Risk assessment of heavy metals associated with food onsumption in Egypt: A pilot study.

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Abstract

Residues of some heavy metals (HM) were monitored in vegetable, fruit and fish samples collected from local markets of Tanta and Ismailia cities, Egypt. The acidic digested samples were measured on Inductive Coupled Plasma-Optical Emission Spectroscopy (ICP-OES). Samples of vegetables and fruits collected from the vicinity of main roads had some higher levels than other samples. In case of catfish, HMs were monitored only in Tanta region since this fish species is not consumed much in Ismailia city. The mean values detected were 5.38, 0.62, 85.96, 6.41 and 55.05 mg/kg for Cu, Pb, Zn, Cd and Mn, respectively. Target hazard quotient (THQ) values were higher than unity for all metals at 50th and 90th percentile of ingestion. Meanwhile, hazard Index (HI) showed the following order: Cd>Mn>Cu>Zn>Pb. The present study indicated that the repetitive consumption of particular type fish might pose some undesirable health effects. The study also emphasized the need for regular monitoring program beside the need for awareness raising about the food contamination with heavy metals.

Introduction

In Egypt several efforts were taken by regulatory bodies to monitor residues of heavy metals and persistent organic pollutants in various environmental matrices [1]. Organic pollutants in of food increasing health risks is that worldwide nations including Egypt didn't provide safety hazardous chemical standard values in foods [2]. Contamination of heavy metals and persistent organic pollutants in food commodities are a key issue, with serious repercussion on public health [3]. Residues of these contaminants have been linked to developmental neurobehavioral problems, altered function of immune cells and possible childhood leukemia [4]. The Total Diet Study or Market Basket Survey Program initiated by Food Drug Administration (FDA) in the early 1960s and modified in 1980s in which dietary intake of selected pesticides, industrial chemicals, toxic elements and radionuclides monitored has been one of the major steps to draw attention to the health impacts of these contaminants [5-7].

Most of HMs are not biodegradable, have long biological half-lives and have the potential for accumulation in the different body organs leading to undesirable side effects [8,9]. Studies have also shown that, the intake of HMs can lead to altering of `humans and animals healthiness state. In this respect there is some strong indications that relate the presence of some heavy metals residues in food and the incidence of gastrointestinal cancer [10,11] and cancer of pancreas, urinary bladder or prostate [12].

Food safety is a major public concern worldwide and food consumption has been identified as the major pathway for human exposure to contaminants. During the last decades, the increasing demand of food safety has stimulated research

regarding the risk of POPs and HMs associated with food consumption [13,14]. Risks of HMs associated with vegetables, fruits and fish consumption were established in many studies. Vegetables, fruits and fish are able to accumulate higher amounts of contaminants in their tissues. Fish are also considered a good indicator for ecosystem pollution [15-17]. This is an original research paper. So kindly discuss the novelty of this. No current studies have focused on the foods HMs monitoring in Egypt. The present study aims to assess the risk of HMs associated with some vegetables, fruits and fish consumption in two main cities in Egypt, Ismailia located in the East of Egypt and Tanta located in the Centre of Nile Delta.

Materials and Methods

Samples collection

Eighty different samples were collected randomly from markets of each of the two cities. Fish samples were Nile tilapia and catfish, while vegetable samples were tomatoes, cucumber, carrots, potatoes and squash, and fruit samples were peach, orange and pineapple. These kinds of foods are the mostly consumed in these regions. The samples were placed in paper bags, labeled and transferred in ice box to laboratory, labelled and stored at -20°C until used.

Heavy metals analysis

The collected samples were washed with distilled water to remove the dust particles. Then, they were cut to small pieces using clean knife. Different parts (roots, stems and leaves) of vegetables were dried at 100°C. After drying, the samples were grinded into a fine powder using a commercial blender and stored in dissector until used for acid digestion.

Fish

The dried samples were digested with concentrated nitric acid. Ten ml of ultrapure concentrated HNO_3 (Merck) were added, and heated on a hot plate for clear solution. After cooling, 10 ml of conc. HCl were added and heated until constant volume. The solution was transferred, diluted and filtered through 0.45 μm nitrocellulose membrane filter [18].

Fruits and vegetables

500 mg of dried sample was put in crucible and digested with perchloric: nitric acid (1:4 v/v) to constant volume. After cooling, the digested samples were filtered and made up to the final volume 30 ml using deionized water [19]. All reagents were of analytical reagent grade. Deionized water was used throughout the study. All the plastics and glass wares were washed in nitric acid for 15 min and rinsed with deionized water before use. Instrumental calibrations with standard solutions were done for optimum conditions.

