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Human health risk assessment associated with current Egyptian dietary intakes of fish

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Abstract

The present study is a theoretical analysis aiming to provide a comprehensive assessment of the threats posed by some metals contaminant of fish to human health. The available data (1990-2006) are the concentrations of metals Cd, Pb, Hg, Zn, Cu, Fe, Mn and Ni in the edible muscle of different fish species collected from River Nile, Lakes of Manzala, Mariut, Edku, Burollous, Bardawil, Qarun and Wadi El-Rayan. It has been found that, the levels of Cd, Pb and Ni and are often above the maximum permissible limits according to FAO standards. In contrast, the levels of Zn, Cu, Fe, Mn, Ni and Hg are within acceptable limits. However, exceptions in concentrations of some metals have been recorded in some locations. The metal pollution index (MPI) of fish collected from different Egyptian aquatic resources was 8.803. To determine if consumers are at risk from consuming fish, the dietary exposure to metals was calculated. A comparison was carried out with the international accepted safe exposure level. The results demonstrated that, in child group(av. Body weight 15kg), the intake of Pb and Hg were generally above the maximum allowable concentrations (MAC), while in youth(av. 40 kg) and adult groups(av. 70 kg) , the intakes were safe within the limits.. Finally, the calculated Cd, Cu, Zn and Fe intakes were clearly below the safe limit. It is concluded that, the intake of metals depends not only on the levels of metals in fish, but also on the amount consumed.

Key words: Heavy metals; Fish; Metal pollution index; Dietary intakes; Provisional tolerable weekly intake; Egypt.

1. Introduction

Fish play an important role in the nutrition of the Egyptian population. According to statistical data of the General Authority of Fish Resources Development, the yearly total per capita consumption of fish has increased from 3.20 Kg in 1974 to 6.50 Kg in 1990 and to 15.32 Kg in 2005 (GAFRD, 2005). Nevertheless, fish is a commodity of potential public health concern as it can be contaminated with a range of environmental persistent chemicals, including heavy metals (United States Environmental Protection Agency, 1996). Therefore, the study of the uptake and bioaccumulation of heavy metals by fish has received a considerable stimulus from concern for the effect on humans from eating fish which might contain these toxicants. In Egypt, although there are no cases of overt metal poisoning resulting from the consumption of fish has been reported, a potential for adverse health effects in some population groups can not be ignored. This is because some people may be increasingly exposed to the effects of metals contaminations and some of the effects of metals toxicity can be subtle and difficult to be detected and measured. So, it is timely to review the metal contaminated load of the Egyptian fish supply and the potential dietary exposure of the population.

The present study has two goals. The first is to determine the levels of heavy metals contamination in some Egyptian fish from different locations. The second is to identify any potential public health risks that could be associated with current Egyptian dietary intakes of fish.

2. Materials and Methods

A literature survey covering the years 1990-2006 were analyzed to identify the mean levels of metal contamination in the muscle of different fish species. No analyses were done on other parts of these fish such as the liver, kidney, brain….etc. where some metals are preferentially stored. The metals of interest were cadmium (Cd), lead (Pb), mercury (Hg), zinc (Zn), copper(Cu), iron(Fe), nickel(Ni) and manganese(Mn). Metals contaminations were identified in fish from the River Nile, Lakes of Manzala, Mariut, Edku, Borollous, Qarun, Bardawil and Wadi El-Rayan. Metals concentrations are reported as per wet weight of tissue. In some references, data were measured as per dry weight. It transforming to wet weight by dividing the dry weight by 5, the wet / dry weight of most tissues (El-Nemr, 2003). Data quality assurance was made by using values within ±0.5 standard deviation. Other results were not used in order to reduce the high variability in fish metal concentrations obtained from different references.

Metal pollution index (MPI) was calculated according to Usero *et al.,* (1997).

$$MPI = (M_1 \times M_2 \times M_3 \times \ldots\ldots\ldots\ldots \times .M_n)^{1/n}$$

Where M_n is the concentration of metal n expressed in µg/g of wet weight. In this study, the metals Cd, Pb, Zn, Cu, Mn, Ni and Hg were used to calculate the MPI.

Daily exposure to a given metal was determined according to the following formula: Daily intake of heavy metal = concentration of heavy metal in fish (µg/g wet weight) × mean fish intake (g / person / day)

Weekly intake of heavy metal = daily intake of heavy metal × 7 days / week

Weekly intake per body weight (Kg) = weekly intake ÷ reference consumer body weight

Where, the weight of adult person is estimated in average as 70 Kg, the young person of approximately 40 Kg and the child of 15 Kg (Salas *et al*., 1985; Albering *et al*., 1999). The fish intake in Egypt is 15.32 Kg/ capita according to GAFRD (2005).

