Heavy metals and health risk analysis of arable farmlands in selected local government areas of Taraba State, Nigeria

Bilyaminu Habibu1*, Otitoju Olawale Francis1, Yakubu Ojochenemi Ejeh1, Moses Adondua Abah1

1 Faculty of Pure and Applied Sciences, Federal University Wukari, Off Katsinala Road, Wukari, PMB 1020, Taraba State, Nigeria.

*Corresponding to: Bilyaminu Habibu. Faculty of Pure and Applied Sciences, Federal University Wukari, Off Katsinala Road, Wukari, PMB 1020, Taraba State, Nigeria. E-mail: Habibu@fuwukari.edu.ng.

Author contributions
Habibu Bilyaminu and Professor Otitoju Olawale conceptualized the research work. Habibu Bilyaminu also carried out the laboratory work which was supervised by both Otitoju Olawale and Ojochenemi Yakubu. Abah Moses wrote the manuscript which was proofread by all coauthors of this work.

Competing interests
The authors declare no conflicts of interest.

Acknowledgments
We would like to thank everyone that contributed to the success of this research work.

Peer review information
Toxicology Advances thanks Tari Vinaya Satyawan Savtri and other anonymous reviewers for their contribution to the peer review of this paper.

Abbreviations
HM, heavy metals; AAS, Atomic Absorption Spectrophotometry; THQ, Target Hazard Quotient; HI, Hazard Index; EDI, Estimated Daily Intake; HQ, Hazard quotients; HI, Hazard Index; EDI, Estimated Daily Intake; ADI, Acceptable Daily Intake; TR, Target Cancer Risk; SPSS, Statistical Package for Social Sciences.

Citation

Abstract
The soil environment is a reservoir of nutrients as well as pollutants, and because of this, most of our food items are ladened with lots of pollutants ranging from fertilizers, pesticides, herbicides to heavy metals (HM). The consumption of these contaminated food items has serious implication on the health and economic status of the populace. These pollutants have also been implicated in causing several problems to plants. This study investigated heavy metals and health risk analysis of arable farmlands in selected Local Government Areas (Donga, Ussa and Takum) of Taraba state Nigeria. Samples obtained were processed and the concentration of following heavy metals (Pb, Cd, Cr, Hg, and As) were determined using Atomic Absorption Spectrophotometry (AAS). The results showed that Chromium had a very high concentration across all the study areas with values ranging from 1.40mg/kg to 2.30 mg/kg. The concentration of Cadmium and Arsenic were moderate, with values ranging from 0.03mg/kg to 0.08mg/kg while Lead and Mercury had the lowest concentration of less than 0.03mg/kg across the three LGAs respectively. The following ecological and health risk assessments parameters; Target Cancer Risk or Target Hazard Quotient (THQ), Hazard Index (HI) and Estimated Daily Intake (EDI) were determined to assess the carcinogenic health risks by consuming produce from such farmlands. Ussa LGA recorded the highest concentration of heavy metals, with the highest health risk index followed by Takum whereas Donga had the lowest risk factors from the analysis. The study showed bioaccumulation of toxics from the soil to crops and grazing plants across the study areas which was as a result of chemical farming that polluted and contaminated the soil, thus posing risk to the populace.

Keywords: heavy metals; risk assessment; cancer estimation; toxicity; bioaccumulation; carcinogenesis
Background

Land is the most important agricultural productivity component for farmers. Land is a highly significant socioeconomic asset, especially in disadvantaged civilizations where ownership and access to land are used to evaluate wealth and survival [1]. Land is the most significant economic resource, especially in developing nations where the majority of people live in rural areas and rely on agriculture for a livelihood. Since the emergence of man, it has remained an important element of production and a vital component of production in the agricultural sector all over the globe, laying the foundation for crop production in Nigeria and Sub-Saharan Africa. Access to fertile land is vital for millions of impoverished people who live in rural regions and rely on agriculture, animals, or forests for a living. It lessens their susceptibility to hunger and poverty and impacts their capability to participate in economic activities and resource management [2].

