicals and reagents was prevented by previously soaking glassware and plastic containers in concentrated nitric acid for 24 hours and rinsing thoroughly with ultrapure water. The contact of the samples with metal-based materials was prevented during the analysis. Blank samples were analyzed along with the samples intermittently to check for background contaminations. Each sample analysis was run thrice and reproducibility of nearly the same values was ensured.

Health risk assessment of the heavy metals in the fish

The non-carcinogenic and carcinogenic risks (CRs) of daily consumption of fish were determined as outlined by Yahaya et al (27). The non-CR was obtained from estimated daily intake (*EDI*), hazard quotient (*HQ*), and hazard index (*HI*) of the heavy metals in the fish (equations 1, 2, and 3, respectively). The *CR* was estimated from equation 4.

$$EDI = \frac{C \times EF \times ED \times FIR}{ABW \times AT} \quad (1)$$

$$HQ = \frac{C \times EF \times ED \times FIR}{ABW \times AT \times RFD} \times 10^{-3} \quad (2)$$

$$HI = \sum HQ \quad (3)$$

$$CR = EDI \times CSF \quad (4)$$

According to Yahaya et al (27), *C* is the concentration of the individual heavy metals in the fish samples, *EF* denotes exposure frequency (365 days $year^{-1}$), *ED* stands for exposure duration (55 years, the average life of a resident Nigeria), *FIR* represents fish ingestion rate in kg $person^{-1}$ day^{-1}, which is 19.5 g per person day^{-1}, *WAB* indicates average body weight (65 kg), *AT* is the average exposure time for non-carcinogens (365 days $year^{-1} \times ED$), and *RFD* means oral reference dose (mg kg^{-1} day^{-1}). According to the USEPA (27), *RFD* for Zn = 0.30, Cd = 0.001, Cu = 0.04, and Pb = 0.004. ∑*HQ* is the summation of the HQs, while *CSF* means cancer slope factor ($mgkg^{-1}day^{-1}$). The *CSFs* of Pb and Cd in fish are 0.009 and 0.60, respectively (28). *HQ* and *HI* values above 1 were considered toxic and CR values above 1×10^{-6} (for a single heavy metal) and 1×10^{-4} (for multiple heavy metals) were considered toxic (28).

Health risk assessment of the heavy metals in water

The non-CR and CR of the heavy metals in the water samples were calculated following the USEPA (29). The non-CR was estimated from the average daily ingestion (*ADI*) and *HQ* (equations 5 and 6, respectively), while the *CR* was estimated using equation 7.

$$ADI = \frac{Cn \times Ir \times EF \times ED}{ABW \times AT} \quad (5)$$

$$HQ = \frac{ADI}{RfD} \quad (6)$$

$$CR = ADI \times CS \quad (7)$$

As postulated by the USEPA (28), *Cn* is the concentration of the heavy metal in water, *Ir* represents the ingestion rate, which is 2 liters per day, *Ef* is the exposure frequency (365), *Ed* stands for the exposure duration (equal to the life expectancy of a Nigerian resident, which is 55), *ABW* denotes the average body weight (65), and *At* is the average time (*Ed* x *Ef*). *RFD* is abbreviated for the oral reference dose (mg/L/d) of heavy metals. *RFD* of Zn = 300, Cd = 0.5, Pb = 1.4, Cu = 40 (the USEPA, 2021). *HQ* values less than one were considered non-toxic (28). The *CSFs* of Cd and Pb in water are 0.38 and 0.085, respectively (28).

Data analysis

The concentrations of heavy metals in the samples were presented as mean ± standard deviation (SD) using the Statistical Package for Social Sciences (SPSS) version 21. The means obtained were compared with standard values using analysis of variance (ANOVA) and significant differences were separated using Duncan. The SPSS was also used to calculate the *ADI*, *CR*, *EDI,* and *HQ* values of the heavy metals. The charts were drawn using Minitab software version 20.

Results

Levels of heavy metals in fish and water samples

Tables 1 and 2 display the concentrations of Zn, Pb, Cu, and Cd in the fish and water samples obtained from Bunza River. In the fish samples, the results indicated significant differences ($P < 0.05$) between the heavy metal concentrations in the fish organs and FAO/WHO standards (30). Zn and Cd levels were significantly lower than the standards ($P < 0.05$), while Cu and Pb were significantly higher ($P < 0.05$) (Table 1). Similarly, significant differences were observed between the concentrations of the heavy metals in the water samples and the standards ($P < 0.05$). It indicated that all the analyzed heavy metals were above the standards in the water samples (Table 2).