Inductively coupled plasma optical emission spectroscopy (ICP-OES)

Five metals; Cd, Pb, Mn, Zn and Cu were analyzed through Inductively Coupled Plasma Optical Emission Spectroscopy (ICP-OES) instrument. All measurements were performed on Agilent microwave plasma model 4200 MP-AES. An auto sampler was used to deliver samples into instrumental at 3 replicates and cyclonic spray chamber (double pass cyclonic Agilent SPS 3) with mass flow controlled nebulizer gas flow as 0.65 L/min. The instrument was operated in a fast sequential mode at rinse time 30 sec with stabilization time 15 sec and featured to cooled CCD detection. Background and spectral interferences could be easily corrected and accurately using Agilent's MP Expert Software.

The limits of detection (LODs) of measured metals were calculated as double of the standard deviation of a series of measurements of a solution against the blank absorbance [20]. Working standards were used to ensure reliability of the results. A recovery experiment was carried out by spiked the blank with 50 and 100 ppm of multi-standards of desired metals and the procedures were done as described above.

Quality assurance/quality control (QA/QC)

Strict quality assurance of the analytical process was routinely observed for the instrumentation processes. All the glass and plastic wares were washed with nitric acid, afterward rinsed with deionized water. All reagents were of analytical grade and deionized water was used throughout the study. Five ranges of external standard solutions were prepared for calibration curve with good linearity (R2>0.99).

Risk estimation

The risk of contaminated fish, vegetables and fruits consumption was estimated based on guidelines of EPA [21-23], concentrations of HMs, data of surveyed questionnaire conducted on inhabitants of Ismailia and Tanta and some data of Integrated Risk Information System [24].

The chronic daily intake (CDI) (mg/kg/day) from food ingestion was estimated using the following formula:

$$CDI = \frac{C.IR . ED . EF}{BW. AT}$$

Where C is the concentration of metal expressed as mg/kg. IR is the ingestion rate (estimated under community survey). ED is the average period (estimated). EF is the exposure frequency (meal/year). BW is the body weight (estimated). AT is the averaging time (365 day/year) [25].

Estimation of cancer risk through ingestion route depend on the availability of cancer slope factors which are provided on USEPA web site [23,24]. In brief, cancer risk was estimated as follows:

$$Risk_{oral} = CDI_{oral} \times SF_{oral}$$

On the other hand, non-carcinogenic risk was evaluated based on the reference doses (RfDs). Target hazard Quotient (THQ) of chemicals via ingestion route was calculated as follows:

$$THQ = \frac{CDI}{RFD}$$

Where, RFD is the reference dose of specified substances [23,24]. Total THQ or hazard index (HI) is the sum of more than one hazard quotient for all metals.

Statistical analysis

Coefficient of variation percentage between obtained data was determined by Gomez et al. [26]. Exposure estimation data were tabulated according to differences in age between adult and children. All exposure estimations, risk and hazard calculations were performed according to probability 50th and 90th percentile of ingestion.

Results

The limits of heavy metals detection (LODs) and other working conditions are presented in Table 1. The selected instrument (ICP-OES) was calibrated on wavelengths; 213.86, 228.80, 324.75, 405.78 and 403.08 nm and adjusted for LODs as follows: 4.50, 2.10, 0.70, 3.30 and 0.2 ng/ml for Zn, Cd, Cu, Pb and Mn respectively.

Heavy metals residue levels

Concentrations of HMs detected are presented in Table 2. The mean concentrations of Pb, Zn, Cd and Mn were 13.86, 26.02, 1.94, 33.34 and 15.29, 93.59, 1.52, 34.81 mg/kg for samples of Tanta and Ismailia regions, respectively. However, Cu ranged from 2.49 to 18.45 mg/kg in samples of Tanta and from BDL to 17.12 mg/kg in samples of Ismailia region. The mean concentrations of Cu, Pb, Zn, Cd and Mn were 4.98, 18.49,

Table 1: Operational conditions of ICP-OES for determination of HMs in different matrixes.

Element	Wavelength (nm)	LOD (ng/ml)	LOQ (ng/ml)
Zn	213.86	4.5	15
Cd	228.8	2.1	7000
Cu	324.75	0.7	2000.33
Pb	405.78	3.3	11
Mn	403.08	0.2	667

LOD= limit of determination. LOQ= limit of quantification.

Table 2: Heavy metals levels (mg/kg) measured in matrixes samples collected during 2015–2016.