The problems of naturally occurring metallic elements in soil, which ultimately enter the food chain and contribute to food insecurity in most developing countries, particularly Africa, are alarming [3]. Most of our food contains a variety of contaminants, including fertilizer, pesticide, and other chemical residues, as well as heavy metals. Consumption of tainted foods has major consequences for the population's health and economic status [4]. Under the idea that heaviness and toxicity are linked, heavy metals include metalloids such as arsenic, which may cause toxicity at low levels of exposure [5]. Although heavy metals are naturally present in the environment in diverse forms, they are seldom toxic [4]. They exist naturally in the earth's crust, but their concentration in the environment increases as a result of numerous human activities [6]. Heavy metal contamination in the environment is becoming a serious worldwide concern [7]. Because of their widespread use, distribution, and particularly their toxicity to humans and the ecosystem, they are ongoing environmental contaminants because they cannot be easily degraded, resulting in the release of pollutants such as hydrocarbons and heavy metals capable of contaminating soil and water bodies and being absorbed by plants and bioaccumulating in them [9]. The buildup of heavy metals and metalloids in soil, water, and plants, particularly cadmium, chromium, arsenic, lead, and mercury, presents several dangers to human health and the environment [10]. These metals and toxic elements may be exposed via the food chain or through direct touch, (soil, water)-plant-human or soil (water)-plant-animal-human, or by direct exposure to soil pollutants (soil-human) or soil-water-human [11]. To soil flora and animals, environmental dangers are described as phytotoxicity or ecotoxicity. The dangers of heavy metal contamination of soils are widely known, and numerous large studies have been published on the issue. In recent years, a great deal of study has been done on assessing the bioavailability and toxicity of metals in soils, despite the fact that many researchers have tried to demonstrate a link between contaminant concentrations in soils or plants and the impacts on plants or organisms (including humans) [10].

Farmers employ a diverse variety of pesticides at various levels to prevent pest and disease losses, according to the findings. Pesticides are substantial environmental toxins, notwithstanding their benefits to agricultural output. Many pesticides and chemicals are not biodegradable; they bioaccumulate in the food chain and are hazardous to human health since many of them were designed to interfere with enzymatic processes in pests and might possibly harm humans and the environment [8]. Because some of these fertilizers and pesticides include heavy metals such as Cd, Pb, and Cr, the regular and ongoing use of these agrochemicals contributes to the buildup of heavy metals in agricultural soils [12]. Continuous heavy metal accumulation in soil could either directly endanger natural soil functions, such as the microbial quorum that coordinates activities below the soil, or indirectly endanger the biosphere through bioaccumulation in the food chain, ultimately endangering human health [13]. There is little or no data on heavy metals and health risk evaluations of fertile farmlands in Taraba State, Nigeria. As a result, this study is required.

Methods

Research area

In this study, three regions in three Taraba State Local Government regions (Donga, Ussa, and Takum) where agricultural and commercial activity coexist were selected for studies of heavy metal danger on farmlands as well as their bindings to the major fractions in soil. Five heavy metals (As, Cd, Hg, Cr, and Pb) were chosen for their agricultural significance and toxicity.

Sampling Site

The Taraba River, which flows through the state's southern half, inspired the name of the state of Taraba in northeastern Nigeria. Taraba's capital is Jalingo. The majority of the population, who are predominantly found in the southern and other parts of the state, are Fulani, Jukun, Chamba, Kuteb, and Ichen. Over 2 million people live in Taraba State, which includes about 40 unique tribes and dialects (according to the 2006 census). The state is bordered on the west by the states of Nasarawa and Benue, on the northwest by the state of Plateau, on the north by the states of Bauchi and Gombe, on the northeast by the state of Adamawa, and on the south by a province of Cameroon (Figure 2). The majority of the state is in the tropical zone, while its southern and northern regions are covered in low woods, respectively. The main line of work for people in Taraba State is agriculture. Among the cash crops farmed in the state are cotton, coffee, tea, groundnuts, and others. Additionally produced in commercial numbers are yams, cassava, millet, sorghum, and maize [14].

