



## Assessment of Plasma Levels of TMagnesium , Zinc and HeamoglobinA<sub>1c</sub>% in Sudanese with Type 2 Diabetes Mellitus.

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### ABSTRACT

This is a case-control, hospital-based study, conducted during the period from July 2011 to March 2013 in Soba hospital, Khartoum state, Sudan. 200 Sudanese patients with type 2 diabetes mellitus and 50 healthy controls were involved in this study. The diabetic group and the control group were matched for age and gender. The objective of this study was to assess the plasma levels of Mg, Zn and Hb A<sub>1c</sub>% in Sudanese with type 2 diabetes mellitus in comparison with apparently healthy volunteers. Mg, Zn and Hb A<sub>1c</sub> were assayed for each participant using standard biochemical methods.

In this study, the means of the plasma levels of Magnesium and Zinc of the diabetic group were significantly reduced when compared to the control group, whereas the means of the blood levels of Hb A<sub>1c</sub>% of the diabetic group were significantly raised when compared to the control group. The study showed a significant weak negative correlation between the plasma levels of Magnesium and Hb A<sub>1c</sub>% ( $r = -0.31$ ,  $p = 0.00$ ). And also showed insignificant very weak negative correlation between the plasma levels of Zinc and Hb A<sub>1c</sub>% ( $r = -0.08$ ,  $p = 0.42$ ). From the results of this study it is concluded that, the plasma levels of Magnesium and Zinc are significantly reduced in Sudanese with type 2 diabetes mellitus compared to healthy controls. The plasma levels of Magnesium have significant negative correlation with Haemoglobin A<sub>1c</sub>% in the diabetic group.

### المستخلص:

هذه الدراسة هي دراسة حالة وضبط تمت خلال الفترة من يوليو 2011 وحتى مارس 2013 في مستشفى سوبا ولاية الخرطوم. متتان من المرضى السودانيين المصابين بمرض السكري من النوع الثاني وخمسون من الاصحاء شملتهم هذه الدراسة.مجموعة السكري والمجموعه الضابطه توافقوا في العمر والجنس. اجريت هذه الدراسة لتقييم وضع بعض العناصر عند السودانيين المصابين بمرض السكري النوع الثاني مقارنة بمجموعة من الاصحاء غير المصابين.نتيجة هذه الدراسة اظهرت أن متوسطات مستويات الدم للماغنيزيوم والزنك لمجموعة السكري كانت منخفضة وذات دلالة معنوية عند مقارنتها بالمجموعة الضابطة في حين كان متوسط مستويات السكر التراكمي لمجموعة السكري مرتفعة وذات دلالة معنوية عند مقارنتها بالمجموعة الضابطة، كما اظهرت أن هنالك رابطة ضعيفة بين الماغنيزيوم والسكر التراكمي في مرضى السكري وأيضا

أظهرت رابطة ضعيفة جدا بين الزنك والسكر التراكمي في مرضى السكري. من هذه النتائج خلصت هذه الدراسة الى أن مستويات الماغنيزيوم والزنك في بلازما الدم تتخفف عند مرضى السكري وأن للماغنيزيوم رابطة ضعيفة وذات دلالة معنوية مع السكر التراكمي في مرضى السكري.

