academicJournals

Vol. 7(5), pp. 154-158, May 2015
DOI: 10.5897/JPHE2014.0676
Article Number: DF2117C52217
ISSN 2006-9723

http://www.academicjournals.org/JPHE

Journal of Public Health and Epidemiology

Full Length Research Paper

Relationship between plasma levels of albumin, selenium, chromium and manganese of healthy subjects and patients with human immunodeficiency virus infection and acquired immune deficiency syndrome (HIV/AIDS), diabetes mellitus and cardiovascular disease in Akwa-Ibom and Cross River States of Nigeria

Kolawole Sunday E.[1]* and Obueh Henrietta O.[2]

[1]National Open University of Nigeria, Benin Study Centre, Benin City, Edo State, Nigeria.
[2]Biology Department, College of Education, Ekiadolor, Benin City, Edo State, Nigeria.

Received 8 September; Accepted 17 March, 2015

Plasma albumin, selenium, chromium and manganese levels of thirty patients each with HIV/AIDS, diabetes mellitus and cardiovascular disease (CVD), and one hundred and six apparently healthy adults in Akwa-Ibom and Cross River States, South-South Nigeria was studied. The mean plasma albumin was higher in the control than in the disease patients. The mean plasma selenium was lowest in the control (0.004 ± 0.01 mg/L) than in the HIV/AIDS (0.007 ± 0.00 mg/L), diabetes mellitus (0.007 ± 0.00 mg/L) and CVD (0.010 ± 0.00 mg/L) patients. The mean plasma chromium was highest in the HIV/AIDS patients (0.125 ± 0.45 mg/L) and lowest in the diabetes mellitus patients (0.106 ± 0.04 mg/L). Plasma manganese level was highest in the control (0.028 ± 0.02 mg/L). Manganese was detected in the plasma of all the diseased patients. For the total healthy subjects, only 55.67, 68.87 and 83.93% had selenium, chromium and manganese detected in their blood plasma. There was no significant correlation between plasma levels of albumin, selenium, chromium and manganese (P > 0.05) in the control. The poor nutritional status of the disease patients was reflected by the depressed albumin levels.

Key words: Health, disease, trace elements, plasma levels.

INTRODUCTION

Many trace elements play important roles in a number of biological processes through their action as activators or inhibition of enzymatic reactions by competing with other elements and proteins for binding sites, by influencing the

*Corresponding author. E-mail:kolasunde@gmail.com.

permeability of cell membranes, or through other mechanisms (Al-Juboori et al., 2009). Trace elements such as zinc, selenium, chromium and manganese are important for maintaining a healthy immune system. Antioxidant nutrient deficiencies may hasten the progression of human immunodeficiency virus (HIV) disease by impairing antioxidant defenses (Stephensen et al., 2007), which influence the development of diabetes and its complications and cardiovascular disease (CVD) due to oxidative stress (Kangralkar et al., 2010; Sotiropoulous et al., 2011). Selenium as an essential mineral is required for the formation of selenoprotein enzymes which are vital for the immune system. Glutathione is the unique tripeptide essential for the functional physiology of the immune system. The raised glutathione levels make the immune system to go into anti-viral, anti-HIV mode and the T-cell function is enhanced (Zhao et al., 2000). Studies have shown that selenium could enhance insulin sensitivity by mediating insulin-like actions (Mueller and Pallauf, 2006) as selenium dependent enzymes are known to have antioxidant properties potentially protecting tissues and membranes from oxidative stress. Therefore, selenium is a co-factor of several key enzymes, the plasma levels of which determines the activities of glutathione peroxidase, thioredoxin reductase and deiodinase (Kohrle et al., 2005).