Results and Discussion

To assess the situation in Egyptian fish supply, a literature study was carried out. A number of relevant publications were analyzed. Most probably more data exist, but the number of sampled fish is large enough to consider the data as representative. The mean metals concentrations in the muscle of fish (µg/g fresh tissue) collected from different Egyptian aquatic resources are shown in Table 1. The levels of toxic metals found in Egyptian fish are relatively high but often above the maximum allowable concentration (MAC) according to generally accepted FAO standards. As far as heavy metals are concerned, especially Pb, the average levels found are generally high (3.13 µg/g fresh tissue) and 71.14% of fish samples are found at levels exceeding the standard (0.50 µg/g fresh tissue). A significant source of the lead contamination of atmospheric water, and thereby also surface water, are the exhausted gases of motor vehicles which contain the products of decomposition of tetraethyl lead. In the aquatic medium, lead largely accumulates in bottom sediments where the lead content is about four orders larger than in water. The highest concentration of Pb was found in Lake Mariut (41.56 µg/g; NWRP, 2000). Lead is known to induce reduced cognitive development and intellectual performance in children and increased blood pressure and cardiovascular disease in adults (Commission of the European Communities, 2001). Also, notorious toxic metals as Cd were found in concentrations above the acceptable levels. The average levels found are generally high (0.37 µg/g fresh tissue) and 91.64% of fish samples were found at levels exceeding the standard (0.05 µg/g fresh tissue). The highest value of Cd was recorded at the Nile, Benha (2.00 µg/g; Ameria, 1998). It is well known that, Cd may accumulate in the human body and may induce kidney dysfunction, skeletal damage and reproductive deficiencies (Commission of the European Communities, 2001). The mean levels of Ni found in this study were generally high (8.11µg/g fresh tissue) and 70.78% of fish samples exceeding the standard (6.00 µg/g fresh tissue). The highest value of Ni was recorded from Lake Edku (31.36 µg/g; Shakweer and Abbas, 2005). Nickel can cause respiratory problems and consider as carcinogen agent (Agency for Toxic Substances and Diseases Registry, 2004). The levels of Hg found in fish are generally within the acceptable limits (0.46 µg/g fresh tissues). However, 27.08% of fish samples were exceeding the standard (0.50 µg/g fresh tissues). The highest concentration was found in Lake Manzala (4.08 µg/g; Abd-El-Kader *et al*., 1993). Mercury may induce alterations in the normal development of the brain of infants and at high levels may induce neurological changes in adults (Commission of the European Communities, 2001). Mercury also has toxic effect on the kidney, the developing fetus and it is a possible human carcinogen (Occupational Safety and Health Administration, 2004). Finally, the levels of Zn, Cu, Mn and Fe in fish were low and within acceptable limits. Therefore, there are no health risks with respect to these metals in fish analyzed.

From the above results, we can see that there is a bias toward too much pollution may be due to, some of these publications concern research of pollution, and the researchers concerned certainly sampled their fish in heavily polluted places. On the other side, the collected data concerned samples taken in the ten to fifteen years period before 2006, which means that possible recent effects from environmental awareness campaigns are not yet reflected the data. Therefore, it was necessary to make data quality assurance to reduce this high variability (standard deviation) as shown in Table 2.

The metal pollution index (MPI) of fish collected from different Egyptian aquatic resources was 8.803. The value of MPI was higher than that reported by El-Nemr (2003) and Khaled (2004).

The human risk assessment has been estimated in this study by comparing the metal intake from the consumption rate of fish with the provisional tolerable weekly intake (PTWI). For a few metals, this PTWI's has been published. For the metals Cd, Pb, Hg, Zn, Cu and Fe were calculated to be 7; 25; 5; 7000; 3500 and 5600 µg/Kg body weight per week, respectively (Joint FAO/WHO Expert Committee on Food Additives, 2004). As shown in Table (3), the weekly intake of Cd consumed by children, youth and adult were 6.86, 2.59 and 1.47 (µg/Kg body weight /w), respectively. It is evident that, the intake of Cd was low for children, youth and adult groups, compared to the international accepted standard for safe exposure (7.0 µg/Kg/w).The dietary exposure estimate for Cd in adult of 70 Kg (10.29 µg/day) was lower to the estimates made for Canada (13.00 µg/day, Gunderson,1995) ; UK (14.00

µg/day , Ysart *et al*., 1999) ; Korea (21.20 µg/day , Moon *et al*., 1995). The Joint FAO/WHO Expert Committee on Food Additives (2004) recommends a PTWI for Cd of 7.0 µg/Kg body weight, equivalent to70 µg/day for an adult of 70 Kg. The intake of Cd in this study was 21.00% of the recommended value and consequently poses no health risk. However, a greater control should be taken, especially in the case of child group (the intake of Cd was 98% of the recommended value).

The weekly intake of Pb (µg/Kg body weight/w) consumed by children, youth and adult person were 38.61, 14.58 and 8.27, respectively. This means that, child group may be at risk of adverse effects because of dietary exposure them to higher levels of Pb (154.45% higher than the allowable limits). It has been calculated that the maximum safe fish intake for children in Egypt is 9.9kg/year On the other hand, the intake of Pb was low for youth and adult groups (14.58, 8.27 µg/Kg body weight/w) compared to the international accepted standard for safe exposure (25 µg/Kg body weight/w).

