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Full Length Research Paper

Assessment of exposure risk to lead and cadmium via fish consumption in the lacusrian village of Ganvié in Benin republic

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The assessment of exposure risk related to lead and cadmium via fish consumption was conducted consecutively to the extent of the high level of pollution of the aquatic system of lacustrian village of Ganvié by recent studies. The evaluation was performed in adults and children by computing daily dose of exposure (DDE) by crossing the average levels of contamination of fish with lead and cadmium with the levels of food consumption. Therefore, thirty six (36) samples of three fish species were collected from Lake Nokoué in the surroundings of lacustrial village of Ganvié and assayed for lead and cadmium by atomic absorption spectrophotometer. The average concentration of cadmium and lead was higher than the allowed limits: 26.80 ± 0.57 ppm (against 0.4 ppm) for Pb and 1.79 ± 0.29 ppm (against 0.05 ppm) for Cd. The values of DDE obtained without systemic exposure were 111.22 and 7.42 mg / kg / day for Pb and Cd in child, respectively, against 2.28 and 34.22 mg / kg / day in adults compared to the limits permitted by WHO which are 3.6 mg / kg / day and 1 µg/kg/day, respectively. These high concentrations of Cd and Pb which imply potential risks especially for children much more exposed than adults appeal to environmental consciousness.

Key words: Lead, cadmium, fish, exposed children, lacustrial city of Ganvié, daily dose of exposure (DDE).

INTRODUCTION

The activities of industrial production generate waste of various kinds which, once discharged into the environment, are likely to adversely affect the ecosystem. They have mostly led to a rapid increase of various pollutants (heavy metals) in urban receiving water bodies such as lagoons, lakes, rivers and seas (Chester, 1982; Ajao et al., 1987; Salvadé et al., 2006). This has adverse effects on the various components of the aquatic environment such as water and fishery products (Skulberg et al., 1984; Saad et al., 1994). Several research works conducted have revealed high doses of contaminants, particularly heavy metals in mussels (Traoré et al., 1999; Moustaid et al., 2005), water (Gnandi et al., 2007; Adam et al., 2010), snails (Edorh et al., 2009) and fish (Gnandi et al., 2007; Hounkpatin, 2010).

This study proposes to assay lead and cadmium in fish from the lacustrial city of Ganvié and to assess the risks

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of the population health. Apart from the lack of information on the subject, a number of reasons warrant this option. The rapid demographic growth, increased urbanization, industrialization and uncontrolled exploitation of natural resources in Benin have resulted in the increase of food-producing crops in the vicinity of streams and market gardens along the beach.

This generates a source of pollution to the sea, rivers and lakes by heavy metals contained in fertilizers and pesticides used. The results of work conducted by Edorh (2009) and Hounkpatin (2010) respectively showed that the sediments of the River Okpara, and Lake Nokoué are polluted by lead and cadmium. Lake Noukoué, the largest inland lake of Benin (150 km² at minimum flow), presents two characteristics: a very high fish production (18046.22 tons on average from 1987 to 1997) (Folal and Gonou, 2001) and a large lacustrian population organized into several villages with houses built on stilts directly implanted into the water. Ganvié is one of the most important villages of the lacustrian housing system with 20,568 inhabitants (INSAE, 2004).

It represents a touristic place visited by many tourists which creates many human-induced activities. Ganvié population has always believed that the lake, their immediate surroundings are an ideal receptacle for waste products in their various natural, domestic and professional activities (Folal Gonou, 2001). The dumping of garbage and solid waste of any kinds, the traffic of petroleum products by dugout canoe, the spillage of petroleum products in the lake, pollution from excessive use of motorized boats, pluvial water disposal from the Cotonou city, the River Ouémé flows, are sources of potential contamination of this ecosystem by heavy metals (Dovonou, 2009). All these wastes, therefore, containing several pollutants, including heavy metals (lead and cadmium), are found directly or indirectly in this lake. They pose a potential risk to this aquatic ecosystem, particularly with their content. These toxic components, very persistent over time, penetrate more or less quickly and directly the food chain, exposing the man slowly but surely to poisoning. In addition, throughout the food chain, some toxic metals (Pb, Cd) are concentrated in living organisms. They can reach very high levels in some species (such as fish) consumed by humans. This presents a real danger to humans because of the phenomena of bioaccumulation in the food chain (CEDA, 1997).

