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Lead, Cadmium and Arsenic in breast milk of lactating mothers in Odumanse-Atua community in Manya Krobo district of eastern region of Ghana

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ABSTRACT

With the recent introduction of the policy of absolute breast feeding of infants in Ghana for the first six months after birth, this triggered our interest in investigating the presences of some heavy metals in breast milk. Breast milk samples were collected from twenty lactating mothers below the ages of twenty five in the Odumanse-Atua community in the Manya Krobo district of Eastern Region of Ghana. The samples obtained by self milking into sterilized polyethylene bottles and well labeled. Few drops of 0.1 M trichloroacetic acid were added to the sample and the aqueous layer heated at 500 ^{0}C for one hour. After ashing, it was digested with 0.5 M HNO_3 and the metals analyzed using an AAS (Philip AAS 9200U model). The mean level of Pb was 4.33 μg/L with a range of < LOD -32.0 μg/L. The mean level of Cd was found to be 1. 34 μg/L and range < LOD -12.301 μg/L. The mean arsenic concentration was 1.54 μg/L and ranging between < LOD - 6.22 μg/L.

Key words: Heavy metal, Breast milk, Lactating mothers, Odumanse-Atua community.

INTRODUCTION

Heavy metal contaminations have been found in human milk and have been found to have potential course of ill health in infants. Exposure of mother to chemicals in most cases is food intake. Even though inhalation and dermal route are possible they are not significant. These metals such as mercury, lead, arsenic, cadmium bismuth antimony and others frequently disrupt immune function, neurological and endocrine functions.

Some common effects of heavy metal toxicity include brain fogginess. Problem with concentration, bi-polar disorders or obsessive compulsive disorder (OCD), infertility, insomnia in children, memory loss, dementia tremors delay development, etc., [1,2]. Due to the toxic nature of heavy metals, the human body upon assimilation begins to quickly remove it out of its system through the organs such as the skin, liver, kidney and through urine and sweat. Unfortunately human milk is one of the routs of elimination for mother's burden, and also a source of exposure to infants**.** Some of these metals are stored in the mothers bones and are extracted from her to provide calcium for the development of the children's bone and as a result these metals enter the maternal blood and breast milk during pregnancy and lactation, exposing the fetus and infants to risk [3,4].

Heavy metals particularly cadmium, lead and mercury have been detected in breast milk in many countries around the world. The World Health Organization[5] WHO (1993) has indicated that the mean and range of metals detected in breast milk around the world are: Arsenic 0.3 ppb(0.1-0.8), Cadmium 0.1 ppb (0.1-3.8), Lead 5.0 ppb (0.0-41.1) Mercury 2.7 ppb (0.64-257.1) and Manganese 18.0 ppb (7.0-102.0). In some countries the metals have been found to exceed the recommended limits [3,6,7].

In many areas of the world lead has been found in breast milk between 5-20 ppb [8]. The sources of lead exposure are numerous; ceramic and pottery glazed with lead, electronic works welding and soldering, jewelry making and repairing, certain hair dyes, automobile repairs etc. [9]. The presence of cadmium has been detected in breast milk as 0.28 μg/L. Cadmium in materials and components of vehicles and in electrical and electronic equipment are some sources. Cadmium levels in breast milk have also been associated with cigarette smoking. Arsenic has not been thoroughly studied in breast milk but is however known to cause cancer in humans [10,11].

This study seek to investigate the levels of lead, arsenic and cadmium in breast milk of lactating mothers in Odumanse-Atua community in the Manya Krobo district of Eastern Region of Ghana. The study would give an indication of the exposure of mothers and infants in the community to the heavy metals and also ascertain the safety of absolute breast feeding of infants.

EXPERIMENTAL SECTION

Samples collection

Samples were collected from twenty lactating nursing mothers aged below 25 years who patronize the post natal clinic of Atua Government district hospital. They were mothers who have had their first delivery. The milk samples were collected in labeled sterilized polyethylene bottles from both breasts after they have been well washed. The milk was collected by self-milking with the nipple well inserted into the bottles.

Samples treatment

Few drops of 0.1 M trichloroacetic acid were added to the sample of breast milk to precipitate the proteins, and the aqueous layer of the milk separated by centrifugation. 5 mL of the aqueous layer were placed in porcelain crucible and then heated in a muffle furnace at a temperature of 500 ^{0}C for one hour. After ashing, 3 mL of 0.5 M HNO_3 was added and then filtered through Whatmann (No 41) filter paper into a volumetric flask. 0.5 M HNO_3 was added to the 10 mL mark.

The concentrations of lead, arsenic and cadmium in blank and the breast milk samples were analyzed with an AAS (Philip AAS 9200U) model. The samples were analyzed in duplicate.

The precision and recovery were also assessed by spiking with 1 µg/L standard of all the metals analyzed; each spiked sample was analyzed thrice.

RESULTS

Results of precision and recovery studied

The spike recovery for each element was greater than 96%. For the reproducibility studies (the precision) for triplicate analysis the relative standard deviation for each metals was less than 4 %.