**KEYWORDS:** Trace elements, glycated hemoglobin, insulin resistance.

## INTRODUCTION:

Diabetes Mellitus is a clinical syndrome characterized by abnormal carbohydrate metabolism leading to an increased risk for atherosclerosis and development of specific micro vascular and neurological complications <sup>(1)</sup>. Type 2 (DM) shows identical pathophysiological features with Type 1 (DM) but differs in etiology. Also the nature of both disease complications are generally the same, but duration and appearance time are different from each other. Findings show that the oxidative stress has the greatest role in developing complications <sup>(2)</sup>. People with diabetes are at increased risk of cardiovascular, peripheral vascular and cerebrovascular disease<sup>(3)</sup>. The role of trace elements in biological systems is beginning to focus attention on their place in human metabolism. Direct association of trace elements with health and disease is already established <sup>(4)</sup>. It is not always clear whether diabetes mellitus and hyperglycemia affect mineral metabolism or alterations in mineral homeostasis influence carbohydrate metabolism<sup>(5)</sup>. Magnesium increases the body's ability to utilize calcium, phosphorus, sodium, potassium, vitamins C, E and B complex <sup>(6)</sup>. Magnesium, on the other hand, having a slight gradient over the plasma, and plays the complementary role of a more long-term regulatory element <sup>(7)</sup>. Alterations of intracellular or

extracellular magnesium concentration may affect cell function through its effect on calcium handling <sup>(8)</sup>. The involvement of Zinc in diabetes mellitus is not surprising because Zinc is an essential trace element critical for the function of over 300 enzymes including members of all enzyme classes <sup>(9)</sup>. Zinc plays a role in processes like DNA/RNA synthesis, cell division and apoptosis <sup>(10)</sup>. Only 2–4 g of Zinc are present in the human body, and 12–16 µm can be normally measured in plasma, a mobile zinc pool that is required for the distribution of Zinc <sup>(11)</sup>. Regarding the small amounts of Zinc and the importance of this metal for enzyme function, it makes sense that Zinc concentration in the human body is tightly regulated by Zinc transporters and Zinc binding proteins like metallothionein (MT), which is capable of tightly binding Zinc on the one hand and of releasing the metal dependent on the redox status on the other hand <sup>(12-13)</sup>.

## MATERIALS and METHODS:

This is a quantitative, analytical, case-control and hospital-based study that was conducted in Soba hospital, Khartoum, Sudan, during the period from July 2011 to March 2013. In this study we have analyzed the plasma levels of Magnesium, Zinc and blood hemoglobin A1c of 200 patients

diagnosed with type 2 Diabetes Mellitus (based on their glucose results) as a test group (113 males and 87 females) and 50 apparently healthy individuals (27 males and 23 females), non-diabetic, as a control group. The test group and the control group were matched for age and gender. Permission of this study was obtained from the local health authorities in the area of the study. Interviews were done to all participants to obtain clinical data and to provide health education. Clinical assessment for each participant was done by a physician. A Questionnaire was specifically designed to obtain information which helps in either including or excluding individuals in or from the study. 5 ml of venous blood were collected from each participant (2.5 mls in lithium heparin for measurement of plasma magnesium and zinc and 2.5 mls in EDTA for determination of HbA1c). Plasma Mg and Zn levels were measured using Biosystem BTS-305 Spectrophotometer(14). Haemoglobin A1c was measured using Fast Ion-Exchange Resin Separation Technique (15).

#### **Statistical Analysis:**

The data collected in this study was analyzed using SPSS (version 11.5) computer analysis program. The means and the standard deviation of the plasma levels of Magnesium, Zinc and blood haemoglobin A1c% were obtained for the test group and the control group. t-test was used for comparison (p value  $\leq 0.05$  was considered significant). Linear regression analysis was used to assess correlation of the plasma levels of magnesium and zinc to haemoglobin A1c%.

#### **RESULTS:**

Table (1) shows insignificant differences between the means of age and height of the test group and the control. The same table shows significant differences between the means of the body weight and the body mass index of the test group and the control group. The body weight and the body mass index were significantly raised in the diabetic group. Table (2) shows significant differences between the means of the plasma levels of Magnesium, Zinc and blood Hb A1c% of the test group and the control group. The plasma levels of Magnesium and Zinc were significantly reduced whereas the blood Hb A1c was significantly raised.