The importance of fish to ensure food security of populations in need was announced in the Bangkok Declaration (Subasinghe et al., 2000). From the standpoint of human nutrition, fish are a source of high biological-value proteins, which currently covers nearly 20% of protein intake. The fish are also excellent sources of micronutrients (trace elements, vitamins or provitamins) and long poly-unsaturated fatty acids (LPUFAs). The LPUFAs promote the improvement of membrane fluidity, decreased blood platelet aggregation and consequently less cardiovascular disease, increased immune resistance and resistance to carcinogenesis (Simopoulos, 2001). These fatty acids are also important for vision and brain development; even they have been played a vital role from the beginning of humanity (Broadhurst et al., 1998; Crawford et al., 1999). Though very essential for man, the sanitary quality of these fish is deteriorating because of pollution of aquatic ecosystems.

The aim of the present study was to determine the concentration of lead and cadmium in fish most consumed in the lacustrian city of Ganvié and to assess the risks associated with its use on the health of populations through the calculation of Daily dose of exposure (DDE).

MATERIALS AND METHODS

Study site

Lacustrian city of Ganvié is located on the north-west bank of Lake Nokoué in Cotonou, at the outlet in the West of Sô Bank in the lake and at 11 km from the landing Whorf of Abomey - Calavi. It is bordered in the north by Sô-Ava, north-east by the lacustrian village of Vekky; north-west by Lake (village near Akassato), in the east by the lacustrian village of Aguégués (Figure 1).

Sampling

All samples were collected in the morning on February 24, 2010, frozen at -20°C and kept cold at 4°C until forwarding to the laboratory of Management, Treatment, and Recovery of Waste (MTRW) called "laboratoire de Gestion, Traitement, et Valorisation des Déchets (GTVD)" of University of Lome (Togo).

The collection of fish was carried out on in the catches from the artisanal fishery made of nets, fish holes (houédos) and acadjas. The fish species most consumed by local people and having an average weight of 70 g ± 5 and an average size of 10 cm ± 2 were selected.

Hence the species:

i. *Sarotherodon melanotheron,* Cichlidae (Omnivore)
ii. *Chrysichthys auratus,* Claroteidae (Carnivore)
iii. *Liza falcipinnis,* Mulgilidae (Omnivore)

Twelve samples of each of these three species of fish chosen were collected (a total of 36 fish). They were placed in labeled polypropylene Falcon tubes, stored in ice and immediately transported to the laboratory.

To assess the risk of population exposure, the whole fish were used but by taking into account the conditions of consumption.

All fish samples were cut and dried in entirety (except viscera) in an electric furnace (oven): initially at 50°C for 12 h and then increased to 120°C for 24 h.

Dosages of heavy metals in samples

All tests were performed in the good laboratory practice, distilled water and pure acids suitable for trace element analysis were used. All samples, after maceration in nitric acid (HNO_3), were digested in a digester (electronic sand bath at 125°C for 1 h) for the extraction of all heavy metals. But only Lead and cadmium were measured by atomic absorption spectrophotometer (AAS).