Health risk of the heavy metals in the fish and water samples

Table 3 shows the health risks of Cd, Cu, Zn, and Pb in the fish samples. The EDI of Pb and Cd were above the permissible limits, while Zn and Cu were within the limits. The HQ and *HI* of all the heavy metals were within acceptable limits (less than 1) in the fish samples (Figure 2).

The ADIs of Cu, Pb, and Cd in the water samples were displayed in Table 4 and were above the recommended limits, while Zn was within the limits. Moreover, the HQ of all the heavy metals was above the recommended limits (> 1).

Figure 3 reveals that the CR of all the heavy metals in the fish samples was above the permissible limits ($< 10^{-6}$).

Table 1. Mean concentrations of heavy metals in the fish samples

Fish species	Heavy Metal (mg/kg)				
	Organs	Zn	Cd	Cu	Pb
Catfish	Skin	33.39±3.62^{b}	0.21±0.08^{a}	5.24±1.54^{c}	3.46±4.84^{bc}
	Intestines	12.56±2.79^{a}	0.65±0.10^{bc}	2.14±0.78^{b}	4.53±0.31^{c}
Tilapia fish	Skin	8.60±6.58^{a}	0.69±0.11^{c}	1.77±0.55^{b}	3.56±1.86^{bc}
	Intestines	9.29±2.23^{a}	0.53±0.02^{b}	1.95±2.38b	1.85±0.70^{b}
FAO/WHO (30)		40^{c}	2.^{0}d	0.5^{a}	0.40^{a}

WHO, World Health Organization; FAO, Food and Agriculture Organization.
Values were expressed as mean±SD; values in the same column with the same superscript letter did not differ significantly (*P*>0.05) and vice versa.

Table 2. Mean concentrations of heavy metals in the water samples

Heavy Metal	Concentration (mg/L)	The WHO (31)
Zn	18.90±3.08^{a}	5.00^{b}
Cd	0.50±0.02^{a}	0.003^{b}
Cu	4.64±0.62^{a}	0.05^{b}
Pb	78±0.70^{a}	0.01^{b}

WHO, World Health Organization.
Values were expressed as mean±SD; values in the same column with the same superscript letter did not differ significantly (*P*>0.05) and vice versa.

Table 3. Estimated daily intake (*EDI*) of heavy metals in the fish samples

Fish species	Heavy Metals (mg/d)				
	Organs	Zn	Cd	Cu	Pb
Catfish	Skin	10.017	0.160	0.772	1.037
	Intestines	3.769	0.195	0.643	1.361
Tilapia fish	Skin	2.580	0.208	0.530	1.069
	Intestines	2.787	0.159	0.586	0.555
RDI (27)		40	0.06	0.9	0.24

RDI, Recommended daily intake.

Table 4. Average daily intake (ADI) and hazard quotient (HQ) of the water samples

Heavy metals	ADI	RDI (27)	HQ
Zn	0.581	3.0	1.94
Cd	0.015	0.06	15.00
Cu	0.143	0.90	35.75
Pb	0.003	0.055	1.375

RDI, Recommended daily intake; HQ≥1: Potential health risk.

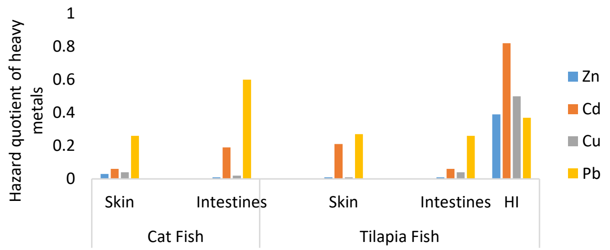

Figure 2. Hazard quotient (HQ) and health risk index (HI) of heavy metals in the fish samples