Table 1: Mean concentrations (µg/L) of Lead, Arsenic and Cadmium in breast milk

Samples	Mean concentration in µg/L		
	Pb	As	Cd
X1	1.5	ND	ND
X2	2.96	0.80	ND
X3	ND	ND	ND
X4	10.4	1.89	ND
X5	ND	1.00	ND
X6	ND	ND	ND
X7	ND	2.00	ND
X8	32.0	ND	ND
X9	ND	5.55	ND
X10	ND	1.83	ND
X11	20.8	ND	3.40
X12	ND	0.24	ND
X13	2.70	ND	1.20
X14	ND	4.40	12.3
X15	ND	2.66	0.40
X16	ND	6.22	1.70
X17	12.40	ND	5.00
X18	ND	2.21	1.70
X19	ND	ND	2.30
X20	13.80	2.71	ND
Mean	4.83	1.54	1.34
SD	±9.016	±1.935	±2.914
% RDS		1.22	2.8

LOD : Pb :0.01 ppm, Cd: 0.001ppm, As : 0.001ppm
ND means < LOD

The results of the analysis of Pb, As and Cd in breast milk of twenty lactating mothers aged below 25 years in the Odumase Atua communities in Ghana are listed in Table 1 above.

The results revealed that the proportion of samples that had Pb, Cd and As levels below the detection limit (LOD) were respectively 60%, 60% and 40%. Thus suggesting that of three metals exposure to arsenic is most prevalent. None of the samples indicated the presence of all the three metals. However, 10% of the samples did not contain any of the metals; 15% contained both Pb and As; 15% contained Pb and Cd and 20% contained Cd and As. The relative standard deviation of the three set of measurement is in the order Cd > Pb > As, indicating the order of variability of the three metals in breast milk.

DISCUSSION

The mean level of Pb was 4.83 μg/L and ranging from 0- 32.0 μg/L; the levels fall within the levels detected in breast milk around the world which is between 0-41.1 μg/L. The mean level of lead is not too high compared to levels found world wide 5-20 ppb [10].(Rabinowitz etal) The level found in Saudi mothers' ranged between 0.318-2.50 μg/dL or (3.18-25.0 μg/L) and a mean of 0.731 μg/dL (7.31 μg/L). Lead levels in women from Mexico city have been found to be 2.47 μg/dL (24.7 μg/L)[12]. Lead concentration in Austrian women's breast milk was 3.58 μg/dL (35.8 μg/L) [13]. Children (infants) within the studied community are likely to ingest about 3.77 μg of lead daily (assuming 0.78 L/day breast milk is consumed). For infants of age 7-12 months and 1-3 years of average weight 9 and 13 kg respectively [14- 16], the daily intake are respectively 0.42 and 0.29 μg/kg/day. All of which are lower than the world health organization daily permissible intake (DPI) of 5 μg/kg/day [3]. None of the samples had levels that exceeded WHO DPI level. The maximum level of lead was 32 μg/L (2.77 μg/kg/day) which is less than the WHO (DPI) limit.

The mean level of cadmium was 1.34 μg/L and ranging from 0-12.30 μg/L. Even though the mean was within levels found world wide and ranging from 0.1-3.8 μg/L, 10% of the samples had levels that exceeded the world wide range. A child would therefore ingest about 1.05 μg daily or 0.11 μg/kg/day and 0.08 μg/kg/day for average weights of 9 and 13 respectively. The levels are about ten times less than DPI for adult, 1 μg/kg/day [6]. The mean exceeds levels found in Japan which was 0.28 μg/L [10].

Children fed with breast milk with high cadmium concentrations are likely to ingest decreased amount of calcium. According to Honda and others [10], increased amount of cadmium in breast milk appeared to decrease the amount of calcium secreted in the milk. Cadmium toxicity affects the kidney and bone and two crucial metabolizing sites decreasing the amount of calcium in blood and eventually in breast milk. Mothers in the community who are exposed high levels of Cd hence they would require vitamin supplements to protect them from Cd toxicity [18].

The mean arsenic concentration in the breast milk was 1.54 μg/L and range between 0-6.22 μg/L. The mean level is higher than levels that have been found in many countries, which range between 0.1 and 0.8 μg/L. 60% of the samples had significant levels of arsenic but 50% had levels higher than 0.8 μg/L. Thus arsenic appears to be most prevalent among the three metals, suggesting that many children in the study area are exposed to arsenic more than cadmium and lead. The occurrence of arsenic in most of the samples could be due to the fact that it is one of the most common elements occurring in the environment. It is estimated that about 60% of arsenic present in the environment is of anthropogenic origin [19]

The prevalence of arsenic could be partly due to the sources of their foods since As is found in most foods and is present in the soil and in the ocean, exposure to vehicular emissions due to the proximity of the community to roads with heavy traffic or the use of herbicides and other pesticide which is common in the Odumase- Atua community.

CONCLUSION

The mean levels of Pb, Cd and As were respectively 4.83 μg/L, 1.34 μg/L and 1.54 μg/L. The presence of these metals in the breast milk of the lactating mothers reflects the absorbed dose of the mothers, and infant exposure. These metals generally do not occur naturally in the body because they are not essential and their presence in breast milk is as a result of occupational and pollution related exposure; exposure to vehicular emissions due to the proximity of the communities to roads with heavy traffic and the use of herbicides and other pesticide which is common in the Odumase- Atua community could contribute to heavy metal exposure.

Even though these metals do not achieve higher concentrations, since they do not accumulate in fats, infants are likely to be exposed to high levels before birth and during breast feeding period. The study revealed that absolute breast feeding of infants could still expose the infants to heavy metal.

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