Figure 1 Arable farmland from the sampling areas. Source: Snap shot

Submit a manuscript: https://www.tmrjournals.com/atr
Sample collection
Three different soil samples from three Local Government Areas of Taraba state (Donga, Takum and Usma) were collected using sterile glass sample collection bottles measured at 5cm depth. The collected samples were then kept in sealed polythene bags and labeled properly, then transported to Biochemistry Laboratory and kept in an air dried place prior to analysis of heavy metals (As, Cd, Pb, Hg, and Cr).

Sample preparation
Hand picking removed undesired elements such as stone, leaves, and debris from the soil samples, which were then air dried for one week to eliminate excess moisture. Large dirt clouds were also pulverized to help the samples dry faster. The dry soil samples were crushed with a pestle in a porcelain mortar. The crushed soil samples were sieved using a 2 mm stainless steel sieve, and the sieved soil samples were pulverized to a fine powder and passed through a 0.5-mm sieve, ready for heavy metal content analysis.

Determination of heavy metal concentration
A measured volume of well prepare sample appropriate for the expected metal concentration was transferred into a conical flask in fume cupboard. 3 mL of conc. HNO₃ was added and covered with a ribbed watch glass and then placed on a heating mantle and cautiously evaporated to less than 5 mL, making sure that sample does not boil. The mixture was allowed to cool and the flask wall was rinsed and washed with a distilled water. Furthermore, 5 mL of conc. HNO₃ was added and the flask was covered with a ribbed watch glass and returned to the heating mantle. Heating continued until digestion was completed. It was cooled, and flask was washed down with water. The solution was filtered and the filtrate was then transferred to a 100 mL volumetric flask built up to the required concentration with distilled water before being used for analysis. Atomic Absorption Spectrophotometer model 6650F using a modified standard method of AOAC [15] was then used to determine the concentration of heavy metals present in the samples. The concentration of each element in the sample solutions contained in the sample bottles was measured. Each element has a unique cathode discharge lamp, and it was this lamp that was used to identify a certain element. Each element being tested for by the discharge lamp emits light at a certain wavelength. The only way to achieve this specificity is from a pure sample of the element that has undergone electrical excitation to create an arc spectrum on that element. The following heavy metals were examined: Cadmium (Cd), Lead (Pb), Chromium (Cr), Mercury (Hg), and Arsenic (As).

Health risk calculation
The Hazard quotients model (HQ) and pollution indices were employed in this research to quantify the danger of heavy metals in soil. The hazard quotient is the ratio of a substance's possible exposure concentration to the threshold at which no adverse effects are predicted. When HQ 1 is used, adverse health consequences are rare, while when HQ 1 [16] is used, possible non-carcinogenic effects may arise. The following formula is used to determine the Hazard Quotient:

Hazard Quotient (HQ) = Estimated Daily Intake (EDI) / Acceptable Daily Intake (ADI)

Hazard Index (HI)
HI = the summation of an individual HQs.
HI = Σ HQi
HI = THQ = THQ (Pb) + THQ (Cr) + THQ (Cd) + THQ (As) + THQ (Hg).
if HI > 1, it means an unacceptable risk of non-carcinogenic effects on health, while HI < 1 means an acceptable level of risk [17].

Estimated Daily Intake (EDI)
EDI was calculated using the equation below [18].
EDI = (Concentration of heavy metal as mg/ kg) x (daily intake of food in kg/person) / Adult body weight (60 kg)

Target Cancer Risk (TR)
TR was calculated using the equation below [18].
Target cancer risk (TR) = Efr x EDTot x SI x MCS x CPSo x 10⁻³ / BWa x ATc
Where Efr = Exposure frequency (350 days/years)
EDtot = Exposure duration, total (30 years)
SI = Soil ingestion, gram per day (1 gram) x 1000mg/kg
MCS = Metal concentration
CPSo = Carcinogenic potency slope, oral (1 mg/kg/day)
BWa = Body weight adult (60 kg)
ATc = Average time carcinogenic (25,550 days)
N.B: If there are numerous carcinogenic components, the cancer risks from each one are added up (presuming additive effects). Risks between 1.0 x 10-6 and 1.0 x 10-2 are considered tolerable.

