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Trace Elements Investigations in the Pathogenesis of Hypertension and Heart Disease Patients in Baghdad-Iraq

Enaam J. Abdullah

Department of Earth Science, College of Science, Baghdad University, Baghdad, Iraq
E-mail: enaamjumaa[at]yahoo.com

Abstract: ***Trace elements are essential for life and their concentrations in serum vary with human ecology and different pathological conditions. The aim of the study is to investigate the role of these elements in hypertensive patients with associated problem of Heart Disease. Determinations of elements: Cd, Co, Cr, Cu, Fe, Mn Se, Pb and Zn were performed using Atomic Absorption Spectrophotometer. The study involved 30 hypertensive with heart diseases patients and 12 healthy subjects who served as controls. Our results show higher values of the toxic elements such as Pb, and Cd, and lower levels of Co, Cr, Cu, Fe, Mn Se and Zn in serum of hypertensive patients with associated problem of Heart Disease in comparison with normal healthy controls. Alterations in the serum concentrations of both essential trace elements and toxic elements may probably be a contributory factor in the pathogenesis of hypertension and heart disease. More extensive studies with better analytical tools are expected to produce better results.***

Keywords: Hypertension, Heart Disease, trace elements, toxic metals

1. Introduction

Essential trace elements of the human body include zinc (Zn), copper (Cu), selenium (Se), chromium (Cr), cobalt (Co), iodine (I), manganese (Mn), and molybdenum (Mo). Although these elements account for only 0.02% of the total body weight, they play significant roles, e.g., as active centers of enzymes or as trace bioactive substances. A major outcome of trace element deficiencies is reduced activity of the concerned enzymes. However, since each trace element is related to so many enzymes, deficiency of a single trace element is often not associated with any specific clinical manifestations, but rather manifests as a combination of various symptoms. Because of the presence of trace elements in very small amounts and the absence of specific clinical features associated with their deficiency, it is often difficult for clinicians to identify deficiencies of some particular trace elements [1].

Heart diseases are common in this modern age. There are different heart diseases, some may be present from early age or from birth such as rare malformations of the structure of heart, and others take a life time to acquire such as the Angina Pectoris [2].

There are different risk factors to contribute to the chances of getting the disease; family pattern, weight watching, smoking tobacco, lack of exercise, diabetes, stress, high cholesterol level, and hypertension. Hypertension is a major health hazard because people with it are more prone to strokes heart disease or kidney failure than people with low blood pressure. Hypertension is an important precursor of cardiovascular morbidity and mortality [3].

Hypertension also known as high blood pressure is one of the most common complex and public health problems which becomes more prevalent in developed and developing countries [4]. It is becoming an area of increasing concern all over the world. The causes of high blood pressure vary. It may be due to smoking of cigarettes, alcoholism and narrowing of arteries. Diet definitely plays a crucial role in the development of hypertension along with stress [5].

Macro and micro elements are known to play a major role in various enzyme reactions directly related to the regulation of blood pressure and indirectly related to generation of oxidative metabolic energy and alterations in blood lipid levels. Disturbances in these elements composition may therefore play a major role in the development and management of essential hypertension [6].

These elements serve as cofactors is various functions of the body. They are present as component of nutrients and constituents of enzymes, vitamins, hormones and other processes and thus take part in growth development and maintenance of health. Deficiency or toxicity deranges life processes. The source of these elements for human is the plants and animals taken as diet. The excess of these trace elements in the body is associated with different pathological conditions such as toxic cancer, malnutrition and a variety of other disorders due to the accumulation of trace elements in the body [7].

The objective of this study is to find out the involvement of serum trace elements in the pathogenesis of hypertension with heart disease in Iraqi people.