Manganese-activated enzymes play important roles in metabolism of carbohydrates, amino acids and cholesterol (Institute of Medicine, 2000). Increased levels of manganese can slow the activity of the reverse transcriptase enzymes, which HIV and other retroviruses use to convert their ribonucleic acid (RNA) to deoxyribonucleic acid (DNA) when they attack and infect human cells (Bolton et al., 2003). Manganese superoxide dismutase (MnSOD) is a principal antioxidant enzyme of mitochondria necessary for the proper development and growth of an organism (Aschner and Aschner, 2005). Manganese deficiency results in glucose intolerance similar to diabetes mellitus. In HIV patients, fasting insulin levels decrease with chromium supplementation. Chromium is a nutrient that potentiates the action of insulin, and may be an essential element for glucose metabolism (Stein et al., 2013). The ability of chromium to improve insulin sensitivity with apparently few serious side effects suggested a possible role for chromium supplementation in insulin resistance associated with HIV disease (Stein et al., 2013). Chromium is an essential element required for normal carbohydrate and lipid metabolism. Insufficient dietary chromium has been linked to maturity onset diabetes and cardiovascular disease. Chromium supplementation of subjects with elevated blood sugar following a glucose load leads to a decrease in blood sugar while hypoglycemics respond to supplemental chromium by an increase in hypoglycemic glucose values, increased insulin binding and alleviation of hypoglycemic symptoms (Kobla and Volpe, 2000).

Impaired glucose tolerance and type II diabetes result to adverse changes in lipid profiles and increased risk of cardiovascular diseases (Kobla and Volpe, 2000).

Plasma albumin is a useful indicator of the nutritional status of a population. A decrease in the serum concentration of albumin is associated with increased risk of death in patients with acute or chronic illness. Normal range of albumin concentration in human blood is 35 to 50 g/L (McPherson and Pincus, 2011). The aim of this study therefore was to compare the mean plasma levels of albumin, selenium, chromium and manganese in human immunodeficiency virus infection and acquired immune deficiency syndrome (HIV/AIDS), diabetes and cardiovascular disease patients, and in healthy individuals in Akwa-Ibom and Cross River states of Nigeria.

MATERIALS AND METHODS

One hundred and six apparently healthy subjects participated in this study and served as control. The population was made up of 40 men and 66 women. They were considered to be in good health based on medical histories and physical examination. The subjects were randomly selected from rural and urban communities of Akwa-Ibom and Cross States South - South Nigeria. All subjects ate ordinary foods available in their communities. Thirty patients with HIV/AIDS (15 men and 15 women), thirty patients with diabetes (15 men and 15 women) and thirty patients with cardiovascular diseases (19 men and 11 women) participated in the study. The patients were outpatients of the University of Calabar Teaching Hospital, Calabar, General Hospital, Ikom in Cross River State and St Luke's Hospital, Akwa-Ibom State.

Collection and preparation of samples

Blood was drawn in the morning into heparinised disposal plastic syringes with stainless disposal needles by peripheral venipuncture. Plasma was immediately separated out by centrifuging the blood samples at 3000 rpm for 10 min (Khalili et al., 2008). The samples were stored at -20°C until required for analysis (Akhlaghi et al., 2012).

Analytical method

Trace metals (selenium, chromium and manganese) were determined suing a Unicam 939/959 Atomic Absorption Spectrophotometer as described by Kaneko (1999). Plasma albumin was determined by the bromocresol green method (Hill, 1985). Albumin in the sample reacted with bromocresol green in acid medium to form a coloured complex measured by spectrophotometry.

Statistical analysis

Statistical analysis of data was carried out using statistical package for the social sciences (SPSS) and the values expressed as mean ±SD. Correlations between plasma levels of albumin, selenium, chromium and manganese in control and disease patients were determined using Pearson correlation. Significant difference was at $P \leq 0.05$.

Table 1. Mean plasma of albumin, selenium (Se), chromium (Cr) and manganese (Mn) in healthy subjects and disease patients.

Subjects	Trace elements			
	Albumin (g/L)	Se (mg/L)	Cr (mg/L)	Mn (mg/L)
Control	49.55±12.70	0.004±0.01	0.111±0.03	0.028±0.02
HIV/AIDS	28.42±8.75	0.007±0.00	0.125±0.45	0.003±0.00
DM	37.67±7.79	0.007±0.00	0.106±0.04	0.003±0.00
CVD	44.39±6.86	0.010±0.00	0.121±0.45	0.004±0.00

Table 2. Occurrence of trace elements in healthy subjects and disease patients.

Subjects	Number of subjects/Trace elements			
	Albumin	Se	Cr	Mn
Control	106	59	73	89
HIV/AIDS	30	10	16	30
DM	30	8	6	30
CVD	30	13	9	30

RESULTS

The mean plasma levels of albumin, selenium (Se), chromium (Cr) and manganese (Mn) in healthy subjects (control) and patients with HIV/AIDS, diabetes mellitus (DM) and cardiovascular diseases (CVD) are presented in Table 1.

