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Estimation of Dietary intake of Cadmium, Lead, Manganese, Zinc and Nickel due to consumption of chicken meat by inhabitants of Port-Harcourt Metropolis, Nigeria

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ABSTRACT

Due to increasing concern about the intake of heavy metal contamination in foods, this study was undertaken. Concentrations of Cd, Pb, Mn, Zn and Ni were determined in chicken meat (muscle, gizzard and liver) consumed by various categories of the population of Port-Harcourt Metropolis. A total of 120 meat samples were analyzed using Flame Atomic Absorption Spectrophometory (FAAS) following sample digestion by wet oxidation. Estimation of the dietary exposure of the consumers to these metals were determined with a food frequency questionnaire based on chicken meat consumption. This was administered to 750 different categories of the population. The dietary intake was estimated based on the mean meat intake of the population and the associated risk was evaluated by comparing intakes with the Provisional Tolerable Weekly Intakes (PTWIs). Nevertheless, the estimated dietary intakes for the whole population (µg/person/week) are: cadmium (20.83), lead (220.40), manganese (220.04) zinc 1586.34) and nickel (61.85) were well within the safe limits (below 20% of PTWIs). It therefore appears that the population of Port-Harcourt metropolis are not at any imminent health risk of due to heavy metals examined in this study.

Key Words: Dietary intake, chicken meat, lead, manganese.

INTRODUCTION

One of the consequences of the current stage of industrialization and the demand for improved quality of life has been increased exposure to pollution coming from industrial activities, traffic and energy production [1]

People may be exposed to potentially harmful chemical, physical or biological agents in air, food, water or soil.

Heavy metals however are one of the environmental pollutants of major concern as a result of industrial and commercial processes which have actively mined, refined, manufactured, burnt and manipulated heavy metal compounds for number of reasons. They are present in virtually every area of modern consumerism, from construction materials to cosmetics, medicine to processed food, fuel sources to agents of destruction appliances to personal care products [2].

Heavy metals are persistent in the environment and are subject to bioaccumulation in food chains. However exposure does not result only from the presence of a harmful agent in the environment. The key word in the definition of exposure is contact [3]. Exposure is often defined as "an event that occurs when there is contact at a boundary between a human and the environment with a contaminant of a specific concentration for an interval of time [4].

Monitoring the concentrations of various metals in food is critical because these contaminants have deleterious effects on humans. Many illnesses and diseases such as hypertension, cancer, depression and metal disorders have been associated with increased concentrations of heavy metals such as cadmium, lead, mercury, nickel and selenium in human organs. [5-12].

Considering that food including meat is a particularly important source of the overall metals exposure, undertaking a risk assessment appears to be justified. This can be done by intake measurement which is a quantitative evaluation of exposure. Several organizations such as FAO, WHO, CDC, USFDA etc provided guidelines on the intakes of metal elements by humans. The acceptable daily intake (ADI) or tolerable daily intake (TDI) or provisional tolerable weekly intakes (PTWI) are used to describe safe levels of intake for several toxicants including toxic metals [13-16]. Exposure exceeding the TDI value for short periods should not have deleterious effect upon health, however acute effects may occur if the TDI is substantially exceeded even for short periods of time [17].

Different countries have carried out food consumption survey in order to estimate the intake of contaminants, additives and other chemicals in food. The survey helps to ascertain the subgroups at risk for an excessive intake of these contaminants.

Thus the aim of this study is to determine whether the levels of Pb, Cd, Zn, Mn and Ni in chicken muscle, gizzard and liver consumed in Port Harcourt metropolis, Nigeria have exceeded the permissible limits stipulated by regulatory agencies and to estimate the dietary exposure of the populace and hence determine if they are at risk of excess exposure to these metals.

MATERIALS AND METHODS

2.1 Sample Preparation & Analysis

A total of one hundred and twenty (120) meat samples comprising of muscle, gizzard and liver obtained from forty (40) live chickens raised in Rivers State were used for the study. The samples were dried in an oven at 105^{o}C to a constant weight and pulverized prior to digestion. 1.00g of each dried meat sample was weighed into a 100ml bottle and digested using 5ml of the digestion mixture (3:2 HNO_3 and $HClO_4$) [18]. The concentrations of Pb, Cd, Mn, Zn and Ni were determined using Flame Atomic Absorption Spectrophotometric (FAAS) technique. The concentrations were blank corrected and expressed as µg/g dry weight.

