# Serum Chromium, Manganese, Zinc and Hemoglobin A $_{1c}$ % in Sudanese with Type 2 Diabetes

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**Abstract:** 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 objective of this study is to compare the serum levels of Chromium, Manganese and Zinc 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 and duration of diabetes. 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 Chromium, Manganese and Zinc were measured using atomic absorption spectrophotometry technique. SPSS was used for analysis of data. The means of the serum levels of Chromium, Manganese and Zinc were significantly reduced when compared with the control group ($P < 0.05$).The serum levels of Chromium, Manganese and Zinc in the diabetic group, all had significant inverse moderate correlations with the duration of diabetes and Hemoglobin $A_{1c}$%($P < 0.05$), except serum Manganese which had insignificant inverse moderate correlation with the duration of diabetes($P > 0.05$). In conclusion**,** The results showed significantly reduced serum levels of Chromium, Manganese and Zinc. The three trace elements had inverse moderate correlations with both; the duration of Diabetes and Hemoglobin $A_{1c}$%.
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**Key words:** Trace elements. Hb $A_{1c.}$ 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 both (Marks and Teal, 1993). 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 body (Kumar and Clark, 2002).

Diabetes mellitus is currently emerging as an important health problem in Sudan, especially in urban areas. It is the comment cause of hospital admission and morbidity in Sudan due to a non-communicable disease (Ahmed and Ahmed, 2001). In Sudan type 2 diabetes constitutes 93.7%, whereas type 1 constitutes 6.3% of the diabetic population (Mahdi et al, 1989). 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 life (kazi et al,2008).They are involved in many physiological process such as prosthetic groups of many proteins, water balance and cofactors of many enzymes(Fraga,2005). The proper metabolic functioning of the trace elements depends on their normal levels in various body tissues (Guidotti et al, 2010). Due to their different metabolic characteristics and functions; various metal such as Chromium (Cr), Manganese (Mn) and Zinc (Zn) are considered as essential for normal human health(Ahmed and Ahmed,2001).Several studies reported that the imbalance of some essential metals might adversely affect pancreatic islets and cause development of diabetes (Chen,2009) and (Valko et al,2005). 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 condition (Jiang et al,2004).

## 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, femals 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 Chromium, Manganese and Zinc were measured using atomic absorption spectrophotometer (Varian AA-1457). 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 Cr, Ma and Zn with Hemoglobin A $_{1c}$% and duration of diabetes.

**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 ±SD of the test group and the control group (55.46±8.56 vs 53.94±8.21, respectively, P= 0.0714)

Table 1: Shows significantly raised means of the serum levels of Chromium, Manganese and Zinc of the test group when compared with the control group.

Table 2: Shows significant inverse moderate correlations of the serum levels of Chromium, Manganese and Zinc with Hb $A_{1c}$%.

Table 3: Shows significant inverse moderate correlations of the serum levels of Chromium, and Zinc with the duration of diabetes. It also shows insignificant inverse moderate correlation of the plasma levels of Manganese with the duration of diabetes.

**Table 1:** Means of the serum levels of Chromium, Manganese and Zinc of the diabetic group and the control group.

| Variable | Test groupn=200 | Control groupn=100 | P. value |
|---|---|---|---|
| S. Chromiumµg/ l | 0.06±0.02 | 0.11±0.02 | 0.000 |
| S. Manganeseµg/l | 0.44±0.08 | 0.63±0.14 | 0.004 |
| S. Zincµg/dl | 76±9 | 95±13 | 0.000 |

The table shows the mean ± sd. and the significance value (P). P ≤ 0.05 was considered significant.

**Table 2:** The relationship of the serum levels of Chromium, Manganese and Zinc to blood Hemoglobin $A_{1c}$% in the diabetic group.

| Variable | Correlation coefficient (r) | P. value |
|---|---|---|
| S.Chromiumµg/l | - 0.72 | 0,015 |
| S. Manganeseµg/l | - o.57 | 0.043 |
| S. Zincµg/dl | - 0.69 | 0.023 |

P ≤ 0.05 was considered significant.

**Table 3:** The relationship of the serum levels of Chromium,Manganese and Zinc to the duration of diabetes.

| Variable | Correlationcoefficient (r) | P. value |
|---|---|---|
| S. Chromium | -0.69 | 0.032 |
| µg/lS. Manganese | -0.51 | 0.053 |
| µg/ls. Zincµg/l | -0.63 | 0.027 |

P ≤ 0.05 was considered significant.

**Discussion:**

Many trace elements are important for human metabolic function. Numerous studies have reported the essential roles of trace elements as chromium, manganese, zinc, magnesium, selenium, vanadium, and molybdenum in insulin action and carbohydrate metabolism (Zangar et al,2002).The actual role of these trace elements in the pathogenesis and progress of diabetes is still unclear (Tuvemo and Cebre-Medhin,1983). Changes of the plasma levels of these elements in diabetics have been attributed to hyperglycemia and increased protein glycosylation reported in this condition (Shrivastava et al,1998). Chromium is required for normal carbohydrate metabolism and as a critical cofactor for insulin action(Kimora,1996) and (Hussain et al,2009). In the present study the mean of the serum levels of chromium in the diabetic group was significantly reduced when compared with that of the control group (P < 0.05). This result agrees the with the results of Kazi et al(2008) who reported deficiency of chromium in patients with type 2 diabetes. The present study also showed significant inverse moderate correlations of the serum levels of chromium with both; Hb $A_{1c}$% and duration of diabetes

Manganese plays a role as a cofactor for the antioxidant enzyme, Mn SOD, whose levels are reported to be lower in the white blood cells of diabetics than in those of non-diabetic controls(el-Yazigi et al,1991). Although the routes of action of Mn has not been thoroughly demonstrated in terms of the pathology of type 2 diabetes, Mn is essential for glucose metabolism and deficiency may result in glucose intolerance similar to diabetes mellitus in some animal species(el-Yazigi et al,1991). In the current study the mean of the serum levels of Manganese in the diabetic group was significantly reduced when compared with that of the control group (P < 0.05). Studies examining the Mn status of diabetic humans have generated contradictory results (Shroeder et al, 1966). Diabetic patients showed significant lower levels of Mn than that of healthy non-diabetic subjects (Waltr et al,1991). However, reduced or similar Mn levels in blood samples of diabetic patients as compared to control subjects are mentioned in previous studies ((kazi et al,2008).

In the current study the mean of the serum levels of Zinc was found to be significantly reduced in the

diabetic group. Similar observations are reported by Al Maroof and al-Sharbati (2006), who also observed significantly reduced serum levels of Zinc in diabetics than in healthy control subjects.. possible explanation of hypozincemia observed in diabetics can be due to hyperzincuria and/or decreased gastrointestinal absorption of zinc(Chausmer,1998). Some other studies have also reported lower serum and plasma zinc levels in diabetics (Chausmer, 1998) and (Anetor et al, 2002).

The current study sowed moderate inverse correlations of the serum levels of chromium, manganese, and zinc with Hb $A_{1c}$% and duration of diabetes. In contrast, Hussain et al (2009), reported that, the glycemic status, duration of diabetes and age did not affect the plasma concentrations of chromium, Manganese and Zinc in patients with type 2 diabetes.

**Conclusion**

The Serum levels of Chromium, Manganese and Zinc were significantly reduced in Sudanese with type 2 diabetes when compared with control subjects. The serum levels of these trace elements showed inverse moderate correlations with the glycemic status and duration of diabetes.

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