Effects of Low level subchronic inorganic mercury exposure on the levels of essential elements analysed by ICP-MS in rat tissues

Wusu A. D.[1] , Ogunrinola O. O.[1], Afolabi O. K.[6], Abam E. O.[3], Babayemi D. O.[3], Dosumu O. A[3]., Onunkwor O. B.[3]Balogun E. A.[5], Odukoya O. O.[4], Onwordi C. T[2] and Ademuyiwa O.[3]

1 Biochemistry and 2 Chemistry Department, Lagos State University, Lagos, Nigeria, 3 Biochemistry and 4 Chemistry Department, University of Agriculture, Abeokuta, Nigeria, 5 Biochemistry Department, University of Ilorin, Kwara, Nigeria, 6Biochemistry Department, Ladoke Akintola University, Ogbomosho, Oyo, Nigeria

dorcaswusu@yahoo.com; +2348026585027

1568/P406

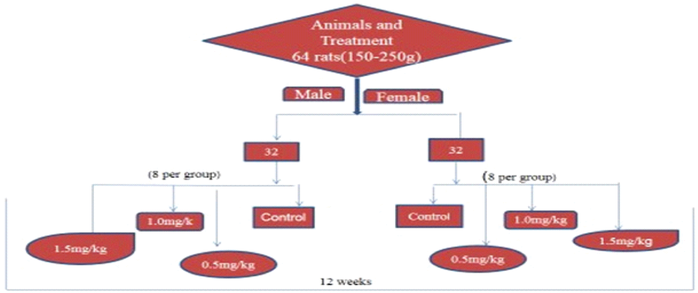
ABSTRACT

The interaction of toxic metals with essential elements could lead to disruption in the homeostasis of essential metals. The study investigated the effect of low level exposure of inorganic mercury to essential elements (Zn, Fe, Se, Mg and Ca) of male and female rats. The rats were exposed to 0.5, 1.0 and 1.5 mg/kg of Hg concentrations for 12 weeks after which blood, liver, kidney, brain, spleen, heart and lungs were removed from the animals and these elements were determined by inductively coupled plasma-mass spectrometer (ICP-MS). The result showed that mercury accumulated in all the organs but more mercury uptakes were observed in the kidney than every other tissues, markedly in females (77.89±7.7 and 23.78±1.59 µgHg/g). The exposure resulted in decrease in Mg, Ca, Fe, and Zn in nearly all the tissues except for brain and liver where Fe increased significantly in both sexes compared to controls($p<0.05$). Se behaved differently in kidney and blood, in terms of its mutual competition with Hg. The increase in Hg dose resulted in gradual and significant increase in the concentration of Se in kidney and blood. There was also significant increase in Ca and Mg in lungs of both sexes. No variation was observed with zinc in brain and liver. Most notably, Hg correlated negatively with Ca and Mg. These findings indicate interaction between essential and toxic metals.

INTRODUCTION

Mercury is one of the non-essential and toxic metals that is naturally present in the environment. The human body requires a delicate balance of the levels of various elements. The interaction of toxic metals with essential elements could lead to disruption in the homeostasis of essential metals (Clarkson et al., 2003; Park and Zheng, 2012). Too much or too little of a particular element can have devastating physiological effects. The significance of the levels of various elements in health makes it important to monitor these elements (Reusser and McCarron, 1994). The study investigated the effect of low level exposure of inorganic mercury to essential elements (Zn, Fe, Se, Mg and Ca) of male and female rats.

MATERIALS AND METHODS



Elemental Determination

Rat tissues (Liver, Kidney, Heart, spleen, lung, and brain) and whole blood were digested in nitric and sulphuric acid mixture and analysed by inductively-coupled plasma mass spectrometry (ICP-MS) for mercury and five essential elements. Results are expressed as µg/g in tissues and µg/ml in blood.

RESULTS

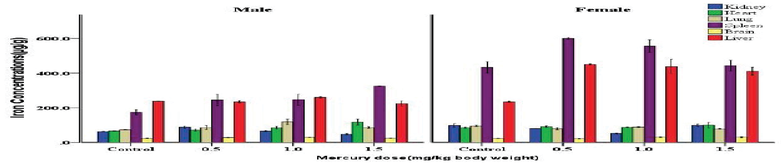


Figure 1.0: Effects of inorganic mercury on Iron concentrations (µg/g) in different tissues. Each bar represents the means±S.E.M. of 8 rats

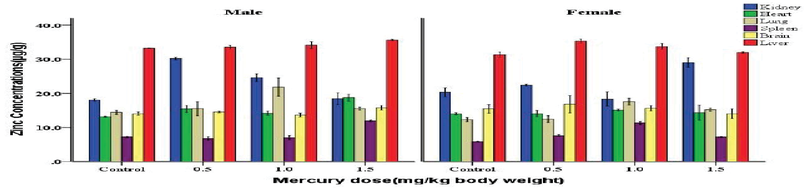


Figure 2.0: Effects of inorganic mercury on Zinc concentrations (µg/g) in different tissues. Each bar represents the means±S.E.M. of 8 rats