**Statistical Analysis**
Duncan’s multiple comparison test was performed to statistically analyze the data, and the results were presented as mean standard error. The Statistical Package for Social Sciences (SPSS) version 23 was used for the statistical analysis, and a significance threshold of P ≤ 0.05 was used.

**Results**

**Concentration of lead, Calculated Risk and Hazard Index of soil samples from selected LGAs in Taraba State**
The result of lead concentration in soil samples obtained from selected LGAs in Taraba state indicated that Donga LGA had the lowest concentration of lead (0.01 ± 0.00 mg/kg) followed by Ussa while Takum LGA had the highest concentration of lead (0.02 ± 0.01mg/kg). Similarly, the calculated risk showed that Donga had the lowest value (0.07) while both Ussa and Takum had the highest calculated risk value (0.13) (Table 2).

**Concentration of Cadmium, calculated risk and Hazard Index of soil samples obtained from selected LGAs in Taraba state**
The result of Cadmium concentration in soil samples obtained from some LGAs in Taraba state showed that Donga LGA had the lowest concentration Cadmium (0.04 ± 0.01 mg/kg) followed by Takum (0.07 ± 0.02 mg/kg) while Ussa had the highest concentration of Cadmium (0.08 ± 0.01 mg/kg). Similarly, the calculated risk showed that Donga had the lowest risk value (0.32) whereas Takum had 0.46 while Ussa has the highest calculated risk value (0.52) (Table 3).

**Concentration of Chromium, Calculated Risk and Hazard Index of soil samples obtained from selected LGAs in Taraba State**
The result of Chromium concentration in soil samples obtained from selected LGAs in Taraba State showed that Donga LGA had the lowest concentration of Chromium (1.40 ± 0.30 mg/kg) followed by Takum (2.25 ± 0.52 mg/kg) while Ussa had the highest concentration of Chromium (2.30 ± 0.25 mg/kg). The calculated risk showed that Donga had a risk value of 9.23 compared to Takum (14.83) and Ussa (15.16) (Table 4).

**Concentration of Arsenic, Calculated Risk and Hazard Index of soil samples from selected LGAs in Taraba State**
The result of Arsenic concentration in soil samples obtained from selected LGAs in Taraba state showed that Donga LGA had the lowest concentration (0.03 ± 0.01 mg/kg) while both Takum and Ussa had (0.06 ± 0.01 mg/kg) respectively. The calculated risk showed that Donga had the lowest risk value (0.26) while Takum and Ussa had a risk value of 0.39 (Table 5).

**Mercury content, Calculated Risk and Hazard Index of soil samples from selected LGAs in Taraba State**
The result of Mercury concentration in soil samples obtained from selected LGAs in Taraba state showed that Donga LGA had the lowest concentration of mercury (0.01 ± 0.00 mg/kg), followed by Ussa (0.02 ± 0.00 mg/kg) while Takum had 0.02 ± 0.01 mg/kg. The calculated risk showed that Donga had the lowest risk value of 0.06 while both Takum and Ussa are had a value of 0.13 high (Table 6).

<table>
<thead>
<tr>
<th>Study areas</th>
<th>Pb (mg/kg)</th>
<th>Cd (mg/kg)</th>
<th>Cr (mg/kg)</th>
<th>As (mg/kg)</th>
<th>Hg (mg/kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Donga</td>
<td>0.01 ± 0.00a</td>
<td>0.04 ± 0.01a</td>
<td>1.40 ± 0.30a</td>
<td>0.03 ± 0.01a</td>
<td>0.01 ± 0.00a</td>
</tr>
<tr>
<td>Takum</td>
<td>0.02 ± 0.01ab</td>
<td>0.07 ± 0.02ab</td>
<td>2.25 ± 0.52ab</td>
<td>0.06 ± 0.01ab</td>
<td>0.02 ± 0.01ab</td>
</tr>
<tr>
<td>Ussa</td>
<td>0.02 ± 0.00ab</td>
<td>0.08 ± 0.01ab</td>
<td>2.30 ± 0.25ab</td>
<td>0.06 ± 0.01ab</td>
<td>0.02 ± 0.00ab</td>
</tr>
</tbody>
</table>

*The results are reported as the mean standard deviation of three determinations. Values with the same superscript have no significant difference between groups, while values with different superscripts significantly differ between groups.