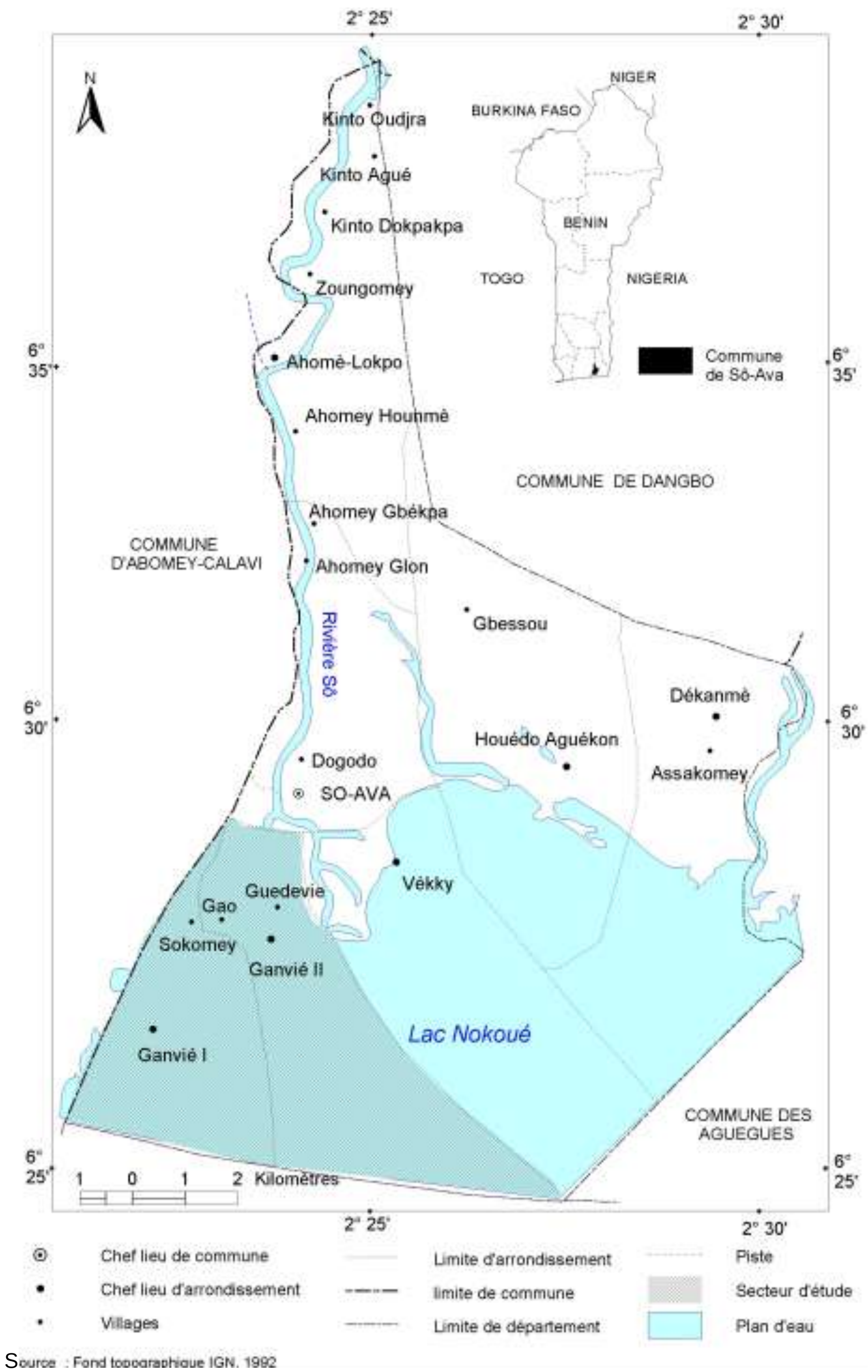

Figure 1. Geographical position of lacustrial city of Ganvié.

Principle of method aphical position of lacustrial city of Ganvié

The atomic absorption spectrophotometer is defined as the absorption of radiation energy by atoms. This absorption is related to the concentration of metal ions present. Which is a metal atom at the fundamental energy state (Eo), this atom receives energy from a radiation (Io), a peripheral electron passes its normal orbit (Eo) to an outer orbit of energy E with

$$E = Eo + h\mu$$

The absorption of a photon intensity Io = hμ is based on spectrophotometry of atomic absorption. After absorption, the incident energy Io becomes I <Io, it is the decrease of energy that is

measured in the atomic absorption spectrophotometer. The decrease in the intensity of transmitted radiation can be represented by the law of Beerlambert:

I = Io expo - (KCL);

I = intensity of transmitted radiation; Io = intensity of incident radiation
K = absorption coefficient; C = concentration in atom; L = length of the path traveled by the radiation through the sample; Absorbance = A = log (lo / l) = Kcl

There was reduction in the number of atoms in the fundamental state which was proportional to the concentration of the absorbing medium. The absorbance was proportional to the number of atoms at any temperature and wavelength.