Table 1: The mean metals concentrations in the muscle of the fish (µg/g fresh tissue) collected from different locations.

n	Cd	Pb	Zn	Cu	Fe	Mn	Ni	Hg	Reference
1.The River Nile:									
11	0.72	0.83	0.97	0.49	N.A.	N.A.	N.A.	0.67	Ameria(1998)
10	0.6	5.14	8.74	0.38	N.A.	N.A.	N.A.	0.4	Abo-salem *et al*.,(1992)
10	1.44	3.14	4.2	0.69	N.A.	N.A.	N.A.	0.45	Abo-salem *et al*.,(1992)
10	0.5	4.44	8.76	3.53	N.A.	N.A.	N.A.	1.02	Abo-salem *et al*.,(1992)
10	0.51	3.08	7.68	0.48	N.A.	N.A.	N.A.	0.89	Abo-salem *et al*.,(1992)
10	2	1.26	5.45	0.55	N.A.	N.A.	N.A.	0.88	Ameria(1998)
10	0.61	0.62	2.5	0.96	N.A.	N.A.	N.A.	0.62	Ameria(1998)
10	0.81	0.89	1.26	2.37	N.A.	N.A.	N.A.	0.31	Ameria(1998)
20	0.26	0.33	N.A.	4.22	N.A.	2.8	1.27	N.A.	Seddek *et al*.,(1996)
35	0.13	0.4	4.61	0.46	16.09	0.64	N.A.	N.A.	Abdel-Satar and Shehata(2000)
9	0.04	1.22	34	1.1	21.3	N.A.	N.A.	N.A.	El-Ghobashy *et al*.,(2001)
N.A.	N.A.	0.05	0.13	2.49	N.A.	N.A.	N.A.	N.A.	Khalaf *et al*.,(1994)
N.A.	N.A.	0.05	3.8	0.87	N.A.	N.A.	N.A.	N.A.	Khalaf *et al*.,(1994)
5	0.59	1.5	14.53	0.98	N.A.	N.A.	N.A.	N.A.	Zyadah(1996)
N.A.	0.21	2.4	0.33	0.73	N.A.	N.A.	N.A.	N.A.	Zyadah(1996)A
5	N.A.	1.92	14.8	1.49	N.A.	N.A.	N.A.	N.A.	Abdel-Baky *et al*.,(1999)
5	N.A.	0.87	13.2	0.99	N.A.	N.A.	N.A.	N.A.	Abdel-Baky *et al*.,(1999)
N.A.	N.A.	0.8	N.A.	N.A.	6.33	2.03	1.45	N.A.	Konsowa(2001)
16	0.43	0.68	48.52	7.54	N.A.	N.A.	N.A.	N.A.	Ibrahim *et al*.,(1999)
35	0.15	0.46	4.79	0.49	16.5	0.77	N.A.	N.A.	Abdel-Satar and Shehata(2000)
N.A.	N.A.	1.59	27.9	2.35	26.14	N.A.	N.A.	N.A.	Zyadah *et al*.,(2003)
N.A.	0.16	0.52	14.8	1.56	N.A.	N.A.	N.A.	N.A.	Hamed (1998)
5	0.18	0.43	4.5	0.55	13.56	0.8	N.A.	N.A.	Abdel-Satar and Shehata(2000)
5	0.31	0.75	5.08	0.57	21.3	1.3	N.A.	N.A.	Abdel-Satar and Shehata(2000)
3	N.A.	1.29	17.57	1.33	18.77	N.A.	N.A.	N.A.	Zyadah *et al*.,(2003)
5	0.02	0.13	3.54	0.37	2.78	N.A.	0.27	N.A.	El-Moselhy (1999)
N.A.	0.04	1.64	2.1	0.46	N.A.	N.A.	N.A.	N.A.	Gomma *et al*.,(1995)
20	0.33	N.A.	N.A.	0.56	N.A.	3.3	2.48	N.A.	Seddek *et al*.,(1996)
N.A.	N.A.	0.17	2.09	2.1	N.A.	N.A.	N.A.	N.A.	Khalaf *et al*.,(1994)

Table. 1 continue.