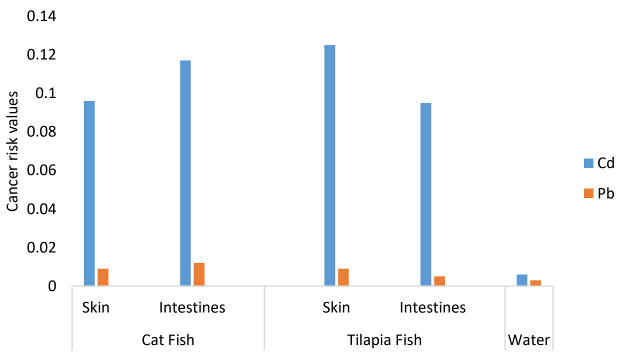

Figure 3. Carcinogenic risks of heavy metals in fish and water samples

Discussion

Health risks of the fish

The catfish and tilapia fish samples contained non-tolerable levels of Cu and Pb and tolerable levels of Cd and Zn, although in appreciable quantities. This suggests that the fish samples may not be ideal for consumption. Cu is a micronutrient, but at high concentrations, it can predispose humans to health challenges (32). Ingesting large amounts of soluble Cu salts can induce acute gut disorders and in rare cases, hepatic problems in genetically predisposed people (32). In an experiment, in which 1 or 2 mg kg^{-1} of Cu was administered daily to some albino rats, both cellular and systemic disorders were observed (33). The levels of Cu injected in the mentioned study fall within the range of 1.77-5.24 mg kg^{-1} detected in the fish samples analyzed in the present study. Pb is highly toxic; it can induce oxidative stress, causing DNA, membranes, cellular defense mechanisms, and multi-organ damage (34). According to the report of the WHO (35), there is no safe blood Pb concentration; even concentrations as low as 3.5 μg dL^{-1}, which falls within the levels (1.85-4.53 mg kg^{-1}) detected in the fish in the present study, may cause cognitive and behavioral abnormalities in children. Zn is a micronutrient that plays a protective role in organisms but can be toxic at a very high amount. In the present study, Zn levels fall within permissible ranges (≤40 mg kg^{-1}), and so may play a protective role when consumed. In particular, Zn may help reduce the levels of other heavy metals in the body, as demonstrated in albino rats exposed to heavy metals by Eddie-Amadi et al (36). However, at higher concentrations, Zn can cause toxicity in cells, which can often result in the disruption of essential biological functions triggered by blocking protein thiols through mismetallation with other metals (37). Cd levels fall within the ≤ 2.0 mg kg^{-1} acceptable concentrations in all the fish in the present study, and so may not pose significant health effects. However, Ezedom et al (38) demonstrated that repeated Cd exposure even at very low concentrations can alter biochemical, genetic, and renal parameters. Excessive exposure to Cd may be related to liver and kidney damage and osteoporosis as well as various types of cancer, including breast, lung, prostate, nasopharynx, pancreas, and kidney cancers (39).

In the health risk assessment, the EDIs of Cd and Pb were above the RDI (≤ 0.06 and 0.24 mg kg^{-1}, respectively), which further proved the unsuitability of the fish samples. Although the Cu concentrations in the fish samples were within the RDI (≤ 0.90 mg kg^{-1}), the levels were appreciable (0.530-0.772 mg kg^{-1}), and thus, portended danger. Meanwhile, the HQ and HI of the heavy metals were within the acceptable limits (< 1), which suggests that the heavy metals may not have chronic effects. However, it is worth mentioning that in strict environmental toxicology, there are no safe limits for heavy metals. So, the mere detection of exogenous heavy metals in the fish portends dangers to consumers, regardless of the outcomes of HQ and HI. The CRs of Pb and Cd, the two carcinogens among the heavy metals, were above the acceptable values (≥ 1), which again proves that consumption of fish may cause health problems. Except for Zn in the skin of the catfish, the levels of the heavy metals were very close when the two fish species were compared organ versus organ. This suggests that the heavy metals were evenly distributed in the water since catfish are benthic while tilapia are pelagic.

Intense farming takes place around the river, and the farmers often use pesticides and fertilizers, both of which contain Cu and could be its source in the river as outlined by Comber et al (40) and the USEPA (41). In addition, mining operations take place along the river and could also be the source of elevated concentrations of Cu in the water and fish (42). Direct discharge of waste and urban runoff containing e-waste and Pb acid battery, auto mechanics, fuel attending, welding, electronic repairing, farming/spraying, mining, tobacco, spices, and paints noted around the river could be the sources of Pb as reported by the USEPA (43,44). Phosphate fertilizers used for farming around the river, sewage sludge, as well as urban runoff carrying NiCd batteries, plating, pigments, and plastics could be the sources of Cd in the river, as reported by the USEPA (45). Zn is naturally abundant in aquatic organisms; however, urban runoff containing pieces of galvanized and coated roofs, painted buildings, and worn tires could be the cause of its high concentrations in the river (46).