Instrumentation and reagents

1. Atomic absorption spectrophotometer (AAS) Thermo Orion assisted with software Solaar S2, includes:

i. A light source: which emits radiation of resonance of the considered element, the line emitted should be fine and radiation must be stable, specific and intense enough.
ii. Hollow cathode lamps. Which consist of:

a. A cathode made of metal element to be assayed
b. An anode consisting of a wire or a tungsten disc. Both electrodes are covered with a glass envelope containing an inert gas under low pressure.
c. A noble gas of filling at low pressure.

The mechanism of formation of atoms is as follows: a potential difference was generated between the electrodes. The atoms of noble gas were transformed into ions at the anode and were pulled at high speed toward the cathode. The bombardment of the cathode by these ions released metal atoms. They collided with ions of noble gas and undergo various states of excitation emitting proper radiation of metals of cathode.

2. A generator of atomic vapor (flameless)
3. A flame;
4. Monochromator: it must separate the resonance line of the other lines in the spectrum. The width of the bandwidth is about 0.1 to 0, 2 nm. If the bandwidth is fine top, the energy was insufficient and the measure was indefinite.
5. Detector;
6. Computer recorder connected to a printer;
7. Sand bath; 50 mL volumetric flasks;
8. Set of atomic pipettes or micropipettes (100 to 1000 uL);
9. Pipette with adjustable volume, from 1 to 5 mL with a rubber vacuum;
10. Electrical Balance SCHIMADZU type BX 3200 D;
11. Mortar and pestle with silica;
12. Automatic pipette Calculator or micropipettes for the preparation of analytical standards;
13. Digester;
14. Teflon tube;
15. Storage Bottles of 125 mL and disposable tips;
16. Reference Standards for Cd and Pb;
17. Stopwatch;
18. Laboratory rags; Nitric acid (HNO_3) pure, concentrated (65%) for analysis;
19. Hydrochloric acid (HCl) pure, concentrated (37%) for analysis;
20. Distilled water

Preparation of standard solutions

Calibration standards were prepared from aqueous standard of the same metals, and acid concentration as the samples in order to minimize the matrix effect. The concentration of all commercial stock solutions (reference standard) is 1000 ppm in order to ensure stability.

The standards were prepared: Pb and Cd: 1, 2 and 4 ppm. The Appendix summarizes the results of the preparation of standards.

We performed a calibration according to the standards required by Directive 2001/22/EC of the Commission on March 8, 2001. The concentration of the standards covered the range of sample concentrations that were measured, and the number of standards was related to the number of metals to be determined. A pure white (control) were also prepared to check the quality of the samples. It consists of distilled water and 2 mL of nitric acid for the fish.

Preparation of samples for assaying through ASA

It is essentially about grinding and acid digestion. The grinding technique does not necessarily produce a uniform sample, but it facilitates the digestion step and increases the level of reproducibility. And cross-contamination between samples is negligible. After grinding, weigh 1 g of ground material in a mortar with silica in the electronic balance SCHIMADZU type BX 3200 D. Spilled in the Teflon tubes previously labeled, and then add 5 ml of distilled water. Then add 2 mL2 of nitric acid (HNO_3) concentrated on fish samples.

After these steps, the acid digestion followed, which involves placing the Teflon tubes containing each mixture in a sand bath for 1 hour. Once digestion is complete, Teflon tubes were removed from the bath sand and were placed at room temperature. The mineralized product (digest) was collected in a flask of 50 mL and supplemented with distilled water to the reference line. It is then filtered and stored at 4°C in a 125 mL flask until assay.