<table>
<thead>
<tr>
<th>Study areas</th>
<th>Pb Concentration (mg/kg)</th>
<th>EDI</th>
<th>Calculated risk</th>
<th>HI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Donga</td>
<td>0.01 ± 0.00</td>
<td>0.000015</td>
<td>0.07</td>
<td>9.94</td>
</tr>
<tr>
<td>Takum</td>
<td>0.02 ± 0.01</td>
<td>0.000030</td>
<td>0.13</td>
<td>15.94</td>
</tr>
<tr>
<td>Ussa</td>
<td>0.02 ± 0.00</td>
<td>0.000030</td>
<td>0.13</td>
<td>16.33</td>
</tr>
</tbody>
</table>

*The results are reported as the mean standard deviation of three determinations. WHO/FAO permissible value of Pb is 0.100 (mg/kg) [19].
Table 3 Heavy metal concentration and risk analysis of soil samples obtained from Donga, Takum, and Ussa

<table>
<thead>
<tr>
<th>Study areas</th>
<th>Cd Concentration (mg/kg)</th>
<th>EDI</th>
<th>Calculated risk</th>
<th>HI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Donga</td>
<td>0.04 ± 0.01</td>
<td>0.000076</td>
<td>0.32</td>
<td>9.94</td>
</tr>
<tr>
<td>Takum</td>
<td>0.07 ± 0.02</td>
<td>0.000107</td>
<td>0.46</td>
<td>15.94</td>
</tr>
<tr>
<td>Ussa</td>
<td>0.08 ± 0.01</td>
<td>0.000123</td>
<td>0.52</td>
<td>16.33</td>
</tr>
</tbody>
</table>

*The results are reported as the mean standard deviation of three determinations. WHO/FAO permissible value of Cd is 0.003 (mg/kg) [19].

Table 4 Heavy metal concentration and risk analysis of soil samples obtained from Donga, Takum, and Ussa

<table>
<thead>
<tr>
<th>Study areas</th>
<th>Cr Concentration (mg/kg)</th>
<th>EDI</th>
<th>Calculated risk</th>
<th>HI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Donga</td>
<td>1.40 ± 0.30</td>
<td>0.00215</td>
<td>9.23</td>
<td>9.94</td>
</tr>
<tr>
<td>Takum</td>
<td>2.25 ± 0.52</td>
<td>0.00346</td>
<td>14.83</td>
<td>15.94</td>
</tr>
<tr>
<td>Ussa</td>
<td>2.30 ± 0.25</td>
<td>0.00353</td>
<td>15.16</td>
<td>16.33</td>
</tr>
</tbody>
</table>

*The results are reported as the mean standard deviation of three determinations. WHO/FAO permissible value of Cr is 0.100 (mg/kg) (WHO/FAO [19].

Table 5 Heavy metal concentration and risk analysis of soil samples obtained from Donga, Takum, and Ussa

<table>
<thead>
<tr>
<th>Study areas</th>
<th>As Concentration (mg/kg)</th>
<th>EDI</th>
<th>Calculated risk</th>
<th>HI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Donga</td>
<td>0.03 ± 0.01</td>
<td>0.0000615</td>
<td>0.26</td>
<td>9.94</td>
</tr>
<tr>
<td>Takum</td>
<td>0.06 ± 0.01</td>
<td>0.0000923</td>
<td>0.39</td>
<td>15.94</td>
</tr>
<tr>
<td>Ussa</td>
<td>0.06 ± 0.01</td>
<td>0.0000923</td>
<td>0.39</td>
<td>16.33</td>
</tr>
</tbody>
</table>

*The results are reported as the mean standard deviation of three determinations. WHO/FAO permissible value of As is 0.200 (mg/kg) [19].