n	Cd	Pb	Zn	Cu	Fe	Mn	Ni	Hg	Reference
N.A.	N.A.	0.25	1.32	1.13	N.A.	N.A.	N.A.	N.A.	Khalaf *et al*.,(1994)
20	0.39	N.A.	N.A.	0.12	N.A.	1.29	0.84	N.A.	Seddek *et al*.,(1996)
5	0.57	3.73	16.38	1.33	N.A.	N.A.	N.A.	N.A.	Zyadah (1996)
20	0.38	N.A.	N.A.	0.86	N.A.	2.2	0.76	N.A.	Seddek *et al*. (1996)
20	0.34	N.A.	N.A.	0.64	N.A.	2.99	0.83	N.A.	Seddek *et al*. (1996)
16	0.88	1.38	62.72	18.23	N.A.	N.A.	N.A.	N.A.	Ibrahim *et al*. (1999)
3	N.A.	1.5	14.5	2.11	15.3	N.A.	N.A.	N.A.	Zyadah *et al*. (2003)
3	N.A.	1.4	7.5	1.53	11.7	N.A.	N.A.	N.A.	Zyadah *et al*. (2003)
2.Lake of Manzala:									
10	1.67	4.08	3.13	2.96	N.A.	N.A.	N.A.	0.79	Ameria(1998)
10	1.19	3.08	2.5	3.01	N.A.	N.A.	N.A.	0.09	Ameria(1998)
20	0.87	2.56	4.83	2.2	14.89	N.A.	N.A.	N.A.	Metwally(1998)
20	1	3.09	5.78	3.11	16.77	N.A.	N.A.	N.A.	Metwally(1998)
N.A.	0.8	6.5	13.6	1.04	N.A.	N.A.	N.A.	N.A.	El-Shebly(1994)
N.A.	0.35	3.2	43.7	1.42	34.3	N.A.	N.A.	N.A.	El-Ghobashy *et al*.,(2001)
30	0.09	3.09	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	Hussein and El-Shebly(2006)
58	0.44	0.43	N.A.	N.A.	N.A.	N.A.	N.A.	0.06	El-Safy(1996)
40	0.11	0.27	16.09	0.66	N.A.	N.A.	N.A.	N.A.	Abdel-Baky(1998)
10	1.49	1.43	N.A.	N.A.	N.A.	N.A.	N.A.	0.06	El-Safy and Al-Ghannam(1996)
10	0.4	0.26	N.A.	N.A.	N.A.	N.A.	N.A.	0.04	El-Safy and Al-Ghannam(1996)
10	0.33	0.39	N.A.	N.A.	N.A.	N.A.	N.A.	0.02	El-Safy and Al-Ghannam(1996)
10	0.57	0.22	N.A.	N.A.	N.A.	N.A.	N.A.	0.05	El-Safy and Al-Ghannam(1996)
10	0.75	0.21	N.A.	N.A.	N.A.	N.A.	N.A.	0.02	El-Safy and Al-Ghannam(1996)
10	0.91	0.25	N.A.	N.A.	N.A.	N.A.	N.A.	0.03	El-Safy and Al-Ghannam(1996)
N.A.	0.29	0.44	32.15	1.39	N.A.	N.A.	N.A.	0.06	Ibrahim *et al*. (1999)
30	0.14	3.8	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	Hussein and El-Shebly(2006)
N.A.	0.71	8.9	5.2	2.2	N.A.	N.A.	N.A.	0.05	Fahmy *et al*. (1997)
25	0.55	10.6	8.8	3	N.A.	N.A.	N.A.	0.07	NWRP(2000)
10	N.A.	N.A.	13.12	1.91	44.2	3.28	N.A.	N.A.	Abdelhamid and El-Zarraf(1996)
30	0.2	4.42	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	Hussein and El-Shebly(2006)
30	0.18	4.27	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	Hussein and El-Shebly(2006)
4	0.05	0.58	6.3	1.25	9.09	0.65	N.A.	N.A.	Abou-Donia(1990)
13	0.03	0.13	5.96	0.51	4.32	N.A.	0.44	N.A.	El-Moselhy(1999)
2	0.03	0.76	4.3	1.44	N.A.	0.29	N.A.	N.A.	Abou-Donia(1990)
12	0.04	0.34	5.5	0.83	N.A.	N.A.	N.A.	4.08	Abd-El-Kader *et al*. (1993)
6	0.33	0.55	N.A.	N.A.	N.A.	N.A.	N.A.	0.01	El-Safy(1996)
24	1	6.3	4.3	1.2	29.24	N.A.	N.A.	N.A.	Shakweer(1999)
14	0.38	0.09	N.A.	N.A.	N.A.	N.A.	N.A.	0.02	El-Safy(1996)
N.A.	0.65	0.73	43.46	14.35	N.A.	N.A.	N.A.	N.A.	Ibrahim *et al*.,(1999)