Flame atomic absorption spectrophotometer flame was used. The assay was performed by interpolation on standard curves prepared from standard solutions. That was how Pb, and Cd found in fish samples were assayed.

Calculations

The results displayed by the software Solaar S2 on the computer screen associated with the spectrophotometer, is for a solution (AA S reduces interference) and are expressed in ppm. To get the corrected concentration this value was multiplied by the dilution factor of the sample and divided by the initial weight of the sample before digestion.
This is:

$$\text{Final Concentration (ppm)} = \frac{\text{Indicated Concentration} \times 50 \text{ mL}}{1\text{g}}$$

Limit of detection (analysis by flame) = (2.0 × 3 × s) / A

Vital tools and reagents

Hollow cathode lamp (Pb, Cd); Sample used to test the limit of detection (blank solution or standard solution with a concentration 3-5 times higher than the concentration of the expected detection

Table 1. Results of the survey on the amount of fish consumption.

Frequency of consumption	Quantity (g)	Children (%)
	25	15
	50	34
	75	20
	100	11
At least once a day	150	9
	175	7
	200	2
	250	1
	300	1
Average/child	83.25	100

M = ((25 × 15) + (34 x 50) + (75 × 20) + (100 x 11) + (150 x 9) + (175 ×7) + (200 × 2) + (250 x 1) + (300 × 1))/100 = 83.25g.

limit);

Distilled water. Stability (analysis by flame): Use the air-acetylene flame to continuously record the absorbance of the standard solution of metal (for an integration time of 30 s) and measure the range of maximum absorbance values. Consider the ratio between the maximum range (W) and the measured value (B) for the absorbance recorded as changes in reading.

Stability = W / B

Evaluation method of exposure risks

The approach for the assessment was standardized (Ricoux and Gasztowtt, 2005) and conducted in four stages:

i. The selection of the heavy metals and the identification of the risks;
ii. The selection of the reference toxicity values;
iii. The estimation of exposure which will cross the levels of contamination of fish in Pb and Cd to the quantities consumed by a sampled population. Data on the habits, the amount and frequency of fish consumption were collected through group interviews;
iv. The characterization of the risks

Statistical analyses

The calculations were carried out in EXCEL. The software used for descriptive statistics was SPSS 17.0 for the averages and standard deviations. The Student test at a probability of 5% using the section « compare means, one way ANOVA » as well as the Pearson correlation test were used.

RESULTS

The identification of risks

The main toxic effects resulting from consumption of food contaminated with cadmium affect the renal system. These nephrotoxic effects are characterized by proximal tubules' damage and a rise in urinary excretion of low molecular weight proteins associated with bone lesions. The exposure to cadmium may lead to lower mobility and density of sperm in men and the decrease in the newborn weight at birth in women.

When 95% of lead is set in red blood cells, anemia is the biological manifestation of toxicity whose prevalence and severity are directly correlated with blood lead concentrations. Several epidemiological studies strongly suggest a relationship between lead exposure and hypertension, even at very low exposure levels comparable to those which a very large fraction of the population is exposed. But the saturnine nephropathy is associated with exposure to high levels of lead for many years. More worrying are still the consequences of exposure to low doses of lead on the occurrence of congenital abnormalities and neurobehavioral development in the early childhood.

Reference toxicological values

The AFSSA (France) has recommended 1 mg / kg and 3.6 mg / kg of body weight for cadmium and lead values respectively as acceptable daily dose (AFSSA, 2003). According to European Regulation EC No 466/2001, the permitted maximum concentration of Cd in fish is 0.05 mg / kg and 0.4 mg / kg for lead.