Table 6 Heavy metal concentration and risk analysis of soil samples obtained from Donga, Takum, and Ussa

<table>
<thead>
<tr>
<th>Study areas</th>
<th>Hg Concentration (mg/kg)</th>
<th>EDI</th>
<th>Calculated risk</th>
<th>HI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Donga</td>
<td>0.01 ± 0.00</td>
<td>0.000015</td>
<td>0.06</td>
<td>9.94</td>
</tr>
<tr>
<td>Takum</td>
<td>0.02 ± 0.01</td>
<td>0.000030</td>
<td>0.13</td>
<td>15.94</td>
</tr>
<tr>
<td>Ussa</td>
<td>0.02 ± 0.00</td>
<td>0.000030</td>
<td>0.13</td>
<td>16.33</td>
</tr>
</tbody>
</table>

*The results are reported as the mean standard deviation of three determinations. WHO/FAO permissible value of Hg is 0.05 (mg/kg) [19].

**Discussion**

Heavy metals quantification was carried out in this study to ascertain the levels of metal exposure to animals, plants and humans as results of artisanal activities in arable farmlands of interest. These contaminants include anything from insecticides to fertilizer. One of the most harmful environmental pollutants that can bioaccumulate in biological tissues is heavy metals. The intake of food, which is the main source of energy and other nutrients for human and animal existence in these research areas, raises certain questions. However, safety of the populace living in those arable farmlands which is the environment from which food is gotten from raises concern.

The findings of this study showed that the soil samples taken from Donga, Takumn, and Ussa included heavy metals (Pb, As, Hg, Cd, and Cr). This result is in tandem with the findings of Abah et al. [8], who also found the presence of the above mentioned metals in leafy vegetables samples obtained from Donga Local Government Area. All the metals with the exception of lead (Pb) occurred in concentrations...
above their WHO/FAO stipulated permissible limits as well as the provisional tolerable week intake (PTWI), where Cd: 0.04mg/kg to 0.08mg/kg, As: 0.03mg/kg to 0.06mg/kg, Hg: 0.01mg/kg to 0.02mg/kg, Pb: 0.01mg/kg to 0.02mg/kg, and Cr: having the highest concentration with values greater than 2.00mg/kg. This result varies slightly with the findings of Okolli et al. [6]. Extraction of heavy metal contents in soil may give indications of the origin of the metals in an arable farmland. The distribution of trace heavy metals in the soil samples allows us to predict their mobility, bioavailability and toxicity [6].

In this investigation, chromium was shown to be the most mobile element, followed by Cd and As, with Pb and Hg being the least mobile. The mobility of extractable metals from soil samples from the study locations, as evaluated, and their predicted risk levels are as follows: Cr > Cd > As > Pb > Hg. As a result, since Cr total concentration was found to be the highest in all soil samples in the research regions combined, it can be assumed that Cr is the most mobile element because it is primarily disseminated around arable farmlands in bigger amounts with a higher risk value than Cd, As, Pb, and Hg. The high concentration of Cr indicates that Cr may readily enter the food chain through plant absorption in the soil. As a result, there is considerable worry about the amount of Cr in the soil. Because it is a cumulative toxic for animals, it mostly enters the soil in arable farmlands via the application of organic manure and fertilizers, as fertilizer and organic manure continue to be the principal sources of nutrients provided to the soil in arable farmlands. The speciation of chromium is critical for its toxicity. Cr (III), the most stable form of Cr found in biological materials, is required for optimal glucose metabolism, but Cr (VI) is very hazardous. Because of its limited absorption (approximately 0.5%), Cr (III) has a low toxicity [21]. The WHO/FAO-specified PTMDI for Cr is 0.06mg/kg. While Cr concentrations in this research varied from 1.40mg/kg to 2.30mg/kg throughout all study regions, the concentration of Cr was above the WHO/FAO required PTMDI threshold of 0.06mg/kg and had the highest determined risk rating. This means that the people in all of the places surveyed are prone to Cr-related health problems.