2. Materials and Methods

The study was conducted in Baghdad city - Iraq. The study population in this investigation was made up of 30 hypertensive with Heart Disease patients (13 male, 17 female) with mean age of 59 year. In addition, 12 control volunteers were also involved in this study (8 male, 4 female) with mean age of 41year. The preparation of serum followed the method mentioned in [8] . 5 ml of

fasting blood serum was drawn from the study subjects for the estimation of various elements by pyrogen free disposable syringe. Blood was allowed to clot for one hour and then centrifuged at 2500 RPM for 15 minutes. Serum thus obtained was refrigerated and stored in contaminant free evacuated tube. Elemental analysis was performed using Atomic Absorption Spectrophotometer (AAS) in the department of chemistry- College of Science /University of Baghdad.

3. Results and Discussion

The serum concentration of Cd, Co, Cr, Cu, Fe, Mn Se, Pb and Zn in hypertensive with Heart Disease patients compared with control normal subjects has been reported in table 1.

Copper: In the general environment humans are exposed to copper via food and drinking water. Copper in drinking water has for some time been regarded as the cause of diarrhea and stomach problems in certain countries. Copper is found naturally in a wide variety of mineral salts and organic compounds and in the metallic form. It is also used in a number of industrial applications. Under abnormal conditions such as genetic diseases (e.g., Wilson's disease), biliary excretion of copper is impaired and it is accumulated in the liver, which is the critical organ of copper toxicity. Copper is an essential metal that can be toxic when homeostatic control fails. Adverse health effects of copper can develop both from deficient and excessive intake. Copper deficiency can cause heart diseases [9] (Nordberg and Cherian, 2005).

Lower serum copper was found in hypertensive with Heart Disease subjects compared with normotensive subjects (Table 1). This agreed with the reports of other workers; [10] and [11] Lesile, 2000 and Bergomi et al., 1997. The abnormal deficiency of copper in hypertensives probably contributes to decreased activities of lysyl oxidase and superoxide dismutase which result in failure of collagen and elastin cross lmminking and impaired defense against free radicals [12](Asaolu et al., 2010).

Manganese: Manganese is an essential trace element required for several enzymes involved in carbohydrate metabolism. Absorption rate is influenced by actual intake, chemical form, and the presence of other metals, such as iron and copper, in the diet. Because of its chemical similarity to iron, manganese also binds to iron-binding proteins such as transferrin. Although manganese is not very toxic, its increased tissue accumulation can cause toxic effects in the brain and lung. Excessive absorption of manganese from lungs can increase its accumulation in the brain [9].

The result of lower serum manganese level in hypertensive with Heart Disease subjects observed in this study (Table 1) may be of special pathogenetic importance. Studies have revealed manganese to possess choline-like lipotrophic properties which is known to prevent atherosclerosis and therefore affect lipid metabolism in hypertensive patients [13].

Chromium: Trivalent chromium is essential for man and animals, and it plays a role in carbohydrate metabolism as a glucose tolerance factor. Both acute and chronic toxic effects of chromium are caused by hexavalent compounds that are very toxic. Ingestion of 1–5 g of "chromate" results in severe acute toxic effects such as gastrointestinal disorders, hemorrhagic diathesis, and convulsions [9].

Cobalt: Cobalt is an essential metal for vitamin B12, which is involved in various methyl transfer reactions. About 25% of cobalt is absorbed from the GI tract, and it is mainly excreted in urine. Addition of cobalt to beer has caused endemic outbreaks of cardiomyopathy among beer drinkers resulting in fatalities [9].

Iron: Iron is an essential element in human nutrition but it can be toxic. Iron toxicity can occur at high levels of intake. Chronic iron over- load results primarily from a genetic disorder (hemochromatosis) characterized by increased iron absorption and from diseases that require frequent transfusions. Iron deficiency, probably the most common nutritional deficiency, is believed by some authorities to affect 80% of the world's population. Low socioeconomic status, high dietary phytate, and other inhibitors of iron bioavailability and low consumption of flesh foods and chronic blood loss increase the risk of deficiency. Iron deficiency may be associated with many abnormalities [9].