Table 1. continue

n	Cd	Pb	Zn	Cu	Fe	Mn	Ni	Hg	Reference
2	0.1	1.2	7.19	1.59	5.28	0.18	N.A.	N.A.	Abou-Donia(1990)
15	0.27	0.73	N.A.	N.A.	N.A.	N.A.	N.A.	0.02	El-Safy(1996)
8	0.41	0.49	N.A.	N.A.	N.A.	N.A.	N.A.	0.07	El-Safy(1996)
10	1.52	2.63	5.86	2.32	15.48	N.A.	N.A.	N.A.	Metwally(1998)
10	0.05	0.7	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	Galab(1997)
10	0.05	0.7	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	Galab(1997)
8	N.A.	0.49	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	El-Safy and Al-Ghannam(1996)
10	N.A.	0.25	37.9	N.A.	N.A.	0.88	N.A.	N.A.	Abdel-Baky(2001)
10	N.A.	0.32	32.6	N.A.	N.A.	0.82	N.A.	N.A.	Abdel-Baky(2001)
10	N.A.	0.26	25.2	N.A.	N.A.	0.47	N.A.	N.A.	Abdel-Baky(2001)
10	N.A.	0.2	16.3	N.A.	N.A.	0.34	N.A.	N.A.	Abdel-Baky(2001)
10	N.A.	0.55	50.9	N.A.	N.A.	1.07	N.A.	N.A.	Abdel-Baky(2001)
10	N.A.	N.A.	18.87	2.23	37.75	3	N.A.	0.07	Abdelhamid and El-Zarraf(1996)
5	0.55	10.6	8.8	N.A.	N.A.	N.A.	N.A.	N.A.	Fahmy *et al*.,(1997)
3.Lake of Mariut:									
N.A.	N.A.	0.19	3.84	1.86	7.06	N.A.	N.A.	N.A.	Khalil (1998)
N.A.	0.53	1.12	34	0.63	45	N.A.	N.A.	N.A.	El-Ghobashy *et al.* (2005)
36	0.99	4.62	13.47	2.46	N.A.	N.A.	N.A.	N.A.	Soliman *et al.* (1997)
31	N.A.	9.7	6.13	1.28	N.A.	0.63	N.A.	N.A.	Shakweer (1998)
32	N.A.	5.5	4.28	1.08	N.A.	0.36	N.A.	N.A.	Shakweer (1998)
26	N.A.	3.55	8.54	1.39	N.A.	0.61	N.A.	N.A.	Shakweer and Abbas(1997)
N.A.	N.A.	13.64	32.81	N.A.	N.A.	N.A.	N.A.	N.A.	NWRP(2000)
N.A.	N.A.	7.56	56.38	N.A.	N.A.	N.A.	N.A.	N.A.	NWRP(2000)
32	N.A.	7.14	5.09	1.18	N.A.	0.49	N.A.	N.A.	Shakweer and Abbas(1997)
N.A.	N.A.	17.46	39.93	N.A.	N.A.	N.A.	N.A.	N.A.	NWRP(2000)
N.A.	N.A.	29.14	20.75	N.A.	N.A.	N.A.	N.A.	N.A.	NWRP(2000)
16	N.A.	9.33	4.79	1.37	N.A.	0.98	N.A.	N.A.	Shakweer and Abbas(1997)
N.A.	N.A.	12.48	46.21	N.A.	N.A.	N.A.	N.A.	N.A.	NWRP(2000)
N.A.	N.A.	41.56	21.33	N.A.	N.A.	N.A.	N.A.	N.A.	NWRP(2000)
4	0.31	0.72	0.28	0.09	N.A.	1.01	N.A.	0.06	Ghazaly(1992)
2	0.08	N.A.	6.56	1.22	6.98	0.34	N.A.	1	Abou-Donia(1990)
17	N.A.	N.A.	6.28	0.88	N.A.	N.A.	N.A.	N.A.	Shakweer(1999)
2	0.05	N.A.	10.47	1.35	3.3	N.A.	N.A.	N.A.	Abou-Donia(1990)
1	N.A.	1	6.77	N.A.	3.99	N.A.	N.A.	1	Abou-Donia(1990)
2	0.07	0.7	N.A.	1.54	N.A.	0.29	N.A.	N.A.	Abou-Donia(1990)
2	N.A.	1.66	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	Abou-Donia(1990)
1	N.A.	0.78	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	Abou-Donia(1990)
N.A.	0.06	0.18	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	Sangak(1998)
4.Lake of Idku:									
15	N.A.	12.27	26.48	17.86	N.A.	N.A.	N.A.	N.A.	Shakweer *et al*. (1993)
N.A.	0.11	1.57	27.7	1.7	22.3	N.A.	N.A.	N.A.	El-Ghobashy *et al*. (1993)

Table 1. continue

n	Cd	Pb	Zn	Cu	Fe	Mn	Ni	Hg	Reference
30	N.A.	8.82	6.07	1.67	N.A.	1.07	N.A.	N.A.	Abbas and Shakweer(1998)
16	N.A.	9.01	6.01	1.66	N.A.	1.21	N.A.	N.A.	Shakweer and Abbas(1996)
15	N.A.	8.63	6.15	1.67	N.A.	0.93	N.A.	N.A.	Shakweer and Abbas(1996)
45	N.A.	N.A.	8.39	5.61	N.A.	N.A.	19.53	N.A.	Shakweer and Abbas(2005)
38	N.A.	N.A.	22.26	9.31	N.A.	N.A.	17.3	N.A.	Shakweer and Abbas(2005)
N.A.	N.A.	N.A.	7.53	5.76	N.A.	N.A.	21.33	N.A.	Shakweer and Abbas(2005)
N.A.	N.A.	N.A.	25.16	12.44	N.A.	N.A.	7.76	N.A.	Shakweer and Abbas(2005)
42	N.A.	N.A.	14.51	5.6	N.A.	N.A.	18.66	N.A.	Shakweer and Abbas(2005)
40	N.A.	N.A.	24.83	13.98	N.A.	N.A.	9.38	N.A.	Shakweer and Abbas(2005)
N.A.	N.A.	N.A.	17.81	4.98	N.A.	N.A.	15.51	N.A.	Shakweer and Abbas(2005)
N.A.	N.A.	N.A.	27.93	19.33	N.A.	N.A.	8.07	N.A.	Shakweer and Abbas(2005)
N.A.	N.A.	N.A.	27.46	10.74	N.A.	N.A.	19.16	N.A.	Shakweer and Abbas(2005)
N.A.	N.A.	N.A.	18.24	7.91	N.A.	N.A.	11.15	N.A.	Shakweer and Abbas(2005)
15	N.A.	N.A.	27.45	14.13	N.A.	N.A.	N.A.	N.A.	Shakweer *et al*. (1993)
8	N.A.	N.A.	30.27	18.9	N.A.	N.A.	N.A.	N.A.	Shakweer *et al*. (1993)
38	N.A.	N.A.	14.58	14.59	N.A.	N.A.	15.52	N.A.	Shakweer and Abbas(2005)
N.A.	N.A.	N.A.	6.11	4.47	N.A.	N.A.	17.67	N.A.	Shakweer and Abbas(2005)
N.A.	N.A.	N.A.	26.17	5.31	N.A.	N.A.	7.58	N.A.	Shakweer and Abbas(2005)
7	N.A.	2.48	19.85	7.69	N.A.	N.A.	N.A.	N.A.	Shakweer *et al*. (1993)
N.A.	0.27	N.A.	5.97	0.18	103.54	3.44	N.A.	0.17	El-Nemr *et al*. (2003)
N.A.	0.36	N.A.	6.75	0.1	28.76	3.42	N.A.	0.15	El-Nemr *et al*. (2003)
N.A.	0.46	N.A.	6.77	0.15	33.36	3.5	N.A.	0.07	El-Nemr (2003)
N.A.	0.46	N.A.	5.58	0.18	55.4	4.1	N.A.	0.02	El-Nemr (2003)
23	1.26	4.06	5.04	1.6	37.8	N.A.	N.A.	N.A.	Shakweer(1999)
16	N.A.	N.A.	7.69	9.94	N.A.	N.A.	28.72	N.A.	Shakweer and Abbas(2005)
18	N.A.	N.A.	7.85	10.38	N.A.	N.A.	31.36	N.A.	Shakweer and Abbas(2005)
6	N.A.	N.A.	15.93	3.93	N.A.	N.A.	N.A.	N.A.	Shakweer(1999)
24	N.A.	N.A.	6.19	6.27	N.A.	N.A.	11.17	N.A.	Shakweer and Abbas(2005)
26	N.A.	N.A.	14.54	6.97	N.A.	N.A.	6.01	N.A.	Shakweer and Abbas(2005)
21	N.A.	N.A.	16.38	20.56	N.A.	N.A.	25.13	N.A.	Shakweer and Abbas(2005)
19	N.A.	N.A.	13.24	8.28	N.A.	N.A.	7.2	N.A.	Shakweer and Abbas(2005)
N.A.	0.33	N.A.	8.54	0.21	92.2	3.23	N.A.	0.03	El-Nemr (2003)
N.A.	0.64	N.A.	9.61	0.23	30.69	3.41	N.A.	0.06	El-Nemr (2003)
N.A.	N.A.	N.A.	6.96	0.17	36.05	3.61	N.A.	0.14	El-Nemr (2003)
N.A.	0.51	N.A.	7.73	0.21	44.16	3.8	N.A.	0.04	El-Nemr (2003)
15	N.A.	N.A.	16.17	22.41	N.A.	N.A.	13.25	N.A.	Shakweer and Abbas(2005)
10	N.A.	N.A.	37.62	8.58	N.A.	N.A.	6.63	N.A.	Shakweer and Abbas(2005)
N.A.	0.05	0.15	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	Sangak(1998)