Element	Tanta		Ismailia		MRL (mg/kg)
	range	mean ± SE	range	mean ± SE	
Vegetables					
Cu	(2.49-18.45)	9.52 ± 0.52	(BDL-17.12)	7.61 ± 0.15	10
Pb	(BDL-37.01)	13.86 ± 0.04	(BDL-33.69)	15.29 ± 0.36	2
Zn	(BDL-67.55)	26.02 ± 0.38	(3.08-267.74)	93.59 ± 0.18	5
Cd	(BDL-4.45)	1.94 ± 1.03	(BDL-4.75)	1.52 ± 0.37	0.1
Mn	(20.07-44.20)	33.34 ± 0.54	(31.81-40.11)	34.81 ± 0.62	2-9
Fruits					
Cu	(BDL-8.69)	4.89 ± 1.03	(BDL-4.52)	2.10 ± 2.04	10
Pb	(2.82-34.21)	18.49 ± 0.26	(BDL-33.02)	11.20 ± 1.78	2
Zn	(BDL-0.59)	0.34 ± 0.04	(BDL-0.57)	5.09 ± 0.57	5
Cd	(3.84-6.87)	4.88 ± 1.43	(4.14-6.21)	1.52 ± 0.37	0.1
Mn	(18.67-21.92)	20.49 ± 0.83	(23.61-37.86)	30.39 ± 1.39	2-9
Tilapia fish					
Cu	(0.96-9.02)	5.29 ± 0.01	(2.14-11.72)	4.59 ± 0.025	3
Pb	(1.90-11.70)	4.68 ± 0.05	(5.88-14.63)	6.34 ± 1.23	2
Zn	(42.29-105.66)	78.91 ± 0.001	(24.42-100.52)	61.41 ± 0.003	30
Cd	(3.64-8.28)	6.16 ± 0.33	(4.65-5.86)	5.20 ± 0.30	0.5
Mn	(50.96-67.31)	60.78 ± 0.38	(45.03-66.30)	59.14 ± 0.02	0.5
Catfish					
Cu	(1.39-8.73)	5.38 ± 0.013	(BDL)	BDL	3
Pb	(0.95-1.54)	0.62 ± 0.05	(1.43-20.70)	9.55 ± 0.018	2
Zn	(40.67-110.63)	85.96 ± 0.001	(43.86-99.52)	83.99 ± 0.002	30
Cd	(3.43-9.90)	6.41 ± 0.33	(3.84-7.27)	5.81 ± 0.48	0.5
Mn	(51.44-90.00)	55.02 ± 0.38	(52.88-73.40)	63.18 ± 0.25	0.5

MRL= maximum residue limit; WHO, 1984.

0.34, 4.88, 20.49 and 2.10, 11.20, 0.19, 5.09, 30.39 mg/kg for samples of Tanta and Ismailia regions respectively.

On the other hand, HMs levels in samples of Nile tilapia of Tanta region were 5.29, 4.68, 78.91, 6.16 and 60.78 mg/kg for Cu, Pb, Zn, Cd and Mn respectively. However, HMs mean values in samples of Ismailia region were 4.59, 6.34, 61.41, 5.20 and 59.14 mg/kg. HMs levels in catfish samples had the mean values 5.38, 0.62, 85.96, 6.41 and 55.05 mg/kg for Cu, Pb, Zn, Cd and Mn, respectively.

Chronic daily intakes

The results of ∑CDIs of HMs associated with different matrix consumption in Tanta and Ismailia region are presented in Table 3. Regarding vegetable consumption, residents of Ismailia region had CDI values higher than those of Tanta residents, where ∑CDIs values of adults were 3.818 and 20.047 mg/kg/day at 50th and 90th percentile of ingestion. The mean values for adults were 11.933 and 5.687 mg/kg/day in Ismailia and Tanta region, respectively. Similarly, children categories in Ismailia had higher values than those of Tanta region However, residents of Tanta had the highest value (1.849 mg/kg/day) for 15 years old group at 90th percentile and the least value (0.258 mg/kg/day) was recorded for 6 years old group at 50th percentile. The percentages of absorbed doses of HMs are illustrated in Figure 1a. In Tanta region, picked up dose percentages for adult had the highest value (39.4%) for Mn, while the least value (2.3%) was recorded for Cd. In Ismailia region, Zn exhibited the highest picked up dose (61.3%) followed by Mn (22.8%), Pb (10.1%), Cu (4.9%) and Cd (0.9%) respectively. Regarding children categories, Mn exhibited the highest value (42.9%) followed by Zn (28.3%), Pb (15.1%), Cu (10.4%) and Cd (3.4%) respectively in Tanta region. In Ismailia region, Zn exhibited the highest

value (61.0%) followed by Mn (22.7%), Pb (10.3%), Cu (5.0%) and Cd (1.0%) respectively.

In case of fruits consumption, no significant differences were recorded between residents of the two cities for adult and children categories. The mean values were 3.295 and 3.820 mg/kg/day for adults of Tanta and Ismailia region, respectively. Children categories had the highest value at 90th percentile 0.679 and 1.374 mg/kg/day for 6 years old group and 1.849 and 1.479 mg/kg/day for 15 years old group respectively. The percentages of taken doses of HMs via fruits consumption are illustrated in Figure 1b. Residents of Tanta region showed the highest value (42.0%) for Mn followed by Pb (37.7%), Cu (10.2%), Cd (10.0%) and Zn (0.5%) respectively. The percentages of picked up doses of HMs in Ismailia region were as follows: Mn>Pb>Cd>Cu>Zn with values 62.1, 22.8, 10.4, 4.3 and 0.4% respectively. Regarding children categories of Tanta, the order was as follows: Mn>Pb>Cu>Cd>Zn with values 42.0, 38.0, 10.2, 10.0 and 0.5%, respectively. However, in Ismailia region concentrations detected for Mn>Pb>Cd>Cu>Zn were as follows 61.0, 22.4, 10.2, 6.3 and 0.4% respectively.

