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Assessment of serum level of selected essential trace elements in patients with renal disorders

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Abstract

Levels of some trace elements in the sera of patients (male and female) with kidney diseases were determined. The patients were twelve (12) in number, aged between 45-65 years and were having occupation traceable to heavy metal exposure. The trace elements determined were iron, manganese, copper and zinc. The investigation was conducted at the in-and-out patient unit of the University College Hospital, Ibadan, Oyo State, Nigeria and the results obtained were compared with the corresponding values obtained in control subjects. The results of this study revealed a significant ($P<0.05$) increase in serum iron and manganese levels where mean serum iron levels of [(92.9±16.5), (45.0±150.9)] mg/100 ml were obtained in patients (both sexes) compared to [(82.5±5.14), (50.8±100.3)] mg/10 0 ml obtained in control subjects respectively. Mean serum manganese levels of [(2.39±1.30), (0.05±6.90)] mg/100 ml were also obtained in patients (both sexes) compared to [(1.20±0.22), (0.70±1.90)] mg/100 ml in control subjects respectively. However, there was significant ($P<0.05$) decrease in serum copper and zinc levels in the patients compared to the control subjects. Mean serum copper levels of [(49.3±12.4), (20.5±92.2)] mg/100 ml were obtained from patients compared to [(82.5±47.3), (50.8±89.2)] mg/100 ml obtained in control subjects while mean serum zinc levels of [(54.3±15.9), (16.5±100.0)] mg/100 ml were obtained from patients compared to [(66.1±5.17), (40.8±84.0)] mg/10 0 ml in control subjects. The results suggest heavy metal interference with the essential trace elements in physiological system of the patients due to occupational exposure.

Keywords: Serum; Trace-Elements; Renal Disorders; Heavy Metals

1 Introduction

Trace elements are mostly metals which may be present in food in an infinitesimal amount, usually below 0.5p.p.m [1] while any deviation from the standard amount is of toxicological significance [2]. Some of the trace elements of importance which are otherwise known as micronutrients include cobalt, a constituent of insulin and many enzymes, copper which occurs in blood combines with globulins forming protein caruloplasm and manganese which is contained in some enzyme systems. Selenium is also important in the body and sometimes substitutes for vitamin 'E' in certain animal species while molybdenum is a notable component of xanthine oxidase in enzyme system [3]. The aforementioned elements are known as essential nutritive elements primarily contributive in growth and development of body tissues [4]. The trace elements are physiologically constant and required in small amount but are as well pathologically variant [5]. Variation in the values of these element beyond limits is of great concern especially in internalized organs or tissues. Besides, indiscriminate exposures to heavy metals in our environment play a critical role in life functions and thus, the determination of the frequency and levels of these elements in human physiologic systemic system is fast becoming imperative due to increasing interest in environmental samples such as soil, water and plants

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[6]. The world health organization had equally set standards and desirable limits of some toxic metals and quality criteria for domestic water supply as well as food safety management [7]. The present study was designed to determine in particular, the serum levels of essential trace elements in patients living with renal disorders who perhaps had been indiscriminately exposed via occupation to heavy metals. This could possibly serve as pointer to the direction of finding remedy to increasing incidence of renal disorders.

2 Material and methods

2.1 Experimental Design

Bood for serum samples was collected from twelve (12) untreated in and out patients with cases of kidney diseases having heavy metal related occupation only. The blood samples were collected with the assistance of the medical officers at the University College Hospital, Ibadan while blood collection from control subjects was carried out after a brief investigation with the individuals. 5 ml of venous blood was collected from each patient and control subject into disposable syringes and later transferred into non coagulant bottle and allowed to clot at room temperature. The clotted blood was centrifuged at 3000rpm for 10mins and the serum samples were stored in the refrigerator prior to analysis.

2.2 Experimental Protocol

10 ml of serum samples was transferred into 250 ml dry digestion flask 16.7 ml HNO_3; $HClO_4$ (2:1) volume was added to each tube under a fume hood and the temperature was set at 100^0C for 2hrs until all water evaporated. The tubes were later made up to 250 ml mark and thoroughly mixed. The solution was then ready for the determination of trace element where Perkin Elmer Buck 200 Atomic Absorption Spectrophotometer was used for the determination of serum levels of the trace element.