Table 1. continue

n	Cd	Pb	Zn	Cu	Fe	Mn	Ni	Hg	Reference
5. Lake of Borrolus:									
29	N.A.	9.09	36.89	9.81	N.A.	N.A.	8.84	N.A.	Shakweer and Radwan(2004)
29	N.A.	6.35	16.41	4.02	N.A.	N.A.	5.46	N.A.	Shakweer and Radwan(2004)
29	N.A.	10.06	16.92	6.81	N.A.	N.A.	6.74	N.A.	Shakweer and Radwan(2004)
N.A.	0.01	0.34	1.97	0.79	3.98	N.A.	N.A.	N.A.	Moussa(2003)
N.A.	0.01	0.29	2.48	0.86	7.95	N.A.	N.A.	N.A.	Moussa(2003)
N.A.	0.01	0.25	3.41	1.02	7.82	N.A.	N.A.	N.A.	Moussa(2003)
N.A.	0.03	1.52	41.3	2.18	30.3	N.A.	N.A.	N.A.	El-Ghobashy *et al.*,(2001)
34	N.A.	8.13	18.06	5.62	N.A.	N.A.	7.54	N.A.	Shakweer and Radwan(2004)
34	N.A.	7.42	17.92	2.88	N.A.	N.A.	4.67	N.A.	Shakweer and Radwan(2004)
34	N.A.	9.19	19.88	3.83	N.A.	N.A.	5.14	N.A.	Shakweer and Radwan(2004)
N.A.	0.03	0.48	2.66	1.02	6.39	N.A.	N.A.	N.A.	Moussa(2003)
N.A.	0.01	0.52	3.79	1.34	7.39	N.A.	N.A.	N.A.	Shakweer and Radwan(2004)
N.A.	0.01	0.33	5.74	1.24	14.83	N.A.	N.A.	N.A.	Shakweer and Radwan(2004)
30	N.A.	7.45	20.16	3.97	N.A.	N.A.	5.3	N.A.	Shakweer and Radwan(2004)
30	N.A.	6.16	17.04	3.75	N.A.	N.A.	5.89	N.A.	Shakweer and Radwan(2004)
30	N.A.	6.77	13.84	3.36	N.A.	N.A.	5.92	N.A.	Shakweer and Radwan(2004)
n	Cd	Pb	Zn	Cu	Fe	Mn	Ni	Hg	Reference
N.A.	0.01	0.31	1.85	0.96	3.03	N.A.	N.A.	N.A.	Moussa(2003)
N.A.	0.01	0.33	1.65	0.67	6.18	N.A.	N.A.	N.A.	Moussa(2003)
N.A.	0.01	0.24	3.33	0.8	3.08	N.A.	N.A.	N.A.	Moussa(2003)
32	N.A.	5.85	21.26	3.35	N.A.	N.A.	9.82	N.A.	Shakweer and Radwan(2004)
32	N.A.	4.78	15.33	5.19	N.A.	N.A.	6.14	N.A.	Shakweer and Radwan(2004)
32	N.A.	10.48	17.49	4.58	N.A.	N.A.	4.65	N.A.	Shakweer and Radwan(2004)
17	1.07	4.1	5.27	1.1	12.93	N.A.	N.A.	N.A.	Shakweer(1999)
6. Lake of Qarun:									
9	0.01	0.33	20.7	0.22	15.7	N.A.	N.A.	N.A.	El-Ghobashy(2001)
N.A.	0.27	1.57	5.26	1.56	5.48	1.17	1.09	N.A.	Ali and Fishar(2005)
N.A.	0.22	1.29	5.18	2.11	4.45	1.67	1.11	N.A.	Ali and Fishar(2005)
N.A.	0.25	1.16	4.57	1.21	3.92	1.09	1.08	N.A.	Ali and Fishar(2005)
6	0.23	1.45	5.88	0.99	14	0.76	0.86	N.A.	Abdel-Satar and Yacoub(2005)
N.A.	0.23	1.32	5.88	1.8	17.11	1.62	1.34	N.A.	Ali and Fishar(2005)
N.A.	0.21	1.27	6.17	1.79	11.15	1.4	1.21	N.A.	Ali and Fishar(2005)
N.A.	0.21	1.3	5.5	1.78	13.06	1.68	0.84	N.A.	Ali and Fishar(2005)
N.A.	0.37	1.63	6.42	2.74	16.47	2.52	1.25	N.A.	Ali and Fishar(2005)
N.A.	0.32	1.39	5.84	1.88	8.61	1.44	1.13	N.A.	Ali and Fishar(2005)
N.A.	0.36	1.27	5.98	2.17	14.82	1.94	1.23	N.A.	Ali and Fishar(2005)