2.2 Determination of dietary intake

Seven hundred and fifty (750) food frequency questionnaires (FFQ) based on chicken meat consumption were used to estimate the daily and weekly consumption of the different chicken parts under study. These FFO's (150 for each group) were distributed to different categories of the populace comprising school children, pregnant women, lactating mothers, adult men and adult women. Additional information on socio-demographic data for each respondent was also given in the questionnaire. The body weight of the subjects were taken and recorded accordingly. Photographic method-a two way dimensional picture was used in estimating the portion sizes [23]. The different parts of chicken meat were purchased, wasted and cut into different sizes ranging from large, moderate and small. The meats were cooked for thirty minutes and a Lumix Panasonic FZ40 digital camera was used to photograph the different sizes of meat which was attached to the questionnaire. The meats were weighed and the weights recorded accordingly. Thus the portion sizes were large (200g), moderate (100g) and small (50g) for chicken muscles, while for the gizzard and liver the sizes were large (55g) moderate (30g) and small (15g) respectively.

2.3 Statistical Analysis

One way analysis of variance (ANOVA) was used to determine any significant difference in the studied metals in the various meat parts while the Monte-Carlo simulation was used to estimate the dietary intake of the metals by the populace.

RESULTS AND DISCUSSION

3.1 Concentrations of heavy metals in chicken meat

The mean concentration of each element in the different meat parts is shown in figure 1. The analytical results showed that all the studied elements were detectable.

The liver contained the highest concentration of the metals Cd (0.046µg/g) Pb(0.304µg/g^{-}), Mn (0.415µg/g), Zn (2.325µg/g) and Ni(0.108 µg/g) followed by gizzard; Cd(0.024), Pb(0.287), Mn(0.127) Zn (1.940) and Ni(0.062) while the muscle had the least concentration except for Mn thus Cd (0.016), Pb(0.215), Mn (0.266) Zn (1.570) and Ni(0.062). This result is similar to a study on concentrations of heavy metal (Pb, Cr, Mn, Fe, Cu and Zn) in different organs of fish [24].

The higher concentration of Pb in the liver is in agreement with most reports which tend to show that liver accumulates lead more than other tissues [25] [26], while the high concentration of lead in the muscle indicates long term bioaccumulation. The concentration of Pb in this study exceeded the FAO/WHO standard of 0.2mgkg^{-1}. The concentration of Mn in liver and muscle were slightly above the WHO reference standard of 0.5mgkg^{-1}. The high concentrations of Pb and Mn could emanate from, feed, water source or the environments. Meanwhile, the concentrations of cadmium, zinc and nickel in the different chicken parts were below all reference standards.

3.2 Estimation of dietary intake/exposure

The dietary intake of heavy metals from food sources is very crucial in order to evaluate the safety of food and consequently its consumers. There was no available literature on the mean consumption of the different parts of meat under study by the Nigerian populace. With regards to this, a food frequency questionnaire (FFQ) was constructed and administered to 750 subjects comprising of school children, pregnant women, lactating mothers, adult men and adult women in order to estimate their daily and hence weekly consumption of these meat parts and thus determine their dietary intake and exposure to Cd, Pb, Mn Zn and Ni from chicken meat The data from the questionnaire was categorized and converted to show the mean daily consumption of the different chicken parts in gram per person per day using Monte-Carlo simulation. . (table

1) The basis of Monte-Carlo simulation for inferential statistics is to gain insights into the characteristics of a statistic by repeatedly drawing samples from the same population of interest and observing the behaviour of the statistics over the samples. The observed values of the statistics for these samples were used to estimate the distribution. In this study, risk to health from heavy metal contaminants in chicken meat were assessed by comparing estimates of dietary exposure with the Provisional Tolerable Weekly Intakes (PTWIs) recommended by the Joint FAO/WHO Expert Committee on Food Additives (JECFA).

