

Serum Selenium and Copper in Sudanese with Type 2 Diabetes Mellitus: A study in Khartoum State, Sudan

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Abstract:

Diabetes mellitus is a chronic metabolic disorder which affects carbohydrate, lipid and protein metabolism. There is accumulating evidence that the metabolism of several trace elements is altered in diabetes mellitus, and these elements might have specific roles in the pathogenesis and progress of this disease. The aim of this study was to compare the serum levels of selenium and copper in Sudanese with type 2 Diabetes with that of non-diabetic healthy controls and to assess the relationship of these elements with the glycemic status. A case-control study was conducted at two diabetes centers in Khartoum state, Sudan, during the period from March to December 2013. A total of 200 diabetic patients and 100 healthy controls were enrolled in this study. Both groups were matched for age and gender. The serum levels of selenium and copper were measured using atomic absorption spectrophotometry technique. HPLC was used for measurement of HbA_{1c}. SPSS was used for analysis of data. In the diabetic group, the mean of the serum levels of selenium was significantly reduced, whereas the mean of the serum levels of copper was significantly raised when compared with the control group ($P < 0.05$). The serum levels of selenium in the diabetic group, had a significant inverse moderate correlation with Hemoglobin A_{1c}% ($P < 0.05$) whereas the serum levels of Copper had insignificant weak positive correlation with Hemoglobin A_{1c}% ($P > 0.05$). In conclusion, the results of this study showed significantly reduced serum levels of selenium and raised serum levels of copper in Sudanese with type 2 diabetes. These serum levels of selenium had inverse moderate correlation with Hemoglobin A_{1c}%.

Key words: Trace elements, HbA_{1c}, Type 2 diabetes.

Introduction:

The term, 'diabetes mellitus' describes a metabolic disorder of multiple etiology, which is characterized by chronic hyperglycemia, with disturbances of carbohydrate, fat and protein metabolism, that result from defects in insulin secretion, insulin action, or both¹. The effects of diabetes mellitus include long term damage, dysfunction and failure of various organs. Long standing metabolic derangement is frequently associated with permanent and irreversible functional and structural changes in the cells of the body².

Diabetes mellitus is currently emerging as an important health problem in Sudan, especially in urban areas. It is the common cause of hospital admission and morbidity in Sudan due to a non-communicable disease³. In Sudan type 2 diabetes constitutes 93.7%, whereas type 1 constitutes 6.3% of the diabetic population⁴. Metals are naturally occurring inorganic elements which are present in very small amounts in the living tissues but are important for the vital process of life⁵. They are involved in many physiological processes such as prosthetic groups of many proteins, water balance and cofactors of many enzymes⁶. The proper metabolic functioning of the trace elements depends on their normal levels in various body tissues⁷. Due to their different metabolic characteristics and functions; various metals such as selenium, copper, Chromium, Manganese and Zinc are considered as essential for normal human health³. Several studies reported that the imbalance of some essential metals might adversely affect pancreatic islets and cause development of diabetes^{8,9}. It is also manifested that some reactive oxygen species (ROS) are produced during diabetes due to imbalance of essential metals. This oxidative stress might decrease the insulin gene promoter activity and mRNA expression in pancreatic islet cells due to hyperglycemic condition¹⁰.

Materials and Methods:

An analytical, case-control and hospital-based study was conducted at Omdurman and Khartoum teaching hospitals in Khartoum state, Sudan, during the period from March to December 2013. A total of 200 diabetic patients (males n=102, females n=98) as a test group and 100 healthy subjects (males n=50, females n=50) as a control group, were enrolled in this study. Both groups were matched for age and gender. A venous blood sample (5 ml) was collected from each participant and allowed to clot to obtain serum. The serum concentrations of selenium and copper were measured using atomic absorption spectrophotometer (Varian AA-1457). HbA_{1c} was measured using HPLC technique. Statistical analysis was performed using SPSS for Windows (version 14.0). The means and the standard deviations (SD) for variables of the test group and the control group were obtained. t-test was used for comparison between variables of the two groups and P-value ≤ 0.05 was considered significant. Pearson's correlation was used for assessment of correlations of the serum levels of selenium and copper with Hemoglobin A_{1c}%.