Table 1. continue

n	Cd	Pb	Zn	Cu	Fe	Mn	Ni	Hg	Reference
7. Lake of Bardawil:									
N.A.	0.05	0.35	0.76	0.97	5.7	0.97	N.A.	2.5	Abou-Donia(1990)
N.A.	0.02	0.36	0.87	50.2	1.9	0.34	N.A.	N.A.	Abdo and Yacoub(2005)
N.A.	0.09	0.11	1.25	38.58	3.33	0.36	N.A.	N.A.	Abdo and Yacoub(2005)
2	0.1	2.73	10.61	1.47	13.36	0.35	N.A.	1	Abou-Donia(1990)
N.A.	0.06	0.02	1.95	24.19	1.92	0.2	N.A.	N.A.	Abdo and Yacoub(2005)
N.A.	0.03	0.09	1.62	35.4	3.14	0.31	N.A.	N.A.	Abdo and Yacoub(2005)
2	0.13	0.48	7.03	1.22	5.06	0.25	N.A.	N.A.	Abou-Donia(1990)
2	0.08	0.72	1.14	1.46	4.83	0.3	N.A.	N.A.	Abou-Donia(1990)
N.A.	0.04	0.45	2.21	39.52	2.33	2.19	N.A.	N.A.	Abdo and Yacoub(2005)
N.A.	0.04	0.19	2.74	43.35	3.07	0.48		N.A.	Abdo and Yacoub(2005)
8. Lake of W.El-Rayan:									
2	0.09	0.81	6.07	2.11	3.6	0.28	N.A.	1	Abou-Donia(1990)
N.A.	0.19	1.39	1.78	0.78	N.A.	N.A.	N.A.	0.79	Saleh *et al*. (1988)
n	Cd	Pb	Zn	Cu	Fe	Mn	Ni	Hg	Reference
N.A.	0.07	1.03	6.69	1.34	3.68	0.3	N.A.	N.A.	Abou-Donia(1990)
N.A.	0.05	0.83	5.26	1.43	3	0.14	N.A.	N.A.	Abou-Donia(1990)
N.A.	0.11	0.58	7.7	1.63	6.8	0.22	N.A.	N.A.	Abou-Donia(1990)
Number	973	1571	1579	1712	305	506	860	374	
Average±S.D.	0.37±0.40	3.12±5.10	13.04±12.42	4.77±8.23	16.97±18.67	1.39±1.17	8.11±7.87	0.46±0.77	
MAC	0.05	0.5	40	60	N.A.	18	6	0.5	

So, it appears that there was no imminent health risk due to dietary lead intake for these groups. The estimated lead exposure in adult group (57.89µg/day) was much greater than the values reported for other countries e.g. Canada (24.00 µg/day, Dabeka and McKenzie, 1995); Spain (28.40 µg/day, Llobet *et al*., 2003). The Joint FAO/WHO Expert Committee on Food Additives (2004) recommended a PTWI for Pb of 25 µg/Kg body weight/week, which is equivalent to 250µg/day for a 70Kg person. The intake measured in this study represents 33.10% of the recommended value and consequently it may be sufficient to conclude that the risk is not here.

As shown in Table 3, the weekly intake of Hg (µg/Kg body weight/w) consumed by children, youth and adult person were 6.27, 2.37 and 1.34, respectively. So, we can say that, child group may be at risk of adverse effects because of dietary exposure them to higher levels of Hg (125.44% higher than the allowable limits). On the other hand, the intake of Hg was low for both youth and adult groups (2.37, 1.34 µg/Kg body weight/w), compared to the international accepted standard for safe exposure (5.0 µg/Kg body weight/w). So, it appears that there was no imminent health risk due to dietary Hg intake for these groups.