Regarding fish consumption, tilapia and catfish are considered the main species for residential consumption in Tanta region, but hardly consumed in Ismailia. ∑CDIs values of tilapia consumption in Ismailia were higher than those of Tanta region. The values were 2.504, 8.879 and 1.300 and 7.870 mg/kg/day for adults at 50th and 90th percentile in Ismailia and Tanta region, respectively. Regarding children categories, the values were 0.360, 0.825, 0.800, 1.895 and 0.046, 0.852, 0.362, 1.510 mg/kg/day for Ismailia and Tanta age groups at 50th and 90th percentile, respectively. The percentages of picked up doses are illustrated in Figure 1c. In Tanta region, Zn in tilapia fish

Table 3: *Sum of chronic daily intake (∑CDIs)(mg/kg/day) of HMs associated with different matrix consumption.*

Age categories	Tanta				Ismailia		
	vegetables	fruits	tilapia	catfish	vegetables	fruits	tilapia
adult							
50th	1.949	1.129	1.3	1.29	3.818	1.222	2.504
90th	9.424	5.461	7.87	7.74	20.047	6.418	8.879
mean	5.687	3.295	4.585	4.515	11.933	3.82	5.692
Children (year)							
(6 year) 50th	0.258	0.136	0.046	0.216	0.37	0.117	0.36
90th	1.172	0.679	0.852	0.838	4.293	1.374	0.825
(15 year) 50th	0.995	0.237	0.362	0.355	0.888	0.353	0.8
90th	1.849	1.231	1.51	1.484	4.65	1.479	1.895
mean	1.069	0.571	0.693	0.723	2.55	0.83	0.97

∑CDIs were estimated for HMs; Cu, Mn, Cd, Zn and Pb, respectively, for desirable age categories.
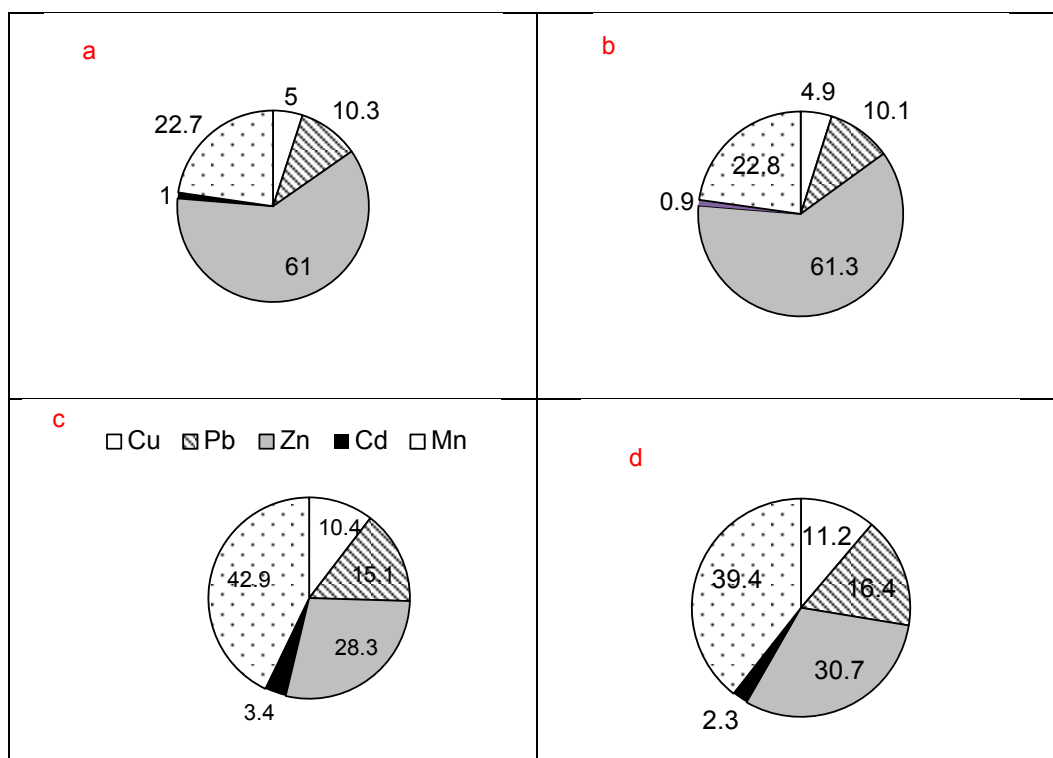

Figure 1a. *The percentage of absorbed doses for HMs via vegetable consumption in Ismailia region (a) children, (b) adult, in Tanta region (c) children and (d) adult, respectively.*

samples exhibited the highest value (50.6%) followed by Mn (39.04%), Cd (3.94%), Cu (3.38%) and Pb (3.05%) respectively for adults. Regarding Ismailia residents, HMs doses percentage were 44.93, 43.27, 4.64, 3.80 and 3.36% for Zn, Mn, Pb, Cd and Cu respectively while for children doses percentage were 50.71, 38.4, 4.33, 3.75, 3.25% and 44.95, 43.2, 4.02, 3.20, 4.64% for Zn, Mn, Cd, Cu and Pb in Tanta and Ismailia region respectively.