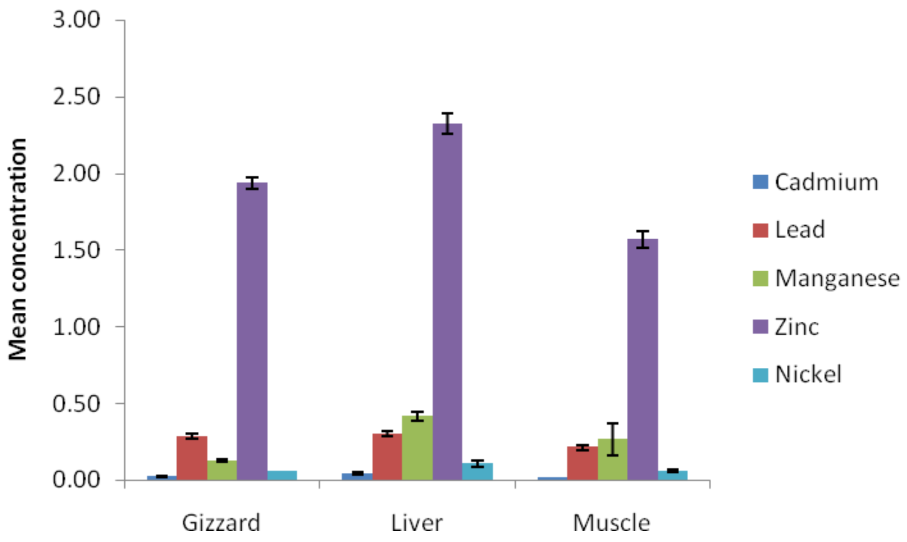

Fig 1: Mean concentration of metals in different parts of chicken

The dietary intake was estimated as mean weekly consumption times mean concentration of the metals in the meat.

Table 1: Mean daily consumption (g/person/day) of the different parts of meat by different categories of people

Group		Muscle	Gizzard	Liver
School Children	**Mean±SD**	46.59±2.19	24.75±3.52	16.89±1.40
	Range	40.75 – 53.39	14.73 – 35.54	13.18 – 21.69
	n	75000	13500	42500
Pregnant women	**Mean±SD**	65.70±5.45	29.26±2.01	22.18±1.23
	Range	52.89 – 83.84	21.37 – 35.03	18.26 – 27.08
	n	75000	75000	75000
Lactating mothers	**Mean±SD**	86.52±7.45	33.93±2.57	17.04±1.12
	Range	63.88 – 107.69	25.62 – 40.94	12.46 – 24.42
	n	75000	61000	50000
Adult men	**Mean±SD**	63.65±6.77	68.06±4.89	37.36±1.53
	Range	42.27 – 86.18	53.69 – 84.09	32.57 – 41.55
	n	75000	65000	26000
Adult women	**Mean±SD**	58.24±3.70	28.77±1.39	23.15±2.75
	Range	47.13 – 68.07	24.11 – 33.29	14.68 – 32.68
	n	75000	52000	27500

n=number of consumable subjects multiplied by the number of trials in the Monte-Carlo simulation.

3.2.1 Dietary intake of Cadmium

The mean dietary intake of cadmium (table 2) show that for school children the intakes (µg/p/wk) were muscle (5.28), gizzard (4.14) and liver (5.40), totaling of 14.82 µg/p/wk. For pregnant women: muscle (7.43), gizzard (4.83) and liver (7.10), 19.36 µg/p/wk. For lactating mothers: muscle (9.81), gizzard (5.46) and liver (5.37), giving a total of 20.64 µg/p/wk. For adult men: muscle (7.22), gizzard (11.24) and (11.95), with a total of 30.41 µg/p/wk. For adult women: muscle (7.27), gizzard (6.10) and liver (7.46) resulting to a total of 18.75 µg/p/wk.

Table 2: Mean dietary intake of Cadmium

Group		Mean metal µg/g	Mean daily consumption g/person/day	Mean weekly consumption g/person/wk	Mean dietary µg/p/wk	Mean dietary µg/kg body wt/wk	Provisional Tolerable Weekly Intake (PTWI) µg/kg body wt/wk	Mean intake % of PTWI
a. School children	Muscle	0.0162	46.59	326.13	5.28	0.15	7	2
	Gizzard	0.0236	24.75	175.25	4.14	0.12		2
	Liver	0.0457	16.89	118.20	5.40	0.15		2
	Total	**0.086**	**88.23**	**619.58**	**14.82**	**0.42**		**6**
b. Pregnant women	Muscle	0.0162	65.70	458.87	7.43	0.08		1
	Gizzard	0.0236	29.26	204.82	4.83	0.05	7	1
	Liver	0.0457	22.18	155.33	7.10	0.08		1
	Total	**0.086**	**117.14**	**819.02**	**19.36**	**0.21**		**3**
c. Lactating mothers	Muscle	0.0162	86.52	605.64	9.81	0.12		2
	Gizzard	0.0236	33.93	237.41	5.46	0.07	7	1
	Liver	0.0457	17.04	119.28	5.37	0.07		1
	Total	**0.086**	**137.49**	**962.33**	**20.64**	**0.26**		**4**
d. Adult men	Muscle	0.0162	63.65	445.52	7.22	0.10		1
	Gizzard	0.0236	68.06	476.39	11.24	0.14	7	2
	Liver	0.0457	37.36	261.52	11.95	1.16		2
	Total	**0.086**	**169.07**	**1183.42**	**30.41**	**0.40**		**5**
e. Adult women	Muscle	0.0162	58.24	407.65	6.60	0.10		1
	Gizzard	0.0236	28.77	201.36	4.75	0.07	7	1
	Liver	0.0457	23.15	162.05	7.40	0.11		2
	Total	**0.086**	**110.16**	**771.06**	**18.75**	**0.28**		**4**
Whole Population	Muscle	0.0162	64.14	448.98	7.27			
	Gizzard	0.0236	36.95	258.68	6.10			
	Liver	0.0457	23.32	163.27	7.46			
	Total	**0.086**	**124.41**	**870.89**	**20.83**			