Consistent with the results of the present study, Anthony et al (22) detected non-tolerable concentrations of Cr, Cd, and Pb, while Zn was within limits in fish and water samples obtained from the Niger River in Yauri, Kebbi State. Similarly, Hassan et al (47) reported non-tolerable concentrations of Pb in fish samples obtained from the Dukku River in Birnin Kebbi, but Cd and Cu were within the tolerable limits. In the heavy metal and physicochemical assessment of water samples collected in Argungu River, Kebbi State, by Yahaya et al (24), Cd and Pb were above the permissible levels, while Zn was within the limit. Moreover, Yazdanbakhsh et al (48) reported non-permissible levels of Zn, As, and Pb in water samples obtained from Ilam city water in Iran. On the other hand, Elinge et al (49) reported permissible concentrations of evaluated heavy metals (Mn, Zn, Fe, Cd, Cr, Cu, Pb, and Ni) in fish obtained from Zamare River in Yauri, Kebbi State. Bawa et al (50) also found tolerable concentrations of heavy metals including Cu, Pb, and Zn in fish samples obtained from Jega River in Kebbi State. Furthermore, Sattari et al (51) detected permissible levels of Pb, Zn, Mn, Cu Cr, and Cd in fish obtained from the South Caspian Sea. Similarly, Naghipour et al (52) did not report the health risks of heavy metals in fish obtained from the Caspian Sea in Iran. Varied geology of rivers and anthropogenic activities in and around river courses could contribute to the inconsistencies of the findings of the above-mentioned studies. According to Yahaya et al (53), seasonal variations exist in the heavy metal concentrations of rivers and so the varied seasons, in which the above-mentioned studies were conducted, could contribute to the inconsistencies.

Health risks of the water

The water samples had non-tolerable concentrations of all the analyzed heavy metals (Zn, Cd, Cu, and Pb) with Zn having the highest concentrations and Cd having the least. Also, ADI, HQ, and CR of all the heavy metals were beyond the recommended limits, except for the ADI of Pb. This suggests that the water may not be ideal for consumption. The potential health hazards and possible sources of the heavy metals in the river were discussed earlier.

It was noted that when the water samples were compared with the fish samples in terms of heavy metals, the fish samples contained higher concentrations of heavy metals (Tables 1 and 2). Similar findings were detected by Yahaya et al (54) in Ogun River in Lagos. Anthony et al (22) and Zanna et al (23) also detected higher concentrations of heavy metals in fish compared to water samples obtained from the Yauri River and Argungu River (respectively) in Kebbi State. Moreover, Ujah et al (55) reported higher concentrations of heavy metals in fish samples compared to water samples collected from the Onitsha section of the Niger River in Anambra State. Heavy metals are persistent and non-biodegradable, so can accumulate gradually to toxic levels in the internal organs of fish, such as the intestine, kidney, and liver, enabling them to accumulate heavy metals in their body beyond the levels of their environment (54,56). In addition, fish eat diverse foods, including insects, worms, shrimps, fingerlings, crustaceans, earthworms, zooplankton, weeds, and even sediments from where they absorb and bioaccumulate heavy metals beyond the levels they occur in the environment (22).

Limitations of the Study

One of the limitations of this study was the inability to evaluate more heavy metals and fish species due to financial constraints. These would have boosted the results of this study.

Conclusion

The catfish and tilapia fish in Bunza River contained toxic concentrations of Cu and Pb and acceptable concentrations of Cd and Zn. The EDI of Pb and Cd through consumption of the fish was above the RDI. However, their HQ and HI were within acceptable limits (< 1). On the other hand, the water in the river contained toxic levels of all the analyzed heavy metals (Cu, Pb, Cd, and Zn). The ADI of the heavy metals from the water as well as their HQ were above the recommended limits. Overall, the consumption of fish and water in Bunza River can cause health hazards to the populace. It is necessary to sensitize people in the town to the heavy metal-related dangers posed by water and fish from the river. Agencies responsible for human and environmental health in the town need to provide policies that will reduce the pollution of the river. More studies are necessary to confirm the findings of the present study as well as to assess more pollutants.

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Authors' contributions

Conceptualization: Tajudeen Yahaya.
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Validation: Mohammed Umar Faruk.
Visualization: Muhammad Nasiru.
Writing–original draft: Tajudeen Yahaya, Abdulrahman Sani Kalgo.
Writing–review & editing: Muhammad Nasiru, Muhammad, Muhammad-Jamil Abubakar, Mohammed Umar Faruk.

Competing interests

The authors declare that there is no conflict of interests regarding the publication of this manuscript.

Ethical issues

This study was approved by the Research Ethics Committee of the Federal University Birnin Kebbi, Nigeria (Ethical code: 1710203027). The guidelines for conducting research as outlined by the Committee were strictly followed.

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