The overall mean ± SD plasma albumin concentration was (49.55±12.70 g/L) for 106 healthy subjects (control) with values higher than in the diseased patients. The HIV/AIDS patients had the lowest plasma albumin (28.42±8.75 g/L). The control had the lowest plasma selenium (0.004±0.01 mg/L) and highest plasma manganese (0.028±0.02 mg/L) concentrations than the diseased patients. Patients with CVD had the highest mean ± SD plasma selenium and plasma manganese with mean ± SD concentration of 0.010±0.00 mg/L and 0.004±0.00 mg/L respectively. The highest plasma chromium concentration was for HIV/AIDS patients (0.125±0.45 mg/L) and the diabetes patients had the lowest plasma chromium concentration of 0.106±0.04 mg/L. There was no significant correlation ($P>0.05$) between the plasma level of albumin, Se, Cr, and Mn levels within the control. Also, no significant correlation ($P>0.05$) was observed between the plasma albumin, Se, Cr, Mn of healthy subjects and patients of the three different diseases. But in the disease patients, there was inverse correlation ($r = - 0.434$, $P = 0.01$) between plasma albumin and manganese levels of HIV/AIDS patients, a negative correlation ($r = - 0.404$, $P = 0.05$) between plasma albumin and manganese of CVD and diabetes patients. There was an inverse correlation between plasma level of selenium and chromium ($r = - 0.447$) though not significant at $P > 0.05$. Table 2 shows the occurrence of trace elements in the healthy subjects and disease patients. Manganese was detected in 89 healthy subjects out of the 106 subjects, and in the plasma of all the 30 HIV/AIDS, 30 diabetes mellitus and 30 CVD patients that participated in this study. Selenium was detected in 59 healthy subjects and only 10 HIV/AIDS, 8 Diabetes and 13 CVD patients. Chromium was detected in 73 healthy subjects and 16 HIV/AIDS patients, 6 diabetes patients and 9 CVD patients.

DISCUSSION

There is an increasing evidence for the important role which micronutrients play in the prevention of disease and promotion of overall health. Inadequate intake of a diet balanced in micronutrients however exists in Nigeria where there is widespread poverty (Kolawole, 2008). HIV infection is a major health problem in developing countries especially where malnutrition and nutritional deficiency prevail. HIV infected individuals are prone to malnutrition due to increased energy requirements, enteropathy and increased catabolism (Khalili et al., 2008). The low plasma albumin level observed in this study is an indication of deterioration in the state of health of the patients. The plasma albumin level in the HIV/AIDS patients was 42.6% lower than that of the healthy subjects which corroborates with the study of Khalili et al. (2008).

Malnutrition and HIV infection can deteriorate immune system function including decline in CD_4 lymphocyte count and delayed type immune reactions (Colecraft, 2008). The plasma level of selenium and chromium were slightly higher in the HIV/AIDS patients than in the control though there was no significant difference ($P > 0.05$). This was contrary to the studies of Khalili et al. (2008) and Akiibinu et al. (2012) who had lower plasma serum levels of Se in HIV/AIDS patients than in the control. HIV requires large amount of Se for its replication in the cells (Arinola and Akiibinu, 2005). The slightly higher plasma Se levels in this study could have been induced by use of antiretroviral therapy. Homeostatic mechanisms may initially operate or maintain or even increase the level of plasma Se. The specific role of Cr in HIV/AIDS infection remains largely undefined but interestingly, there is possibility that Cr increases lean body mass (Kobla and

Volpe, 2000). During most infections, the plasma levels of trace elements change but it is not clear if this reflects changes in the infected tissues. The very low levels of Mn in the HIV/AIDS patients observed in this study as compared to the control, though not significant, may be due to lack of activity of antioxidant enzymes (Akiibinu et al., 2012). Manganese is essential in the activity of antioxidant enzymes that protect the cells against highly toxic reactive oxygen species and also enhance the immunologic activities of phagocytes and lymphocytes (Akiibinu et al., 2012).