In case of catfish, HMs had ∑CDIs values of 1.290 and 7.740 mg/kg/day for adults of Tanta region at 50th and 90th percentile of ingestion. However, they had values of 0.216, 0.888, 0.355 and 1.484 mg/kg/day for children categories at 50th and 90th percentile. The percentages of picked up doses are illustrated in Figure 1d. The percentage values were in the following order: Zn>Mn>Cd>Cu>Pb for adults 56.04, 35.88, 4.10, 3.54 and 0.10% respectively. The order for children categories was 56.10, 35.90, 4.20, 3.50 and 0.30% respectively.

Non-cancer risk

Target hazard quotient (THQ) values of HMs associated with vegetables consumption in Tanta and Ismailia are illustrated in Figure 2(a). In Tanta region, HI was estimated for Cu, Pb, Zn, Cd and Mn respectively at 50th and 90th percentile of ingestion. For adults, Cd had the highest values of 3898 and 18848 at 50th and 90th percentile, while Pb had the least values of 4.53 and 21.92 at the same rank of ingestion. Among children categories, HI ranged from 114.66 to 433.46 at 50th and from 522.87 to 946.25 at 90th percentile of ingestion. The positively detected HMs had the following HI values Cd>Mn>Cu>Zn>Pb respectively. In case of Ismailia region, Cd showed the highest values at 7636 and 40094 at 50th and 90th percentile, while Pb had the least values 8.88 and 46.62 at the same rank of ingestion. Among children, HI ranged from 164.18 to 395.95 at 50th and from 1914.13 to 2059.18 at 90th percentile of ingestion. The response of HI was as follows: Cd>Mn>Cu>Zn>Pb for both age groups.
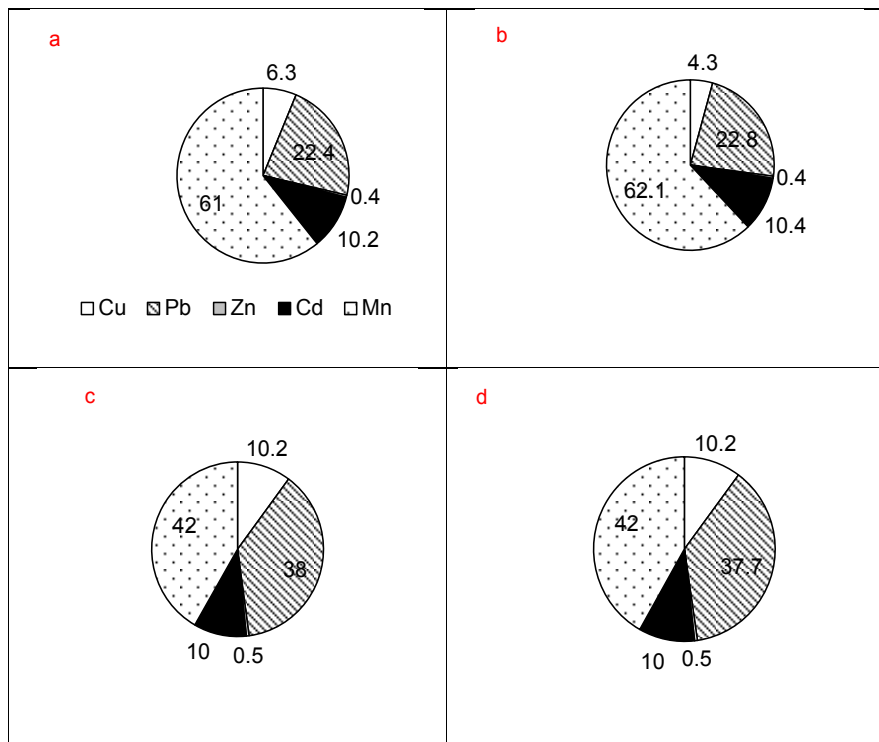
Figure 1b. *The percentage of absorbed doses for HMs via fruits consumption in Ismailia region (a) children, (b) adult, in Tanta region (c) children and (d) adult, respectively.*
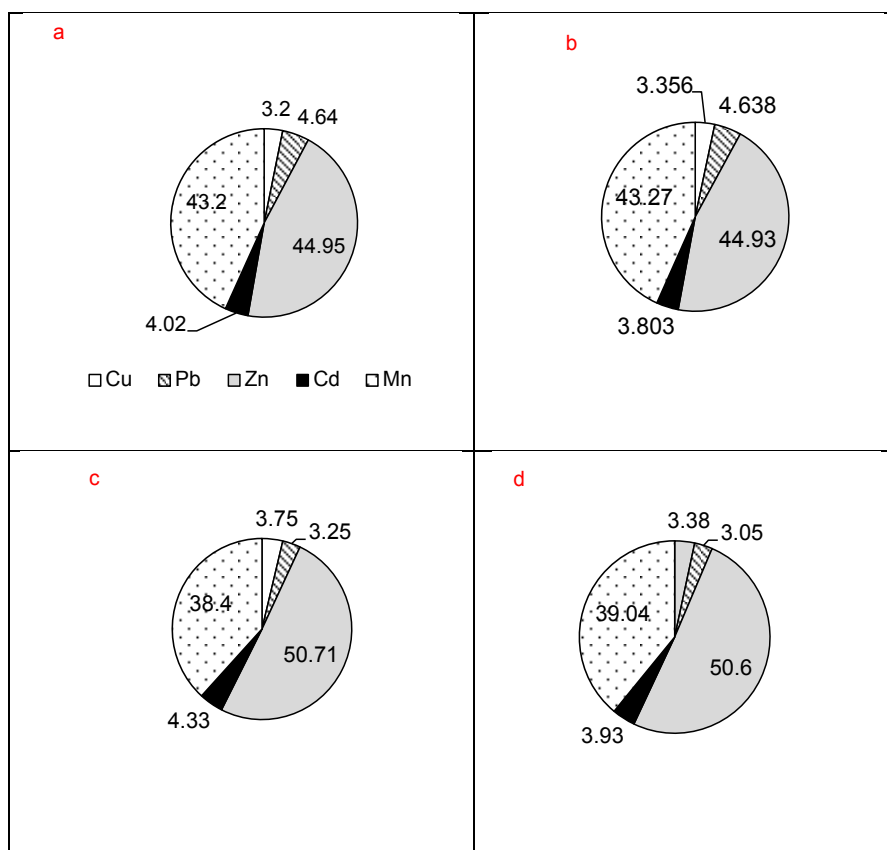