Average body weight (kg) a=35; b=92; c=80; d=75; e=68

Comparing the intakes with the provisional tolerable weekly intake (PTWI) guideline of 7 µg/kg body weight/week stipulated by joint FAO/WHO Expert Committee on Food Additives (JEFCA), the average intake/kg body wt/wk by the different groups for the chicken parts were much lower than the PTWI as shown table 2. The low % intakes of PTWI of the different categories of the populace indicate low exposure to cadmium from chicken meat probably as a result of low consumption by the populace as well as the low mean metal in the meat parts. The dietary intake for the whole population 20.83µg/p/wk is lower than 60 µg/p/wk for beef, mutton and chicken reported in Lahore, [27] and 76.1 µg/p/wk reported for food in Korea [28], and 129.5 µg/p/wk for food among secondary school students in Hongkong [29] but higher than 1.46 µg/p/wk reported in Dutch for beef [30].

3.2.2 Dietary intake of Lead

The mean dietary intake of lead (table 3) show that the intakes (µg/person/week) were, for school children: muscle (70.12), gizzard (50.30) and liver (35.93), total 151.35 µg/p/week. For pregnant women: muscle (98.66), gizzard (58.78) and liver (47.22), total 204.18 µg/p/week. For lactating mothers: muscle (130.21), gizzard (68.14) and (36.26) total 234.61 µg/p/week. For adult men: muscle (87.64), gizzard (136.72) and liver (79.50) total 312.01 µg/p/week. For adult women: muscle (87.64), gizzard (57.79) and liver (49.26) total 194.63 µg/p/week. For the whole population: muscle (96.53), gizzard (74.24) and liver (49.63) resulting to a total of 220.40 µg/p/week.

Table 3: Mean dietary intake of lead

Group		Mean metal (µg/g)	Mean daily consumption (g/person/ day)	Mean weekly consumption (g/person /wk)	Mean dietary intake (µg/p/ wk)	Mean Dietary intake (µg/kg body weight/wk)	Provisional tolerable weekly intake (PTWI) (µg/kg body weight/wk)	Mean intake % of PTWI
[a]. **School children**	Muscle	0.215	46.59	326.13	70.12	2.00	25	8
	Gizzard	0.287	24.75	175.25	50..30	1.44		6
	Liver	0.304	16.89	118.20	35..93	1.03	"	4
	Total	**0.806**	**88.23**	**619.58**	**151.35**	**4.47**		**18**
[b]. **Pregnant women**	Muscle	0.215	65.70	458.87	98.66	1.07		4
	Gizzard	0.287	29.26	204.82	58.78	0.64	"	3
	Liver	0.304	22.18	155.33	47.22	0.51		2
	Total	**0.806**	**117.14**	**819.02**	**204.18**	**2.36**		**9**
[c]. **Lactating mothers**	Muscle	0.215	86.52	605.64	130.21	1.63		7
	Gizzard	0.287	33.93	237.41	68.14	0.85	25	3
	Liver	0.304	17.04	119.28	36.26	0.45		2
	Total	**0.806**	**137.49**	**962.33**	**234.61**	**2.93**		**12**
[d]. **Adult men**	Muscle	0.215	63.65	445.52	95.79	1.28		5
	Gizzard	0.287	68.06	476.39	136.72	1.82	"	7
	Liver	0.304	37.36	261.52	79.50	1.06		4
	Total	**0.806**	**169.07**	**1183.43**	**312.01**	**4.16**		**16**
[e]. **Adult women**	Muscle	0.215	58.24	407.65	87.64	1.29		5
	Gizzard	0.287	28.77	201.36	57.79	0.85	"	3
	Liver	0.304	23.15	162.05	49..26	0.72		3
	Total	**0.806**	**110.16**	**771.06**	**194.63**	**2.86**		**11**
Whole Population	Muscle	0.215	64.14	448.98	96..53			
	Gizzard	0.287	36.95	258.68	74..24			
	Liver	0.304	23.32	163.27	49..63			
	Total	**0.806**	**124.41**	**870.89**	**220.40**			