The plasma albumin level in the diabetes patients was 24% lower than that of the healthy patients. This could be due to the status of ill – health of the diabetes patients. The higher plasma Se levels in the diabetes patients corroborated with the study of Yang et al. (2011), who had serum selenoprotein concentrations significantly higher in patients with type 2 diabetes than normal patients. Selenoprotein and glutathione peroxidase are important for selenium storage and metabolism. Increasing evidence suggests that high selenium levels are associated with diabetes and CVD (Yang et al., 2011). Adewumi et al. (2007), revealed significantly lowered serum concentration of chromium and manganese in diabetic patients compared to the control. This is agreeable with the result of this study that showed lower plasma chromium and manganese levels. The very high plasma manganese level in the control than the diabetic patients disagreed with studies of Anetor et al. (2007) and Flores et al. (2011). Several dietary factors may affect manganese absorption for example dietary iron, presence of phytate and type of fat (Williams et al., 2010). Plasma manganese in this study for healthy Nigerians was generally high. There was a negative correlation between plasma albumin and manganese levels in the diabetic patients and this agreed with the study of Flores et al. (2011). Chromium is thought to play a key role in normal carbohydrate metabolism by potentiating the action of insulin leading to increase insulin sensitivity in type II diabetes and obesity (Sreekanth et al., 2008). This could be the reason for the lowered levels of chromium in the diabetic patients than healthy individuals in this study.

The plasma albumin was 10.4% lower in the cardiovascular patients than in the control. This could be due to the inadequate dietary intake of nutrients and also due to the infection. Plasma selenium and chromium were higher in the cardiovascular disease patients than in the control. Diet and nutrition have been extensively investigated as risk factors for major cardiovascular diseases like coronary heart disease and stroke, and are also linked to other cardiovascular risk factors like diabetes, high blood pressure and obesity (Reddy and Katan, 2004). Selenium deficiency has established implications in cardiovascular diseases particularly on cardiac muscle integrity (Safaralizadeh et al., 2005). This essential trace element takes part not only in the direct protection of endothelial cells against the accumulation of aggressive oxygen species but also in biosynthesis of arachidonic acid derivatives involved in platelet and acid derivatives involved in platelet and leucocyte functions or in regulation of cholesterol (Kolaawole, 2008).

The values obtained in this study showed no significant correlation between plasma selenium levels in control and patients of cardiovascular diseases. This corroborated with the study of Stranges et al. (2006) that showed lack of significant association and effect of 200 g daily selenium supplementation with cardiovascular disease after 7.6 years follow up. Epidemiological studies assessing the role of chromium by Quallar et al. (2005) reported that higher levels of chromium were associated with lower risk of myocardial infarction in men. Supplementation with chromium picolinate, a stable and highly bioavailable form of chromium, has been shown to reduce the risk of CVD and type II diabetes (Hummel et al., 2007). The mean plasma chromium levels in this study for cardiovascular diseases patients were higher than control. The results do not indicate that plasma chromium levels in the patients reflect impairment of glucose tolerance. Mean plasma levels of manganese obtained in this study for cardiovascular disease patients were lower than the control. The low levels of plasma manganese in the cardiovascular disease patients could be due to the depressed activity of the antioxidant enzyme Manganese superoxide dismutase (MnSOD). Low activity of manganese superoxide dismutase could cause an increase in the level of superoxide radicals and thus increased oxidative stress (Zablocka et al., 2012.)

The plasma levels of selenium, chromium and manganese of healthy subjects showed detection of only 55.67, 68.87 and 83.96% respectively of the trace elements. Adequate intake (AI) of selenium is 55 µg/day for women and 70 µg/day for men (FNB, 2001). Studies in Nigeria showed mean plasma selenium to be 0.188±0.026 mg/L (Babalola et al., 2003) and 0.057±2.50 mg/L (Arinola and Charles – Davis, 2008). The AI of chromium 35 µg/ day for men and 25 µg/L for women (FNB, 2001) while the plasma chromium is between 0.18 and 0.47 mg/L or less than 0.50 mg/L (Chernecky and Berger, 1997). The AI for manganese is 2.3 mg/day for men and 1.8 mg/L for women while blood serum manganese is between 0.003 to 0.010 mg/L for healthy adults (FNB, 2001). The low plasma selenium as shown by the values obtained could be as a result of foods and diets consumed by the participants of this study which were made up of starchy foods, cereals and fruits. Selenium has been shown to be more available from diets of animal origin that those of plant sources (Combs, 2001).