Report of fish consumption data

The quantities were estimated according to the images of fish presented on props by parents who gave at least fish to their children a day (Table 1). The minimum average amount of fish consumed per child a day was the median M:

M = ∑ (Quantity (g) x % Children) / 100

M: Median (The minimum average Amount of Fish Consumed per child a day) Quantity (g): minimum amount of fish consumed by children in a day (g) % Children: percentage of children corresponding to different amounts
100: Number of children surveyed

M = ((25 × 15) + (34 x 50) + (75 × 20) + (100 x 11) + (150 x 9) + (175 × 7) + (200 × 2) + (250 x 1) + (300 × 1))/100 = 83.25 g

Measurement of lead and cadmium in fish samples

There was a significant difference ($p < 0.05$) for lead concentration between *S. melanotheron* and *L. falcipinnis* (Table 2). For other means, there was no significant difference ($p > 0.05$). However, since this is an exposure, the average amount of Pb that a child may ingest through

Table 2. Concentrations of lead in fish.

Heavy metal	Sample	Levels of fish contamination by heavy metal (mg/kg)		
		Chrysichthys auratus	***Sarotherodon melanotheron***	***Liza falcipinnis***
Pb	1	23.12	13.12	35.21
	2	28.42	21.02	30.17
	3	31.49	19.48	32.69
	4	29.59	17.13	34.01
	5	27.44	20.18	32.54
	6	29.12	18.59	32.02
	7	32.56	21.01	29.87
	8	32.57	19.44	30.12
	9	30.34	16.98	31.65
	10	28.22	20.12	29.87
	11	27.93	22.06	31.78
	12	33.44	21.03	30.47
	Average ± standard deviation	29.52 ± 2.84	19.18± 2.46	31.70± 1.71
	Overall average ± standard deviation		26.80 ± 0.57	

the consumption of these three species of fish was calculated and was 26.8 ± 0.57 mg/kg.

There was no significant difference for cadmium concentration between the three averages taken in pairs ($p > 0.05$). The average amount of Cd that a child may ingest through the consumption of these three species of fish was calculated and was 1.798 ± 0.29 mg/kg.

The characterization of the risks: calculation of DDE

The daily dose of exposure (DDE)

$DDE_x = (Q \times C_x)/BW$

DDE_x is the daily dose of exposure for the metalin µg /kg/day; Q is the average quantity of fish consumed by a child per kg; C_x is the average concentration of métal measured in the three fish species in µg /kg; BW is the body weight of consumer (child) in kg $_{;\ x:}$ Pb , Cd.

$DDE_{child} = DDE\ e + DDE\ al$;

Where: DDE_{child} = total daily dose of exposure to a toxic in µg / kg / day; DDE_e = daily dose of exposure provided by the consumption of fish contaminated with a toxic in µg / kg / day and DDE_{al} = daily dose of exposure to a toxic food provided by the line feed in µg / kg / day.

$DDE_{adult} = (DDE_{child} \times AW_{child})\ AW_{adult}$

Where: DDE_{child} = daily dose of exposure in child in µg /
Where: DDE_{child} = daily dose of exposure in child in µg /
kg / day; DDE_{adult} = daily dose of exposure in adult in µg / kg / day and AW_{adult} = average weight in adult of 65 kg.

Calculation of risk quotient

The risk quotient is defined as the ratio between the observed average of DDE and corresponding tolerable daily dose (TDD) using the following formula:

$RQ = DDE_{total}/TDD$.

Where, RQ is the risk quotient, DDE_{total} is the total daily dose of exposure in µg / kg / day, and TDD the tolerable daily dose in µg / kg / day.

DISCUSSION

The assessment of exposure of the target population to lead and cadmium in the lacustrian city of Ganvié required the use of two sources of data according to Ricoux and Gasztowtt (2005): The information provided by questionnaire on consumption (Table 1) and the results of the measurements of lead and cadmium in fish samples (Tables 2 and 3). Only the average concentration of lead between *S. melanotheron* and *L. falcipinnis* were significantly different ($p < 0.05$). For other results, there was no significant difference both for the lead and for cadmium ($p > 0.05$) in all the different fish species used. The WHO standards (1998) for the limit concentrations were 0.4 and 0.05 ppm respectively. The values of DDE obtained in the present study were higher than the limits permitted by WHO (1998) which were 3.6 and 1 mg / kg and were more alarming than those obtained with adults of 65 kg which were 34.22 and 2.28 mg / kg,

Table 3. Concentrations of cadmium in fish.