Results:

In this study, the test group included 200 Sudanese patients with Type 2 Diabetes (51% males, 49% females) and 100 healthy subjects (50% males, 50% females) as a control group. No significant difference in age, between the Mean \pm SD of the test group and the control group (55.46 \pm 8.56 vs 53.94 \pm 8.21, respectively, P=0.07)

Table 1: Shows a significantly reduced mean of the serum levels of selenium, and significantly raised mean of the serum levels of copper in the test group when compared with the control group.

Table 2: Shows a significant inverse moderate correlation between the serum levels of selenium and HbA_{1c}% among the diabetic group. The same table shows a significant weak positive correlation between the serum levels of copper and Hemoglobin A_{1c}% of the diabetic group (P > 0.05).

Table 1: Means of the serum levels of selenium and copper of the diabetic group and the control group.

Variable	Test group n=200	Control group n=100	P. value
S.Selenium μ g/l	85.31 \pm 7.65	101.37 \pm 9.12	0.000
S. Copper μ g/dl	139.28 \pm 13.74	107.52 \pm 12.62	0.000

The table shows the mean \pm Sd. and the significance value (P). $P \leq 0.05$ was considered significant.

Table2: The relationship of the serum levels of selenium and copper to blood Hemoglobin A_{1c}% in the diabetic group.

Variable	Correlation coefficient (r)	P. value
S.Selenium μ g/l	-0.62	0.031
S. Copper μ g/l	0.27	0.083

Discussion:

Many trace elements are important for human metabolic function. Numerous studies have reported the essential roles of trace elements as selenium, copper, chromium, manganese, zinc, magnesium, vanadium, and molybdenum in insulin action and carbohydrate metabolism¹¹. The actual role of these trace elements in the pathogenesis and progress of diabetes is still unclear¹². Changes of the plasma levels of these elements in diabetics have been attributed to hyperglycemia and increased protein glycosylation reported in this condition¹³. Selenium is an important component of the antioxidant enzyme, glutathione peroxidase (GSH-Px) that protects cells from the adverse effects of free radicals and lipidperoxides. A deficiency of selenium lowers the tissue activity of GSH-Px which in turn may have unfavorable effects on lipoprotein and arachidonic acid metabolism^{14,15}. These metabolic changes associated with compromised selenium status may lead to damage of the vascular endothelium and increased platelet adhesion which increase the risk of Diabetes mellitus complications¹⁶.

In the present study the mean of the serum levels of selenium in the diabetic group was significantly reduced when compared with that of the control group ($P < 0.05$). This result agrees with the results of many authors^{12,14,17} who reported deficiency of selenium in patients with type 2 diabetes. While in the current study selenium levels decreased significantly in diabetic patients, other studies reported serum selenium levels of diabetic patients to have increased, decreased or remained unchanged compared to controls^{18,19}. Significant reduction in the serum levels of selenium is an indicator of metabolic response to oxidative stress

in patients with type 2 diabetes¹⁹. The present study also showed significant inverse moderate correlation of the serum levels of selenium with HbA_{1c}%, that means poor glycemic control is associated with low levels of the antioxidant selenium.

In the present study there was a significant increase in the serum levels of copper in patients with type 2 diabetes as compared to controls. Zargaretal²⁰ showed that copper levels were significantly elevated in type 2 diabetic patients than in healthy subjects. Schlienger et al²¹, and Sarkar A et al²² also reported elevated levels of copper in patients with type 1 and type 2 diabetes when compared to controls. It is well known that copper plays a vital role in oxidative stress^{22,23}. Copper in its free form is a potent cytotoxic element because of its redox chemistry²⁴. It readily participates in Fenton and Heiber Weiss reactions to generate reactive oxygen species^{24,25}. A high level of copper enhances the toxic effect of metal dependent free radicals. Moreover the increase in copper levels in patients with type 2 DM might also be attributed to hyperglycemia, which stimulates glycation and causes release of copper ions from copper binding sites of proteins. The release of copper ions into blood further accelerates the oxidative stress²⁶. In the current study, the serum levels of copper showed insignificant weak positive correlation with Hb_{a1c}% in the diabetic group.

CONCLUSION:

The Serum levels of selenium were significantly reduced in Sudanese with type 2 diabetes when compared with healthy control subjects, and showed a significant inverse moderate correlation with Hb_{a1c}%. The serum levels of copper were significantly elevated in Sudanese with type 2 diabetes when compared with healthy control subjects, and showed insignificant weak positive correlation with Hb_{a1c}%.

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