CONCLUSION

The plasma levels of manganese and chromium in the healthy adults seemed adequate but the plasma selenium

seemed to be low when compared with values obtained in other studies. The HIV/AIDS, diabetes and cardiovascular disease patients had lower plasma albumin which was an indication of deteriorating health. People with poorly controlled diseases are susceptible to multiple micronutrient deficiencies. They should be educated on the importance of acquiring these nutrients from natural food sources in order to reduce high risk of diseases.

Conflict of interest

The authors declared that they have no conflict of interest.

REFERENCES

Adewumi MT, Njoku CH, Saidu Y, Abubakar MK, Shehu RA, Bilbis LS (2007). Serum chromium, copper and manganese levels of diabetic subjects in Katsina, Nigeria. Asian J. Biochem. 2:284-288.

Akhlaghi F, Bagheri SM, Rajabi O (2012). A comparative study of relationship between micronutrients and gestational diabetes. ISRN Obstetr. Gynecol. Article 2012:470419.

Akiibinu MO, Adesiyan AA, Olalekan AO (2012). Micronutrients and markers of oxidative stress in symptomatic HIV positive /AIDS Nigerians: A call for adjuvant micronutrient therapy. The Institute of Integrative Omics Appl. Biotechnol. J. IIOABJ 3(2):7-11.

Al-Juboori IA, Al-Rawi R, Al –Hakeim HK (2009). Estimation of serum copper, manganese, selenium and zinc in hypothyroidism patients. IUFS J. Biol. 68(2):121-126.

Anetor JI, Arisibo OA, Adedapo KS, Akingbola TS, Olorunnisola OS, Adeniyi FA (2007). Increase plasma manganese, partially reduced ascorbate 1 and absence of mitochondrial oxidative stress in type 2 diabetes mellitus: Implications for the superoxide uncoupling protein 2 (UCP-2) pathway. Biological Trace element Res. 120:19-27.

Arinola OG, Akiibinu MO (2005). Effect of HIV, urinary schistosomiasis or malaria on the levels of nutritionally essential trace elements in Nigerians. Eur. J. Scientific Res. 6(1):65-73.

Arinola OG, Charles-Davies O (2008). Micronutrient levels in the plasma of Nigerian females with breast cancer. Afr. J. Biotechnol. 7(11):16–20.

Aschner JL, Aschner M (2005). Nutritional aspects of manganese homeostatis. Mol. Aspects Med. 26:353-362.

Babalola OO, Anetor JI, Adeniyi AA (2003). Assessment of Se status of healthy adults in South West Nigeria. ASSEST Series A 3(4):111–120.

Bolton EC, Mildvan AS, Boeke JD (2002). Inhibition of reverse transcriptase in vivo by elevated manganese ion concentration. Mol. Cell 9:879-889.

Chernecky CC, Berger BJ (1997). Laboratory tests and diagnostic procedure. 2nd edition. Philadelphia. Saunders. pp. 367–368.

Colecraft E (2008). HIV/AIDS: Nutritional implications and impact on human development. Proc. Nutr. Soc. 67:109-113.

Combs GF (2001). Selenium in global food system. Br. J. Nutr. 85:517-547.

Flores CR, Puga MP, Wrobel K, Sevilla EG, Wrobel K (2011). Trace elements status in diabetes mellitus type 2: possible role of the interaction between molybdebum and copper in the progress of typical complications. Diabetes Res. Clin. Practice 91:333-341.

Food and Nutrition Board FNB (2001). Dietary reference intake for Vitamin A, Vitamin K, Boron, Chromium, Copper, Iodine, Iron, Manganese, Molybdenum, Nickel, Silicon, Vanadium and Zinc. Institute of Medicine Washington DC. National Academic Press. pp 197–223.

Hill PG (1985). The measurement of albumin in serum and plasma. Ann. Clin. Biochem. 22:565–578.

Hummel M, Standl E, Schnell O (2007). Chromium in metabolic and cardiovascular disease. Hormone Metab. Res. 39:741-743.

Institute of Medicine (2000). Chromium picolinate: Prototype monograph In: Dietary supplements a framework for evaluating safety. Washington DC, Institute of Medicine P B1- B80.

Kaneko JJ (1999). Clinical biochemistry of animals. 4th Edition (ed J.J Kaneko), Academic press, Inc. New York 932 pp.

Kangralka VA, Patil SD, Bandivadekar RM (2010). Oxidative stress and diabetes: a review. Int. J. Pharm. Appl. 1:38-45.