Heavy metal	Sample	Levels of fish contamination by heavy metal (ppm)		
		Chrysichthys auratus	*Sarotherodon melanotheron*	*Liza falcipinnis*
Cd	1	0.23	2.22	2.18
	2	0.26	2.56	3.31
	3	0.41	3.32	2.12
	4	0.27	2.55	2.54
	5	0.32	4.02	1.98
	6	0.13	1.88	1.65
	7	0.57	3.12	3.04
	8	0.47	2.74	2.02
	9	0.33	3.42	1.13
	10	0.18	3.91	1.34
	11	0.22	2.86	2.22
	12	0.21	2.92	1.79
	Average ± standard deviation	0.3± 0.12	2.96± 0.64	2.11± 0.63
	Overall average ± standard deviation		1.79 ± 0.29	

Table 4. Average daily supply and daily dose of exposure to lead and cadmium.

Variable	Lead	Cadmium
ADF child 3 to 8 years	52 µg/jour	7.6 µg/day
DDE al child (20 kg)	2.60 µg/kg/jour	0.38 µg/kg/day
DDE al adult (≥65 kg)	0.68 µg/kg/jour	0.16 µg/kg/day

respectively. However, the DDE obtained in children must be added to the daily dose provided by the line feed (DDEal), inasmuch as children were exposed to the same heavy metals through other foods in the same way as the general population (Ricoux and Gasztowtt, 2005). The average daily food (ADF) and daily doses of exposure (DDEal) provided by the line feed for lead only (Table 4) imply that other foods were contaminated in the same way as fish. The total daily dose of exposure to lead and cadmium (Table 5) was lower in adults (35.01 and 2.40 mg / kg / d) than in children (113.80 and 7.80 mg / kg / d). The risk quotient was very much greater than 1 for children (31.60 and 7.80) and closer to 1 for adults (9.72 and 2.40). Therefore, children pay a double tribute to this pollution because they are not only more exposed to the heavy metal but their bodies are more fragile. Children are more exposed since they consume, with relation to their weight, at least twice as much food as adults and that the contaminants are more easily absorbed in their bodies (RCAP, 1996). Ingested contaminants such as metals can be even more harmful to children. The body of the child absorbs potentially more contaminants and cannot eliminate them as easily as adults since their scavenging system is less developed. Children spend more time playing outdoors and are more exposed to airborne contaminants (RCAP, 1996) which are also in one way or the other in the overall exposure. In addition, there is more risk to an average consumption of 83 g / d of contaminated fish in the village of Ganvié, which is not the case in adults where the risk is theoretically lower. Adults are the main victims of contamination or poisoning with lead and cadmium, but when young children are affected, their health is at risk. Lead and cadmium are the metals most toxic to humans (Testud, 2005). Very small amounts of metals can interfere with cognitive development and cause serious problems. In addition, a significant proportion of pollutants in particular lead inserted into their bodies, about 25%, remains in their blood and causes neurotoxic effects. By contrast, in adults, only 5 to 10% of absorbed lead remains in their blood. The rest is fixed in the bones and teeth (Sanborn et al., 2002). Daily doses of exposure to lead via consumption of fish species *Liza falcipinnis, Sarotherodon melanotheron, Chrysichthys auratus* were found generally higher compared to DDE provided by the line feed (111.22 mg / kg / j> 2.60 mg / kg / day for Pb and 7.42 mg / kg / d> 0.68 g / kg / d for Cd), which implies that lead exposure is more important through consumption of fish than other food sources.

Moreover, lead, toxic element (Le Roux et al., 2005) can cause neurological, hematological, gastrointestinal, reproductive, immunological and apoptotic disorders

Table 5. The results of the assessment of exposure to Pb and Cd.