Average body weight (kg) a=35; b=92; c=80; d=75; e=68

Comparing the intakes with the PTWI guidelines of 25 µg/kg body wt/week stipulated by JEFCA, the average intake of the different groups of the studied population for the different meat parts were much lower than the PTWI as shown in Table 3. The mean % intake of PTWI for the meat parts for the different groups (2-8%) was lower than 6 – 40% reported for Croatian population [31]. The low mean intake % signifies a low exposure from chicken meat despite the fact that the mean Pb in the meat parts were above the permissible limits. The mean weekly consumption of chicken meat by the whole population gave a total of 870.89g/p/wk of chicken meat. This value is lower than the 2030g/p/wk recorded in some USA cities [32] but higher than 304.78g/p/wk reported in Dutch [30] and 600g/p/wk reported in Lahore [27] The dietary intake of Pb (220.40 µg/p/wk) as recorded for the whole population is lower than 1624 µg/p/wk in food stuffs in Crotia [31] but higher than 2.8 x 10^{-5} µg/p/wk reported for meat, fish and milk in Brazil [33].

3.3.3 Dietary Intake of Manganese

The mean dietary intake of Manganese (Table 4) show that for school children the intakes (µg/person/wk) were muscle (86.75), gizzard (21.92) and liver (49.05) total, 108.67µg/p/wk. For pregnant women: muscle (122.16) gizzard (25.90) and liver (64.46), total, 212.52µg/p/wk. For lactating mothers: muscle (160.90), gizzard (30.03) and liver (49.50), total, 240.43µg/p/wk. For adult men: muscle (118.37), gizzard (60.26) and liver (106.53) total, 285.16µg/p/wk. For adult women: muscle (108.31), gizzard (25.47) and liver (67.25), total, 201.03µg/p/wk. For the whole population: muscle (119.43), gizzard (32.85) and liver (67.76), resulting to a total of 220.04 µg/p/wk.

Table 4: Mean dietary intake of Manganese

Group		Mean metal µg/g	Mean daily consumption (g/person/ day/)	Mean weekly consumption (g/ person/ wk/)	Mean dietary intake (µg/ Person)	Mean Dietary intake (µg/kg body weight)	Recommended daily intake (RDI) µg/kg body weight	Mean intake % of RDI
a. School children	Muscle	0.266	46.59	326.13	86.75	2.48	40 - 70	3.5
	Gizzard	0.127	24.75	175.25	21.92	0.63		1
	Liver	0.415	16.89	118.20	49.05	1.40		2
	Total	**0.808**	**88.23**	**619.58**	**108.67**	**4.51**		**6.5**
b. Pregnant women	Muscle	0.266	65.70	458.87	122.16	1.33	"	2
	Gizzard	0.127	29.26	204.82	25.90	0.28		0.4
	Liver	0.415	22.18	155.33	64.46	0.70		1
	Total	**0.808**	**117.14**	**819.02**	**212.52**	**2.31**		**3.4**
c. Lactating mothers	Muscle	0.266	86.52	605.64	160.90	1.75	"	1
	Gizzard	0.127	33..93	237.41	30.03	0.33		0.5
	Liver	0.415	17.04	119.28	49.50	0.54		0.8
	Total	**0.808**	**137.49**	**962.33**	**240.43**	**2.62**		**2.3**
d. Adult men	Muscle	0.266	63.65	445.52	118.37	1.69	40-70	2.4
	Gizzard	0.127	68.06	476.39	60.26	0.86		1.2
	Liver	0.415	37.36	261.52	106.53	1.55		2.2
	Total	**0.808**	**169.07**	**1183.43**	**285.16**	**3.10**		**5.8**
e. Adult women	Muscle	0.266	58.24	407.65	108.31	1.72	"	2.5
	Gizzard	0.127	28.77	201.36	25.47	0.40		0.5
	Liver	0.415	23.15	162.05	67.25	1.07		1.5
	Total	**0.808**	**110.16**	**771.06**	**201.03**	**3.19**		**4.6**
Whole Population	Muscle	0.266	64.14	448.98	119.43		-	-
	Gizzard	0.127	36.95	258.68	32.85			
	Liver	0.415	23.32	163.27	67.76			
	Total	**0.808**	**124.41**	**870.89**	**220.04**			

Average body weight (kg) of a=35; b=90; c=82; d=75; e=68

Comparing the intakes with the Recommended Daily Intake (RDI) guideline of 40 – 70 µg/kg body weight by National Academy of Science / National Research Council (NRC), the average intake per kg body weight by the different groups for the meat parts were very much lower than the RDI as shown in Table 4. The very low % intakes of RDI of the different categories of the populace indicate very low exposure to manganese from chicken meat probably due to the low mean metal in the meat parts as well as the low consumption of chicken by the populace.