Khalili H, Soudbakhsh A, Hajiabdolbaghi M, Dashti –Kharidaki S, Poorzare A, Saeedi AA, Sharififar R (2008). Nutritional Status and serum Zinc and selenium levels in Iranian HIV infected individuals. BMC Infect. Dis. 8:165-171.

Kobla HV, Volpe SL (2000). Chromium, exercise and body composition and weight loss. Crit. Rev. Food Sci. Nutr. 40(4):291-308.

Kohrle J, Jacob F, Contempre B, Dumont JE (2005). Selenium, the thyroid and the endocrine system. Endocrine Rev. 26(7):944-984.

Kolawole SE (2008). An assessment of the plasma status of selenium, chromium and manganese in adult Nigerians in health and disease in Akwa Ibom and Cross River States of Nigeria. PhD Thesis University of Calabar.196 pp.

McPherson RA, Pincus MR (2011). Laboratory methods. Henry's Clinical Diagnosis and Management Expert Consult - Online and Print. *22nd ed. Saunders*.

Mueller AS, Pallauf J (2006). Compendium of antidiabetic effects of supranutritional selenate doses. *In vivo* and *in vitro* investigations with type II diabetic db/db mice. J. Nutr. Biochem. 17:548-560.

Quallar E, Jimenez FJ, Veer PV, Bode P, Riemersma RA, Gomez – Aracena J, Kark JD, Arab L, Kok FJ, Martin – Moreno JM (2005). EURAMIC – Heavy metals and myocardial infarction study group. Low toe nails chromium concentration and increased risk of nonfatal myocardial infarction. Am. J. Epidemiol. 162:157-164.

Reddy KS, Katan MB (2004). Diet, nutrition and the prevention of hypertension and cardiovascular diseases. Public Health Nutrition 7(1A):167-186.

Safaralizadeh R, Kardar GA, Pourpak Z, Moin M, Zare A, Teimourian S (2005). Serum concentration of selenium in healthy individuals living in Tehran. Nutrition J. 4:32-34.

Sotiropoulous A, Papadodima SA, Papazafiropoulou AK, Ioannidis A, Kokkinari A, Apostolou Q, Spiliopoulou CA, Athanaselis S (2011). Serum selenium levels do not differ in type II diabetic subjects with and without coronary artery disease. BMC Research Notes 4:270-276.

Stein SA, McNurian M, Philips BT, Messina C, Mynarcik D (2013). Chromium therapy for insulin resistance associated with HIV disease. J. AIDS Clin. Res. 4:239–245.

Stephensen CB, Marquis GS, Douglas SD, Kruzich LA, Wilson CM (2007). Glutathione, gluthatione peroxidase and selenium status in HIV positive and HIV negative adolescents and young adults. The Am. J. Clin. Nutr. 85:173-181.

Stranges S, Marshall JR, Trevisan M, Natarajan R, Donahue RP, Combs GF, Farinaro E, Clark LC, Reid ME (2006). Effects of selenium supplementation on cardiovascular disease incidence and mortality: Secondary analyses in a randomized clinical trial. Am. J. Epidemiol. 163(8):694-699.

Williams BB, Kwakye GF, Wegrzynowicz M, Li D, Ashner M, Erikson KM, Bowman AB (2010). Altered manganese homeostatis and manganese toxicity in a Huntington's disease striatal cell model are not explained by defects in the iron transport system. Toxicol. Sci.117:169-179.

Yang SJ, Hwang SY, Choi HY, Yoo HY, Seo JA, Kim SG, Kim NH, Balk SH, Choi DS, Choi KM (2011). Serum seloprotein P levels in patients with type 2 diabetes and pre-diabetes: Implications for insulin resistance, inflammation and Atherosclerosis. J. Clin. Endocrinol. Metab. 96(8):1325-1329.

Zablocka SK, Grajeta H (2012). The role of manganese in etiopathogenesis and prevention of selected diseases. Postepy higieny i medycyny doswiadczainej 66:549-553.

Zhao L, Cox AG, Ruzicka JA, Bhat AA, Zhang W, Taylor EW (2000). Molecular modeling and in vitro activity of an HIV – I encoded glutathione peroxidase. Proc. Nat. Acad. Sci. 97(12):6356-6361.