Figure 1c. *The percentage of absorbed doses for HMs via tilapia fish consumption in Ismailia region (a) children, (b) adult, in Tanta region (c) children and (d) adult, respectively.*

THQ values of HMs associated with fruits consumption are illustrated in Figure 2(b). In Tanta region, Cd had the highest values of 2258 and 10922 at 50th and 90th, while Pb had the least values of 2.63 and 12.70 at the same rank of ingestion pathway. Regarding children categories, HI ranged from 60.07 to 105.33 at 50th and from 1325.49 to 548.57 at 90th percentile of ingestion pathway. HI values of measured HMs were in the following order Cd>Mn>Cu>Zn>Pb for both age groups. In Ismailia region, Cd showed the highest values of 2444 and 12836 at 50th and 90th while Pb recorded the least values 2.84 and 14.93. For children groups, HI ranged (52.4-156.86) and (112.92-639.44) at 50th and 90th percentile of ingestion pathway at the same minor.

THQ values of HMs associated with tilapia fish consumption are illustrated in Figure 2(c). As mentioned above, Cd had the highest values of 2600 and 15740 for adults residents of Tanta region. However, Pb recorded the least values 3.02 and 18.30 at 50th and 90th percentile of ingestion pathway. Among children categories, HI exhibited the ranges (20.30-32.13) and (75.85-134.51) at the same rank of exposure. HI was in the same minor as described above in cases of vegetables and fruits consumption. Regarding Ismailia residents, the highest values of HI for Cd were 1001.6 and 3552.0 and the least values for Pb were 1.16 and 4.13 at the same rank of exposure. HI exhibited the ranges (160.61-357.00) and (368.06-845.42). Moreover, HI for all HMs was in the same minor.

THQ values of HMs associated with catfish consumption are illustrated in Figure 2(d). Mean HI values of Cu, Pb, Zn, Cd and Mn were 112.88, 10.5, 15.05, 9030.0, 903.0 respectively, for adult at 50th and 90th. Regarding children categories, HI ranges were (18.85-31.66) and (74.73-287.54) at the same rank of exposure.

Discussion and Conclusion

Metals are considered the most common environmental pollutants. Their accumulation and distribution in soil and water increase to an alarming rate, causing deposition and sedimentation in water reservoirs and affecting aquatic organisms [27,28]. Rapid, unorganized urban and industrial developments have contributed to the elevated levels of HMs in the urban environment of developing countries such as Egypt [29], Iran [30], China [31] and India [32-35].On the other hand, plants contain the amount of Cu, which is inadequate for normal growth of plants. However, application of micronutrient fertilizers and copper-based fungicides may sometimes increase it to the alarming levels [29].