Lower serum chromium, cobalt and Iron were found in hypertensive with Heart Disease subjects compared with normotensive subjects (table 1). This disagreed with [12] who found higher values of Fe, Co, and Cr for hypertensive patients in comparison with normal healthy controls.

Selenium: Selenium is an essential trace element. Recent studies have indicated that selenium exerts a beneficial effect on coronary disease mortality, and that selenium plus garlic produces significant anticancer activity. Selenium deficiency gives rise to heart diseases like Keshan disease, which is most frequently seen in children. Another disease associated with selenium deficiency is Kashin-Beck. Cancer is connected to selenium and influences diseases of the muscles and joints and rheumatics and senility. High intakes of selenium influence the occurrence of caries, the garlic smell of breath, and the blue staining of nails [9].

Zinc: Zinc is an essential trace element found in all food and potable water as salt or an organic complex. The principal source of zinc is normally the diet. Zinc in surface and groundwater usually does not exceed 0.01 and 0.05 mg L^{-1}, respectively, and concentrations in tap water can be much higher as a result of dissolution of zinc from pipes. Today, more than 300 enzymes are known to be dependent on zinc for catalytic, structural, regulatory, and noncatalytic functions Zinc deficiency occurs in human beings when intake is low. This depends on the intake of diets that are low in readily bioavailable zinc [9].

Lower serum of Selenium and Zinc also was found in hypertensive with Heart Disease subjects compared with normotensive subjects (table 1).

Cadmium: It is also amongst the elements which are toxic to the body. It is present in human body at birth but accumulates with age. Cadmium is widely dispersed in the environment. Human exposure to low levels occurs as a result of natural processes and of human activities, e.g., mining, smelting, fossil fuel combustion, and industrial use. Due to the natural occurrence in the geo-environment and its active uptake by plants, some farming products such as tobacco could be high in cadmium content. The metal also remains strongly bound to other compounds in the soil and water [4]. adverse physiological effects commonly encountered to high cadmium exposure include depressed growth rate, anemia, hypertension, damage to renal tubules and poor mineralization of bones [14]. Cadmium is classified as a human carcinogen [15].

Lead: Lead occurs in ore and soil as both inorganic and organic compounds with different types of toxicity to humans. Lead has been used in paint, in ceramics, and in home utensils. The main exposure route is via food and drinking water. It can cause neurotoxic effects in children [9]. It is one of the toxic elements that have known to biological functions [16]. The myocardial infraction patients have high level of lead than the normal ones [17]. It accumulates with age in bones, aorta, kidney, liver and spleen. Lead is a general protoplasmic poison that is cumulative, slow acting and subtle and produces a variety of symptoms. Tetraalkyl lead used as gasoline additive is the main source of environmental pollution in urban areas. The other sources of lead are plasters, paints, house dust and new prints. The lead absorption increases in case of protein and iron deficiency. The toxic symptoms are anemia, insomnia, headache, dizziness, irritability, weakness of muscles and kidney damage [8].

High serum concentration of both toxic elements Pb and Cd was observed in hypertensive with Heart Disease patients (Table 1). This was in agreement with [6]. and [12]. These toxic elements usually replace essential elements of the same charge or shape in the molecules or enzymes and they can also precipitate metals of metalloenzymes. This may account for the reduced levels of some of these essential elements in hypertension [12]. The toxicological action of several heavy metal ions including cadmium, lead, mercury, and thallium can cause hypertension by affecting hormone metabolism, vasoconstriction, and renal tubular function [6].

The results obtained in the present study are agreed with those of [18] and [19] who examined serum of a number of patients having Ischemic Heart Disease and hypertension.

Results also are agreed on reports [14] and [16] of an elevation in blood pressure with increasing serum Pb concentration.
It has been suggested by [8] that an elevated Cd concentration lead to hypertension / Ischemic Heart Disease or it is the result of onset of disease which is resulted in the elevation of Cd. It has been also reported the possibility of atherosciersis with elevated Cd concentration which may lead to hypertension [20]. Cd has generally been reported higher in conditions associated with heart diseases [7].