The dietary intake of Mn for the whole population (220.04 µg/day) was very much lower than 2500 µg/day reported for foodstuffs in Rio de Janeiro city, Brazil [33]. The mean dietary intake of Mn/kg body weight for adult men (3.10) and adult women (3.19) in this study is also very much lower than the 5200 µg/kg body weight and 4100 µg/kg body weight reported for adult male and female respectively for foods consumed by Koreian adults [34].

3.2.4 Dietary intake of Zinc

The mean dietary intake of zinc (Table 5) show that the intakes (µg/person/week) for school children were muscle (512.02), gizzard (339.99) and liver (274.82). total 1126.83 µg/p/wk. For pregnant women: muscle (720.43), gizzard (397.35) and liver (361.14) total 1478.92 µg/p/wk. For lactating mothers: muscle (950.85), gizzard (460.58) and liver (277.33), total 1688.76 µg/p/wk. For adult men: muscle (699.47), gizzard (924.20) and liver (608.03), total 2231.70 µg/p/wk. For adult women: muscle (640.01), gizzard (390.64) and liver (376.77), total 1407. 42 µg/p/wk. For the whole population: muscle (704.90), gizzard (501.84), giving a total of 1586.34 µg/p/wk.

Table 5: Mean dietary intake of Zinc

Group		Mean metal (µg/g)	Mean daily consumption (g/person/day)	Mean weekly consumption (g/person/ wk/)	Mean dietary intake (µg/p/wk)	Mean dietary intake (µg/kg body weight/wk)	Provisional tolerable weekly intake (PTWI) (µg/kg body weight/wk)	Mean intake % of PTWI
[a] School children	Muscle	1.570	46.59	326.13	512.02	14.63	7000	0.21
	Gizzard	1.940	24.75	175.25	339.99	9.71		0.14
	Liver	2.325	16.89	118.20	274.82	7.85	"	0.11
	Total	**5.835**	**88.23**	**619.58**	**1126.83**	**32.19**		**0.46**
[b] Pregnant women	Muscle	1.570	65.70	458.87	720.43	7.83		0.11
	Gizzard	1.940	29.26	204.82	397.35	4.32		0.06
	Liver	2.325	22.18	155.33	361.14	3.93	"	0.06
	Total	**5.835**	**117.14**	**819.06**	**1478.92**	**16.08**		**0.23**
[c] Lactating mothers	Muscle	1.570	86.52	605.64	950.85	11.89		0.17
	Gizzard	1.940	33.93	237.41	460.58	5.76		0.08
	Liver	2.325	17.04	119.28	277.33	3.47	"	0.05
	Total	**5.835**	**137.49**	**962.33**	**1688.76**	**21.12**		**0.20**
[d] Adult men	Muscle	**1.570**	**63.65**	**445.52**	**699.47**	**9.33**		**0.13**
	Gizzard	**1.940**	**68.06**	**476.39**	**924.20**	**12.32**		**0.18**
	Liver	**2.325**	**37.36**	**261.52**	**608.03**	**8.11**	"	**0.12**
	Total	**5.835**	**169.07**	**118.43**	**2231.70**	**29.76**		**0.43**
[e] Adult women	Muscle	1.570	58.24	407.65	640.01	9.41		0.13
	Gizzard	1.940	28.77	201.36	390.64	5.74		0.08
	Liver	2.325	23.15	162.05	376.77	5.54	"	0.08
	Total	**5.835**	**110.16**	**771.06**	**1407.42**	**20.69**		**0.29**
Whole Population	Muscle	1.570	64.14	448.98	704.90			
	Gizzard	1.940	36.95	258.68	501.84			
	Liver	2.325	23.32	163.27	379.60			
	Total	**5.835**	**124.41**	**870.89**	**1586.34**			

Average body weight (kg) a=35; b=92; c=80; d=75; e=68

Comparing the intakes with the PTWI guidelines of 7000 µg/kg body weight/week stipulated by JEFCA, the average intake of the different groups of the studied population for the different chicken parts were much lower than the PTWI as shown in Table 5. The dietary intake of zinc for the whole population, 1586.34 µg/week was much lower than 46620 µg/week reported for meat, fish and poultry in some USA cities [32], and 17013 µg/week reported for meat in Greece [35]. The extremely low % intakes of PTWI of zinc for the different groups indicate that inhabitants of Port-Harcourt metropolis are not at any risk of exposure to zinc due to the low mean metal in the chicken meat they consume.