In this investigation, Cd concentrations varied from 0.04mg/kg to 0.08mg/kg in all soil samples, which is greater than the WHO [22] PTWI of (0.007 mg/kg). Cadmium was found to be the second most abundant heavy metal in soil samples throughout the research sites, indicating that its availability is vulnerable to ionic composition changes in the environment. As a result, there is an implication that the level of Cd present in the soil samples studied is one of the cumulative poisons for mammals, and its main way of entering the soil could be primarily through fertilizer, pesticides, and herbicides application as a source of nutrient to the soil, which then can find its way to plants and animals and easily transferred to the food chain. According to this research, the Cd level in the soil may be a severe worry. Its excessive exposure may cause obstructive lung disease, also known as cadmium pneumonitis. Cadmium (Cd) poisoning may cause a variety of health problems in humans and animals. In humans, Cd poisoning may cause anemia, renal impairment, bone disease, and lung cancer. As a result, persons living in these research regions may be at risk of Cd-related health problems [19].

The amounts of arsenic (As) in all of the soil samples tested in this research varied from 0.03–0.06 mg/kg. This number is more than the 0.01mg/kg WHO/FAO19 PTWI for arsenic. According to the findings of this research, the population in the study regions may be predisposed to As-induced health disorders such as arsenicosis [20]. Because of their specificity in diagnosis, most reports of chronic arsenic poisoning in humans focused on cutaneous signs. The particular skin lesions that suggest chronic arsenic poisoning include pigmentation and keratosis [20].

Lead (Pb) and mercury (Hg) concentrations were low in all soil samples tested. They looked to be the lowest metals discovered. Tread in this investigation, which may be a small pollution indication, but their presence in the soil creates severe worry to the local population. Pb was mostly derived from traffic, since most soil samples were obtained near roads. Pb enters the soil primarily by air dry and wet depositions and sewage sludge discharge. Lead has been linked to worse cognitive development and intellectual performance in children, as well as higher blood pressure and cardiovascular disease in adults [21]. The WHO/FAO stipulated maximum level of Pb in soil is (1–6900 mg/kg), and based on the findings of this study, Pb concentration is very low at less than (0.03 mg/kg) in all soil samples, implying that Pb may not pose a serious health risk to the people living in those areas in the short term, but it may in the long run [22].

Mercury (Hg) is a hazardous heavy metal whose poisoning (or excessive consumption) may cause a variety of health problems. In comparison to other metals such as lead, cadmium, chromium, and arsenic, mercury is recognized to be a latent neurotoxic. A high food intake of mercury (organic) over the recommended limit has been linked to an increased risk of coronary heart disease [21]. The World Health Organization and the Food and Agriculture Organization [19] set the PTWI for inorganic Hg and methyl mercury at 4g/kg (0.004 mg/kg) bw and 0.0016 mg/kg bw, respectively. Hg values in all soil samples varied from (0.01–0.3 mg/kg) in this investigation. These concentrations exceed the WHO [22] PTWI. This means that consuming food from these research sites on a regular basis might lead to Hg-related health concerns if plant absorption is exactly proportionate to the available concentration in the soil.

Conclusion

The circulation of the heavy metals of concern in this research (Cr, Cd, As, Pb, and Hg) in nine chosen arable farmlands from three LGAs in Taraba State was investigated in this research. The findings represent the first attempt to measure the ambient level of these metals as a function of their availability in the environment. Heavy metal analysis and risk calculation of acquired soil samples from arable farmlands revealed that the discovered heavy metals are largely prevalent in the majority of the research regions, suggesting the necessity for anthropogenic control actions. With the exception of Pb, all other heavy metals examined (Cr, Cd, As, and Hg) were detected in amounts more than the WHO’s allowed limit of consumption. As a consequence, the findings may imply that anthropogenic heavy metals are more readily transportable and potentially more phytoavailable in arable farmlands than lithogenic and pathogenic heavy metals. A high mobile level of any metal may also be a sign of which metal has recently entered the soil, indicating that this pattern is related to human pollution sources.

References