It, therefore, could be concluded that alterations in the serum concentrations of both essential trace elements and toxic elements may probably be a contributory factor in the pathogenesis of hypertension and heart disease.

4. Conclusion

It is concluded from the foregoing results that the balance of different metals is altered in case of hypertension and heart disease and that alterations in the serum concentrations of both essential trace elements and toxic elements may probably be a contributory factor in the pathogenesis of hypertension and heart disease. A monitoring of metals in different groups of normal population may suggest some prophylactic measures which may result to make the problem less severe. More extensive studies with better analytical tools are expected to produce better results.

Table 1: Trace elements levels (µg/L) in serum of hypertensive associated heart disease and controls subjects.

Zn	*Pb*	*Se*	*Mn*	*Fe*	*Cu*	*Cr*	*Co*	*Cd*	*Sample No.*
Hypertensive with Heart Disease Patients									
550	8	84	18	620	1300	22	38	6	***1***
450	15	79	22	670	960	26	32	11	***2***
570	7	83	19	670	1510	38	29	8	***3***
550	16	81	15	720	870	25	25	9	***4***
540	8	89	24	460	980	26	24	13	***5***
510	4	67	16	580	1230	38	27	7	***6***
460	9	73	18	580	1140	41	26	9	***7***
770	6	84	17	560	1230	36	24	8	***8***
580	14	77	19	710	930	44	25	9	***9***
680	11	69	21	680	1240	43	30	16	***10***
680	8	70	26	760	920	43	29	6	***11***
570	10	73	24	710	1120	42	28	8	***12***
670	7	66	19	650	970	44	29	11	***13***
740	9	66	24	750	920	48	26	9	***14***
450	15	66	16	680	960	36	30	9	***15***

570	7	68	19	670	1410	38	28	8	***16***
550	13	71	22	760	970	46	25	9	***17***
670	6	81	18	620	1200	52	34	10	***18***
580	8	69	20	580	1270	52	32	5	***19***
550	11	74	22	690	950	56	26	11	***20***
680	11	79	19	820	1190	48	27	7	***21***
620	8	78	16	880	920	52	28	12	***22***
580	14	77	19	710	930	44	25	9	***23***
670	7	66	19	650	970	44	29	11	***24***
570	7	72	22	730	940	48	28	7	***25***
620	14	83	18	760	1130	58	27	7	***26***
570	7	72	22	730	940	48	28	7	***27***
750	7	60	23	610	940	59	28	11	***28***
680	10	62	24	740	1170	76	26	10	***29***
670	11	68	26	580	1150	70	32	10	***30***
603.33	9.6	73.56	20.23	677.66	1078.6	44.76	28.16	9.1	***Mean***
Control Subjects									
980	3	88	40	1060	1280	49	38	3	***1***
1040	5	96	37	1230	1240	51	39	5	***2***
1220	4	98	39	1140	1340	50	44	4	***3***
1240	4	99	42	1210	1350	49	40	4	***4***
1250	3	89	44	1130	1260	54	43	6	***5***
1240	5	94	43	1160	1280	52	39	3	***6***
1260	4	95	41	1250	1160	47	40	5	***7***
1150	4	97	40	1140	1140	52	43	4	***8***
1190	3	88	37	1220	1190	50	38	3	***9***
1210	5	99	42	1130	1220	47	42	4	***10***
1260	4	98	39	1170	1130	51	41	5	***11***
1170	3	94	43	1030	1250	46	42	3	***12***
1184	3.9	94.5	40.5	1155.8	1236.6	49.8	40.75	4	***Mean***

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Author Profile

Dr. Enaam J Abdullah: Assistant Professor (PhD.) Department of Earth Sciences, College of Science, Baghdad University, Baghdad, Iraq.

Specialization: Medical geology, Environmental Geochemistry

E-mail: enaamjumaa[at]yahoo.com