3.2.5 Mean dietary intake of Nickel

The mean intake of nickel (table 6) show that for school children the intakes (µg/p/week) were muscle (20.22), gizzard (10.87) and liver (12.77), total 43.86 µg/p/wk. For pregnant women: muscle (28.45), gizzard (12.70) and liver (16.78), total 57.93 µg/p/wk. For lactating mothers: muscle (37.55) gizzard (14.72) and liver (12.88), total 65.15 µg/p/wk. For adult men: muscle (27.62), gizzard (29.54) and liver (28.24), total 85.40 µg/p/wk. For adult women: muscle (25.27), gizzard (12.48) and liver (17.50), total 55.25 µg/p/wk. For whole population: muscle (27.84), gizzard (16.38) and liver (17.63) with a total of 61.85 µg/p/wk.

Table 6: Mean dietary intake of Nickel

Group		Mean metal (µg/g)	Mean daily consumption g/ person /day)	Mean weekly consumption (g/ person /wk)	Mean dietary intake (µg/p/wk)	Mean dietary intake (µg/kg body weight/wk)	Provisional tolerable weekly intake (PTWI) (µg/kg body weight/wk)	Mean intake % of PTWI
[a] **School children**	Muscle	0.062	46.59	326.13	20.22	0.58	35	2
	Gizzard	0.062	24.75	175.25	10.87	0.31		1
	Liver	0.108	16.89	118.20	12.77	0.36	“	1
	Total	**0.232**	**88.23**	**619.58**	**43.86**	**1.25**		**4**
[b] **Pregnant women**	Muscle	0.062	65.70	458.87	28.45	0.31		1
	Gizzard	0.062	29.26	204.82	12.70	0.14		0.40
	Liver	0.108	22.18	155.33	16.78	0.18	“	0.53
	Total	**0.232**	**116.14**	**819.02**	**57.93**	**0.63**		**2**
[c] **Lactating mothers**	Muscle	0.062	86..52	605.64	37..55	0.47		1.34
	Gizzard	0.062	33..93	237.41	14.72	0.18		0.53
	Liver	0.108	17.04	119.28	12.88	0.16	“	0.45
	Total	**0.232**	**137.49**	**962.33**	**65.15**	**0.81**		**2.3**
[d] **Adult men**	Muscle	0.062	63.65	445.52	27.62	0.37		1
	Gizzard	0.062	68.06	476.39	29.54	0.39		1
	Liver	0.108	37.36	261.52	28.24	0.38	“	1
	Total	**0.232**	**169.07**	**1183.43**	**85.40**	**1.14**		**3**
[e] **Adult women**	Muscle	0.062	58.24	407.65	25.27	0.37		1.05
	Gizzard	0.062	28.77	201.36	12.48	0.18		0.53
	Liver	0.108	23.15	162.05	17.50	0.26	“	0.74
	Total	**0.232**	**110.16**	**771.06**	**55.25**	**0.81**		**2.3**
Whole Population	Muscle	0.062	64.14	448.98	27.84			
	Gizzard	0.062	36.95	258.68	16.38			
	Liver	0.108	23.32	163.27	17.63			
	Total	**0.232**	**124.41**	**870.89**	**61.85**			

Average body weight (kg) a=35; b=92; c=80; d=75; Aw=68

Comparing the intakes with the provisional tolerable weekly intake (PTWI) guideline of 35 µg/kg body weight/week stipulated by JEFCA, none of the average weekly intake/kg body weight of the different groups exceeded the PTWI as shown in Table 6. The very low % intakes of PTWI of Ni for the different groups show a very low exposure of the populace to the metal probably due to low meat consumption and the mean metal content of the meat parts. The dietary intake of nickel for the whole population (61.85 µg/week) in this study is comparable with the 61 µg/week reported for meat in Greece [35] but lower than 822 µg/week reported for meat in Lahore, Spain [27], as well as, 7840 µg/week reported for meat, fish and milk in Rio de Janeiro city, Brazil [33].

CONCLUSION

The growing rate of industrialization, urbanization and population growth in Nigeria is gradually leading to contamination and deterioration of the environment. This has resulted in undue levels of toxic chemicals like heavy metals in our foods, water and soil etc. The result of this study however indicated that chickens consumed in the oil rich Port-Harcourt metropolis has low levels of the studied heavy metals in the chicken muscle, gizzard and liver, but the accumulation of lead and manganese has been appreciable when compared to permissible limits stipulated by some regulatory agencies. This could be as result of contamination from the feeds, drinking water and the general environment.

The dietary exposure analysis on the studied population revealed low exposure of these metals from chicken meat. It can be concluded that inhabitants of Port-Harcourt metropolis would be unlikely to experience major toxicological effects of the five heavy metals studied. It therefore appears that they are not at any imminent health risk of excess exposure from chicken meat consumption.