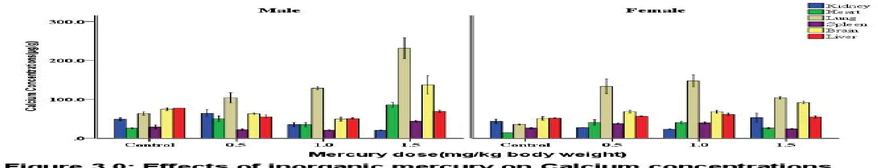


Figure 3.0: Effects of inorganic mercury on Calcium concentrations (µg/g) in different tissues. Each bar represents the means±S.E.M. of 8 rats

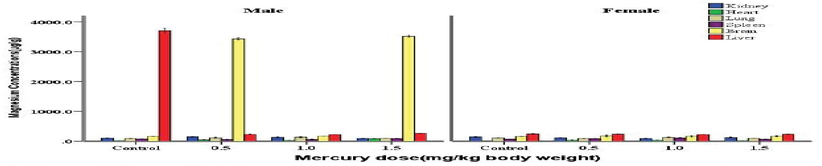


Figure 4.0: Effects of inorganic mercury on Magnesium concentrations (µg/g) in different tissues. Each bar represents the means±S.E.M. of 8 rats

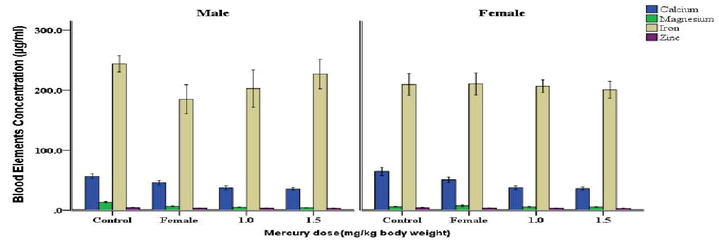


Figure 5.0: Effects of inorganic mercury on essential elements concentration (µg/g) in the blood. Each bar represents the means±S.E.M. of 8 rats

Table 2.0: Association between mercury level and some essential elements in tissues of the animals

Essential Elements In Tissues	Mercury in Tissues (µg/g)													
	Brain		Liver		Lungs		Kidney		Heart		Spleen		Blood	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Ca	0.378*	0.273	0.091	0.319	0.220	0.071	0.303	0.052	0.357*	0.059	0.256	0.154	-0.35*	-0.25
Mg	0.245	0.016	-0.31*	-0.374*	0.094	-0.201	0.290	0.070	0.284	0.195	0.451**	0.699**	-0.47**	0.030
Fe	0.008	0.202	0.043	0.483**	0185	-0.366*	0.260	0.123	0.163	-0.094	0.357*	0.486**	0.28	0.101
Zn	0.205	-0.153	0.373	0.130	0.087	0.191	0.617**	0.678**	0.279	0.097	0.556*	0.872**	-0.25	-0.09

*Correlation is significant at the 0.05 level; **Correlation is significant at the 0.01 level.

Table 2.0: Association between mercury level and some essential elements in tissues of the animals

Essential Elements In Tissues	Mercury in Tissues (µg/g)													
	Brain		Liver		Lungs		Kidney		Heart		Spleen		Blood	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Ca	0.378*	0.273	0.091	0.319	0.220	0.071	0.303	0.052	0.357*	0.059	0.256	0.154	-0.35*	-0.25
Mg	0.245	0.016	-0.31*	-0.374*	0.094	-0.201	0.290	0.070	0.284	0.195	0.451**	0.699**	-0.47**	0.030
Fe	0.008	0.202	0.043	0.483**	0185	-0.366*	0.260	0.123	0.163	-0.094	0.357*	0.486**	0.28	0.101
Zn	0.205	-0.153	0.373	0.130	0.087	0.191	0.617**	0.678**	0.279	0.097	0.556*	0.872**	-0.25	-0.09

*Correlation is significant at the 0.05 level; **Correlation is significant at the 0.01 level.

CONCLUSION

The findings of this study indicate that sub-chronic exposure to inorganic mercury is associated with decreased calcium and magnesium. This may lead to disruption in the homeostasis of essential metals.

REFERENCES

Clarkson, T.W., Magos, L., Myers, G.J., 2003. The toxicology of mercury current exposures and clinical manifestations. N. Engl. J. Med 349, 1731-1737.

Park, J.D., Zheng, W., 2012. Human exposure and health effects of inorganic and elemental mercury. J. Prev. Med. Public Health 45, 344-352.

Reusser, M. E.; McCarron, D. A. Nutrition Rev., 1994, 52, 367–375.