Metal	Q (kg/d)	Ce (mg/kg)	BW (kg)		DDE (µg /kg/d)		DDE total (µg/kg/d)		RQ	
			Child	Adult	Child	Adult	Child	Adult	Child	Adult
Lead	0.083	26.80	20	65	111.22	34.22	113.80	35.01	31.60	9.72
Cadmium		1.79			7.42	2.28	7.80	2.40	7.80	2.40

(Patrick, 2006; Xu et al., 2008). Recent studies have shown that lead inhibits the activity of enzymes involved in oxidative stress (glutathione peroxidase, catalase and dismutase desuperoxide) (Ercal et al., 2001; Bolin et al., 2006). Other studies carried out in vitro have shown the increase in the production of free radicals after treatment with inorganic lead (Chen et al., 2003; Aykin-Burns et al., 2005). Clinical manifestations of lead are associated with blood lead concentration. However, the threshold of blood lead concentration which shields against clinical signs is related to the acceptable daily dose (ADD) that is achieved with a blood lead level of 20 mg / L in children, corresponding to an acceptable daily dose of 3.6 mg / kg (OMS, 1986). The consumption per individual of food contaminated with lead, which can cause blood levels of 10 mg / dL, may cause the inhibition of enzymes responsible for the synthesis of heme. This inhibition is total for 90 mg / dL (Landrigan and Tod, 1997). On the other hand lead slows the transfer of iron necessary for the development of heme from 15 mg / dL in children and 25-30 mg / dL in adults. It follows a damage of digestive tract, blood (anemia), kidneys and nervous system (Beauchamp, 2003) which are the symptoms of lead poisoning. The signs of chronic intoxication appear with constipation or diarrhea with paroxysmal abdominal pain (Dreisbach, 1983; Beauchamp, 2003). Excessive exposure of human to cadmium can cause his death because of its toxicity (Othumpangat et al., 2005). It enters cells and accumulates in high concentrations in cytoplasmic and nuclear space (Beyersmann and Hechtenberg, 1997; Satoh et al., 2003). It has a high affinity for the liver and kidneys (Cai et al., 2001). The phenomenon of acute toxicity in humans has been known since 1950 as Itai-Itai syndrome defined by the association a renal failure with osteoporosis (demineralization and weakening of bones) and osteomalacia (demineralization and deformation of bones). It is carcinogenic (Satoh et al., 2002; Banerjee and Flores-Rozas 2005) and teratogenic (Hovland et al., 2000). The genotoxic and apoptosis effect was observed in several types of cells (Fahmy and Aly, 2000; Kim et al., 2005; Mondal et al., 2005). WHO recommends that a tolerable weekly dose (TWD) of 7 micrograms of cadmium per kilogram of body weight per week in humans (Regulation CE No. 1881/2006) or 1 mg / kg / day. This element is not virtually eliminated by the body and its half-life in humans ranges from 17 to 30 years (Miquel, 2001).

Moreover, the results obtained in the area of study can be extrapolated to all children in the region due to the relative homogeneity of the average levels of lead and cadmium in fish (Ricoux and Gasztowtt, 2005) apart from the significant difference that exists between *S. melanotheron* and *L. falcipinnis.*

Conclusion

The effects of lead and cadmium on health in terms of risk identification are well known; the concentrations of Cd and Pb were higher than that recommended by WHO which imply potential health risks in the regions. Therefore it is imperative to tackle the problem of the pollution in the Lake Nokoué so as to reduce health risk. Henceforth, the use of chemical fertilizers and pesticides in the plantations in the surroundings of the Lake, the discharge of garbage and solid waste of any kind into the lake, and the spillage of petroleum products in the lake must be prohibited.

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Appendix. Concentrations of standards.

S/N	Standards of reference (ppm)	Final volume (mL)	Volume measured (mL) and final standard(ppm)			
			Pb		Cd	
			V. measured	Final C.	V. measured	Final C
1	1000	50	0.05	1	0.05	1
2	1000	50	0.1	2	0.1	2
3	1000	50	0.2	4	0.2	4