The information presented by Dogheim et al. [36] are in agreement with this study, where Cd slightly exceeded MPL. Many investigators are in agreement with our findings, Soliman et al. [36-39] who reported occurrence of Pb in different kinds of vegetables at similar concentration levels.

Hassan et al. [40] determined some trace metals in commercial fruit juices in Egypt. They reported moderate Cu values. However, Zn concentrations in all samples were lower than MPL, besides Cd and Pb were below MPL. Comparing with our findings, Zn and Cu also were lower than MPL. Abou-Arab et al. [41] reported that the highest levels of Pb were detected in the samples collected from industrial and areas of heavy traffic. While the least Pb value was recorded in the rural areas. Consequently, we can explain, why there are high levels of Pb in some fruit and vegetable samples in the present study. From this point, the levels of Pb in the atmosphere of Egyptian industrial and urban areas were higher than the levels in in rural areas and in some other countries [42,43].

Although, vegetable and fruit samples of Tanta region have slightly lower Mn contents than Ismailia region, levels of Mn in both regions exceeded MPLs. The reasonable explanation is mainly attributed to the heavy traffic in both Tanta and Ismailia, in addition to the presence of some industrial facilities in the country side of close proximity to areas grown with vegetables and fruits.

The selection of fish species is a critical issue in bio-monitoring studies. Nile Tilapia avoid long-term exposure to metal pollution at a particular site by activity swimming, while African catfish have a more stationary behavior and thus may be exposed to metal pollution for a long time [44]. However, the difference in sensitivity of Nile Tilapia and African catfish to metal bio-accumulation might be attributed to their feeding peculiarities' [45]. Mohamed et al. [46] reported the concentrations of Pb, Cd
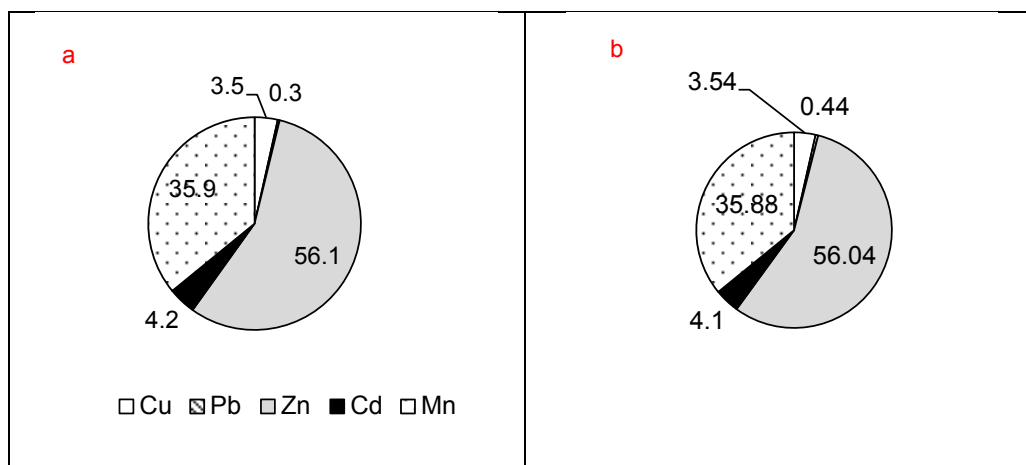