3 Results

Table 1 Mean serum levels of trace elements in patients with renal diseases (mg/100 ml)

Kidney Disease	No of Patients	Age	Mean Serum Concentration of Trace Elements			
Patients			Iron	Copper	Manganese	Zinc
Male	10	35-70	100.4±15.0	52.5±15.0	2.21±0.87	37.5±23.1
			80.6±140.0	20.5±92.2	0.08±4.50	30.0±100.0
Female	**2**	50-65	81.0±34.5	44.3±15.4	1.50±2.70	43.5±15.9
			45.0±150.0	20.5±75.0	0.05±6.90	16.5±75.2
Mean value			92.9±16.5	49.3±12.4	2.39±1.30	54.3±13.2
			45.0±150.9	20.5±92.2	0.05±6.90	16.5±100,0

Table 2 Mean serum levels of trace elements in control (normal) subjects (mg/100 ml)

Control	No of Patients	Age	Mean Serum Concentration of Trace Elements			
Subjects			Iron	Copper	Manganese	Zinc
Male	10	35-65	90.5±3.70	75.0±5.36	1.40±0.18	70.0±5.29
			76.6±100.3	55.8±89.2	0.70±1.80	50.9±84.0
Female	2	25-35	70.0±6.85	75.0±5.37	1.42±0.24	60.8±7.05
			50.8±83.7	50.8±84.2	0.80±1.90	40.8±74.1
Mean value			82.0±5.14	82.5±4.73	1.20±0.22	66.1±5.17
			50.8±100.3	50.8±89.2	0.70±1.90	40.8±84.0

4 Discussion

Table 1 above shows that the mean serum iron level obtained in patients was significant (P<0.05) when compared to the control subjects. The range reported for both patients and normal subjects conformed within the normal or expected range of serum iron level (70-80) mg/100ml reported by [8]. The increase level perhaps could be due to bioaccumulation of unabsorbed iron in the kidney tissue as they remain unbound due to interference of some suspected heavy metals and their reaction with delta aminolevulinic acid dehydratase as well as ferrochelatase where they cause inhibition of their physiologic functions [9] which might eventually result in development microcytic anemia. Furthermore, the unbound irons are passed onto the kidney where the toxic effect of the metals is exerted on the kidney tissues. This has high propensity to damaging the kidney and induce nephropathy which could also affect the excretory pathway to rid-off the excessive bioaccumulation of the iron [10]. The decrease in serum copper and zinc levels obtained from the results could be attributed to excessive excretion of copper which could possibly result from a defect in copper transport mechanism or genetic defect. Besides, copper sometimes may be indiscriminately deposited in the tissues, thus, reducing its bioavailability in the plasma. Also zinc usually accumulates in soft tissues such as pancreas, kidney, liver and spleen. However, kidney plays very crucial role in metabolism especially ultra-filtration of food molecules for excretion of unwanted metabolic waste products from the body. Hence, impairment of the kidney could invariably reduce its physiologic and metabolic functions and thus, affect the level of these trace elements. This must have contributed to decrease in zinc and copper serum levels obtained from the patients as mean values did not conform with the expected range (70-150) mg/100 ml. However, the mean values obtained from control subjects are in tandem with Kossman's range [11]. On the contrary, mean serum manganese level of [(2.39±1.30; 0.05±6.90)] mg/100 ml obtained from patients did not fall within the range of (0.04±1.40) mg/100 ml as reported by [12] while serum levels obtained from normal subjects fell within the range. Hence, increase in serum level of manganese in patients could be as a result of depressed absorption. The investigation conducted on this study suggests that renal disorders are associated directly or indirectly with heavy metals contamination and indiscriminate exposure which poses high propensity of sustaining renal diseases at variable degrees.

5 Conclusion

The results from this study infer that heavy metal interference with the essential trace elements is deleterious to body physiological system and which is attributed to indiscriminate occupational exposure. This study however, could serve as research guide towards finding lasting remedy to rampant incidence of renal disorders.

Compliance with ethical standards

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Disclosure of conflict of interest

The authors appreciate all that contributed to the success of this research.

Statement of Ethical approval

Ethical permission was issued by University College Hospital Research Ethical Committee before the commencement of the research work.

Statement of informed consent

The authors hereby declare no conflict of interest on this research.

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