The estimated Hg intake in adult group was 9.1µg/day is much greater than the values reported for other countries e.g. USA (2.8 µg/day, Gunderson, 1995); UK (4.0 µg/day, Ysart *et al*., 1999) and Chile (5.0 µg/day, Munoz *et al*., 2005). The Joint FAO/WHO Expert Committee on Food Additives (2004) recommended a PTWI for Hg of 5.0 µg/Kg body weight/week, which is equivalent to 50.0 µg/day for an adult of 70 Kg person. The measured in this study represents 26.88% of the recommended value and consequently it may be sufficient to say that the risk is not present. However, it is important to mention that, the estimation of daily intake of heavy metals in different countries is based mainly on the data of metal concentrations in food items i.e. fish, seafood, vegetables and fruits.

Table2: Summary of data of heavy metals in the muscle of fish before and after quality assurance.

Metal	MAC	Average*±S.D.	Average**±S.D.	Highest found	Highest where	Reference
Cadmium	0,05	0.37±0.40	0.35±0.11	0.57	Manzala	El-Safy *et al*.(1996)
Lead	0.50	3.12±5.10	1.97±1.34	5.50	Mariut	Shakweer(1998)
Zinc	40.00	13.04±12.42	12.76±3.95	18.87	Manzala	Abdelhamid and El-Zarraf(1996)
Copper	60.00	4.77±8.23	2.48±1.91	8.58	Idku	Shakweer and Abbas(2005)
Iron	N.A.	16.97±18.67	15.07±4.39	26.14	Nile	Zyadah *et al*.(2003)
Manganese	18.00	1.39±1.17	1.25±0.43	1.94	Qarun	Ali and Fishar(2005)
Nickel	6.00	8.11±7.87	6.98±2.16	11.17	Idku	Shakweer and Abbas(2005)
Mercury	0.50	0.46±0.77	0.32±0.28	0.79	Manzala	Ameria(1998)

* Average of metals concentrations in the muscle of fish collected from different locations.
**Average of metals concentrations in the muscle of fish after data quality assurance.
MAC:Maximum allowable concentration in fish,based on FAO guidelines,1989.

Finally, the calculations in Table 3, demonstrated that the concentrations of the metals Zn, Cu and Fe in the muscle of Egyptian fish supply from different locations are much lower than the PTWI values (0.30%-5.27%), and accordingly there is no risk for human consumption of these fish.

Table 3: Summary of data on the intake of heavy metals (ug/kg body weight/week) from Egyptian fish supply.

Metal	Concentration(µg/g)	Metal intake (µg/kg body weight/w)			% of heavy metals to PTWI		
		Child	Youth	Adult	Child	Youth	Adult
Cd	0.35*	6.86	2.50	1.47	98.00	37.00	21.00
Pb	1.97*	38.61**	14.58	8.27	154.45	58.31	33.10
Hg	0.32*	6.27**	2.37	1.34	125.44	47.36	26.88
Zn	12.76	250.10	94.42	53.59	3.57	1.35	0.77
Cu	2.48	48.610	18.35	10.42	1.39	0.52	0.30
Fe	15.07	295.37	111.52	63.29	5.27	1.99	1.13

* Above the MAC according to FAO(1989)

**Above the PTWI according to the Joint FAO/WHO Expert Committee on Food Additives(2004)

Conclusions

1. Although the data may be not fully representative for the most recent situation, they still should provide a strong warning to the Egyptian population and authorities regarding the quality of fish.
2. The intake of metals depends not only on the levels of metals in fish, but also on the amount consumed. Thus many governments have provided dietary advice to consumers to limit consumption where levels are elevated.
3. Child group (high consumers) may be at risk of adverse effects because of dietary exposure them to higher levels of such contaminates. So, this group should continue to be provided with advice on safe levels of consumption (9.9 kg per year).
4. The estimated intake of Cd, Pb, Hg, Cu, Zn and Fe from weekly consumption of 294.6 g of fish for both youth and adult group pose no risk.
5. It is recommended that more research and assessment of fish quality is needed to provide more data and help safeguard the health of humans.

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تقدير مدي خطورة استهلاك الأسماك علي المواطنين في جمهورية مصر العربية

تهدف هذه الدراسة البيئية الي تقدير المأخوذ اليومي من العناصر الثقيلة المتراكمة في الأسماك التجارية المتداولة في جمهورية مصر العربية والتي تم جمعها من البحيرات المصرية المختلفة خلال الفترة من 1990 -2006 وذلك لمجموعات عمرية مختلفة (الأطفال-الشباب-البالغين). وقد أظهرت نتائج الدراسة مايلي :

1. تركيز العناصر الثقيلة في أسماك البحيرات المصرية تعتبر مرتفعة بالمقارنة بالمستويات العالمية وخاصا عنصر الرصاص والكادميوم.

2. المأخوذ اليومي من العناصر الثقيلة لا يعتمد فقط علي تركيزها في الأسماك ولكن أيضا علي كمية الأسماك المستهلكة.

3. أرتفع معدل المأخوذ اليومي من العناصر الثقيلة بالنسبة للمجموعات العمرية من الأطفال عن المسموح به عالميا , اما بالنسبة للمجموعات العمرية من الشباب و البالغين فقد كانت في الحدود المسموح بها.

4. توصي هذه الدراسة المواطنين باستهلاك كمية أقل من الأسماك لحين استكمال منظومة معالجة المخلفات البيئية وذلك من أجل المحافظة علي الصحة العامة.