Figure 1d: *The percentage of absorbed doses for HMs via catfish fish consumption in Tanta region (a) children and (b) adult, respectively.*
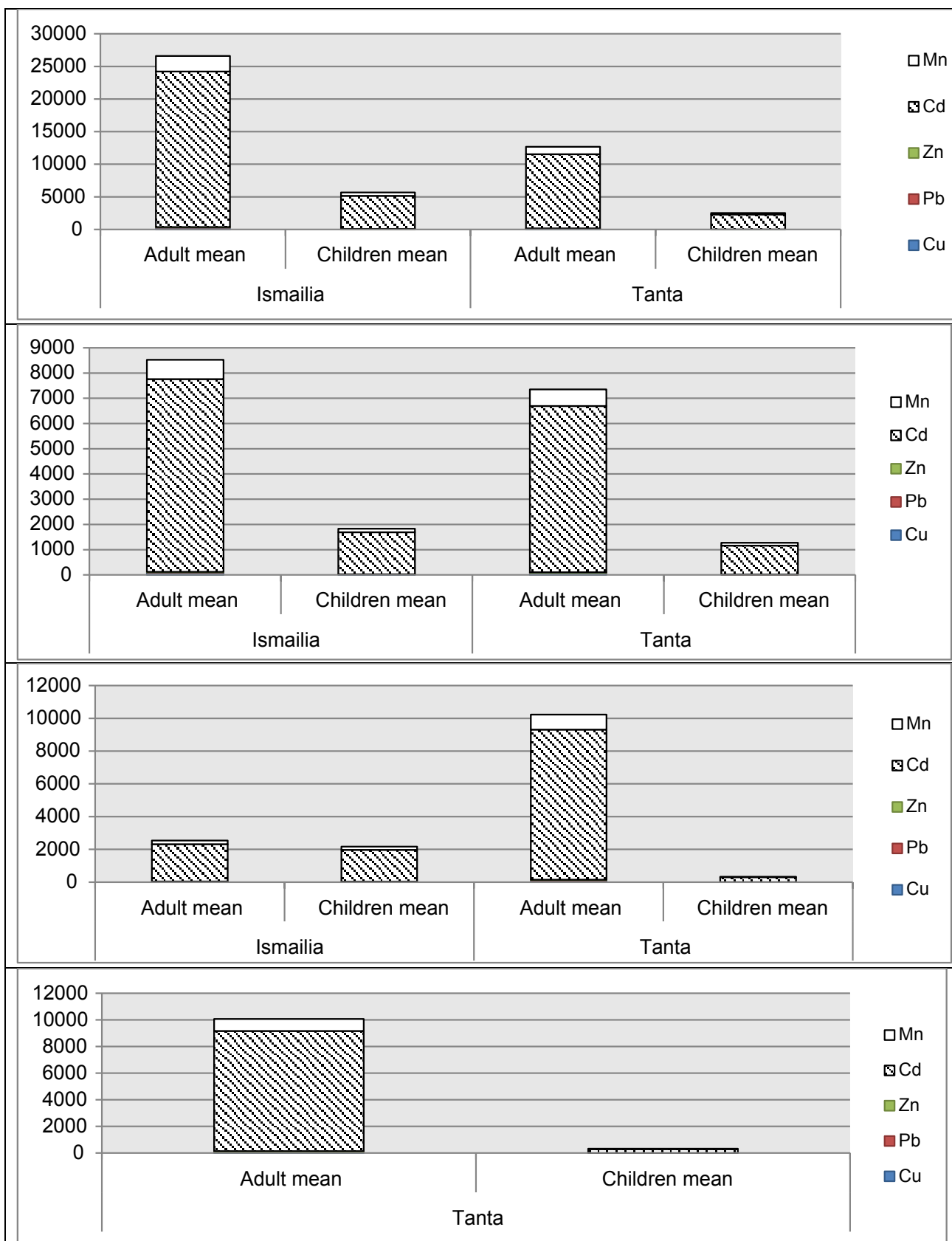
Figure 2: *Estimated non cancer risk (THQ) of heavy metals associated with (a) vegetables, (b) fruits, (c) tilapia fish and (d) catfish consumption, respectively.*

and Cu in the edible parts of fish samples in the following order Pb> Cd> Cu respectively. This finding is exactly in agreement with the current study regard fish samples from Ismailia region. Monitoring of HMs by Ibrahim et al. [47] showed that Zn and Cu concentrations were the highest in muscles of African catfish in the same minor for Zn levels. This is in agreement with the findings of Shakweer et al. [48], who concluded that the concentration of trace metals in various organs of fish reflects the degree of water pollution in the aquatic environments.

Non-cancer risk

In the present study, HI values resulting from vegetables, fruits and fish ingestion exceeded the threshold value (HI=1) indicating signs of possible toxicity for both age categories. Abdel-Halim et al. and Omer et al. [49-51] showed that HI values of HMs resulting from fish ingestion were greater than unity suggesting some undesirable health effects associated with high fish consumption. Abdel-Khalek et al. [52] showed that the calculated HI indicated that each metal had low HI, but the cumulative impacts of all metals represented possible threat for consumers of higher consumption rate of fish.

The toxicity of non-essential metals occur through the displacement of essential metals from their native binding sites, or through ligand interactions in the conformational structure of nucleic acid and proteins or the interference with oxidative phosphorylation and osmotic balance [53]. Higher levels of both essential and non-essential metals can damage cell membranes, alter enzyme specificity, disrupt cellular functions, bind with greater affinity to thiol-containing groups and oxygen sites than the essential metals do, and damage the structure of DNA [54]. Previous studies have shown that certain metals can cause either increasing or decreasing levels of serum protein, glucose and cholesterol, as well as changes in serum enzymes activities [55]. In toxicological studies acute exposure changes in activities of some enzymes may reflect cell damage in specific organs [56]. HMs are among the major contaminants of food supply and may considered the most important problem to environment [57]. The problem is specially developing countries because of lack of awareness [58-61].

The present study has indicated the need to monitor contamination with heavy metals in food on regular basis and at larger scale. In addition, the study emphasize the importance of raising awareness about heavy metals contamination as one important issue that include the need for through washing of fresh food before consumption in order to avoid risks posed by heavy metals contamination [62-64]. Equally important is to devise a mechanism to monitor residues of heavy metals in various matrices, with special reference to food at larger scale that would allow a more comprehensive view [65-67].

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