REFERENCES

[1] WHO **2007**. Health risks of heavy metals from long-range Trans boundary air pollution. Joint WHO/Convention Task Force on Health Aspects of Air Pollution.
[2] Extreme Health **2005.** Toxic heavy metals; symptoms, sources and specific effect. http://www.womenshealth-naturalsolutions.com.oral % 20 chelation %20 and %20 metal %20 toxicity.htm Retrieved on 31/09/09
[3] Berglund, M., Elinder, C.G., and Jarup, L. **2001**. An introduction WHO/SDE/OEH/01.3
[4] NRC. Human exposure assessment for airborne pollutions. Advances and opportunities Washington, DC: National Research Council, **1991**. National Academy Press.
[5] Goyer, R.A. *Environ Health Perspect*. **1990**. 86: p.177-81.
[6] ATSDR. **1993.** Toxicological profile for lead. U.S, Department of health & human services. Public Health Service. Agency for Toxic Substances and Disease Registry.
[7] Batuman.V., Landy, E., and Maesaka, J.K. *N Engl J med*. **1983.** 309: p. 17-21.
[8] Weiss, S.T., Munoz, A. and Stein, A. *Am J. Epidemiol*. **1986**. 123: p.800-08.
[9] Cooper, W. C. *J. of Toxicol. Environ. Health*. **1984**.14: p.23-46
[10] Stewart, W. F., *et al., Neurology* **1999.** 52: p.1610 – 1617.
[11] Benoff, S. *et al., Hum Reprod Update*. **2000.** 6: p.107-121
[12] Cardoso, C *et al., Portugal. Risk Analysis*. **2010** 30 (6). 952–961.
[13] Speijers, G. *Regul. Toxicol. Pharmacol*. **1999.**30: p87 – 93.
[14] Herman, J.L. and Younes, M. *Regul Toxicol. Pharmacol*. **1999**. 30: p.109-113
[15] Larsen, J.C. and Richold, M. *Regul. Toxicol. Pharmacol*. **1993** 30:p. 2 – 12.
[16] Krors, R. and Kozianowski, G. *Toxicol. Letl*. **2002.** p. 127:43-46.
[17] Silver, A.L. O *et al., Braz J. Plant physiol*. **2005.** 7 (1): p.79 – 93.
18] Clark, R.B. Marine Pollution. In: Oxford Science Publications, **1989.** 2nd ed. Clarendon Press, Oxford.
[19] Gonzalez – Weller, D, *et al. Food Additives and Contaminants,* **2006.** 23: p.757-763.
[20] Mariam, I. *et al Int. J. Agric Boil*. **2004.** 6: p.816-820.
[21] Iwegbue C.M.A. *et al., Bulg. J. Vet. Med*. **2008.** 11(4): p. 275 – 280
[22] Posner, B.M. *et al., J.Am Diet Assoc*. **1992.** P. 92:738 – 741.
[23] Williamson D.A *et al., J. Am Diet. Assoc*. **2003.**103: p.1139 – 1145.
[24] Zeijka M., *et al., Journal of Animal and Veterinary Adv*. **2011.** 10(9): p.1214 – 1218.
[25] Miranda M. *et al., Environ Int*.**2005.** 31: p. 543 – 548.
[26] Korenekova B *et al., Int. J. Agric Boil*. **2002.** 8: p. 234-242
[27] Talib, H. Study of environmental pollutants in and around the city of Lahore. Unpublished Ph.D thesis, **1991.** University of the Punjab, Lahore, Pakistan.
[28] Haeny – Shin L. *et al., Journal of Food composition & Analysis*. **2006.** P. 19: 531 – 37.
[29] Food and Environmental Hygiene Department: HKSAR Chemical Harzard Evaluation Studies: Dietary exposure of heavy metals of secondary school students. Hongkong Risk Assessment Studies. **Report N0.10B.2002**.
[30] Winter – Sorkina, de R, Bakker M.I, van Donkersgoed G, Van Klaveren J.D (**2003**): Dietary intake of heavy metals (Cadmuim, lead and mercury) by Dutch population. National Institute of Public Health and environment (RIVM) report 320103001.
[31] Blanusa, M. and Juresa D. *Arh Hig Rada Toksikol*. **2001.** 52: p.229 – 237.
[32] Mahaffey, K. R *et al., Environ Health Perspect*. **1975.** P.12: 63–69.
[33] Santos, E.E *et al., Sci of Total. Environ*. **2004.** 327 (1-3): p.69 – 79.
[34] Eun – Young, K *et al., Nutrition Research and Practice* **2008.** 2(1): p.22 – 25.
[35] Tsoumbaris, P. and Tsoukali – Papadopoulou, H. *Bull. Environ Contam. Toxicol*. **1994.** 53: p.67 – 70.