Table (1): Baseline characteristics of the test group and the control group

Variable	Diabetic group n = 200	Control group n = 50	P value
Age (Years)	60.3± 6.9 (45 – 75)	58.3 ± 6.4 (43 – 71)	0.63*
Body weight (kg)	86 ± 17 (71 – 133)	75 ± 15 (56 –95)	0.00*
Height (cm)	174 ± 7.5 (155 –195)	173 ± 9 (153 – 192)	0.55*
BMI (kg/m <sup>2</sup> )	32.6 ± 3.8 (26 – 45)	24.6 ± 4.6 (22 – 30)	0.00*
Gender			
Male	113 (56%)	27 (54%)	
Female	87 (44%)	23 (46%)	

Table (2): Comparison of the means of the plasma levels of Mg, Zn and blood HbA<sub>1c</sub>% of the test group and the controls.

Variable	Diabetic group n = 200	Control group n = 50	P value
Plasma Mg mg/dl	0.94 ± 0.23 (0.60 – 1.62)	1.95 ± 0.47 (1.0 – 3.1)	0.00*
Plasma Zinc ug/dl	80 ± 17 (41 – 107)	96 ± 13 (61 – 111)	0.00*
HbA <sub>1c</sub> %	6.0 ± 0.9 (5.3 – 9.4)	4.2 ± 0.4 (2.0 – 5.0)	0.02*

Figure (1) shows a significant weak negative correlation between the plasma levels of Magnesium and HbA<sub>1c</sub>%.

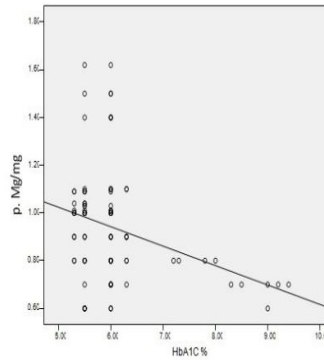


Fig. (1): The relationship between HbA<sub>1c</sub>% and the plasma level of Mg in the diabetic group, (r:0.31, p= 0.00).

Figure (2) shows insignificant very weak negative correlation between the plasma levels of Zinc and HbA<sub>1c</sub>%.

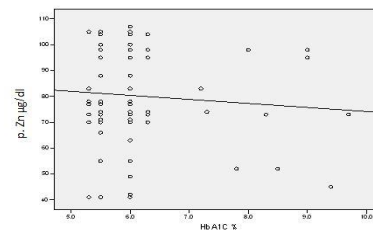


Fig. (2): The relationship between HbA<sub>1c</sub>% and the plasma level of Zn in the diabetic group, (r:-008, p= 0.42).

## DISCUSSION:

Diabetes Mellitus is a pandemic metabolic disease with substantial morbidity and mortality. Patients with diabetes mellitus have various complications. Recent scientific researches give new data about increasing number of metals involved in various human biological pathways. The deficit or the excess of some microelements in human body can lead to a wide range of diseases. <sup>(16, 17, 18, 19)</sup>

Diabetes Mellitus represents today a disease with massive spreading and medical and social consequences. Recent research has shown a tight relation between some specific oligoelements and Diabetes Mellitus, with implications for the pathogenesis of this disease and its vascular complications. <sup>(20, 21, 18, 19, 22)</sup> In the present study the plasma levels of Magnesium and Zinc of the diabetic group were significantly reduced, this reduction was reported by many authors in different countries <sup>(23, 24)</sup> which may be due to Magnesium and Zinc depletion as a result of osmotic diuresis, or may be caused by poor dietary intake. In contrast to plasma zinc concentrations and the zinc-magnesium ratio were lower in diabetic subjects <sup>(24)</sup>, although the diabetic subjects had lower plasma magnesium. Plasma magnesium correlated positively with duration of diabetes, whereas there was no correlation between age and plasma magnesium concentrations. The current study showed a significant weak negative correlation between blood HbA<sub>1c</sub>% and the plasma levels of Magnesium and insignificant very weak negative correlation between the plasma levels of Zinc and Hb A<sub>1c</sub>% in the diabetic group. This study concluded that poor glycaemic control

is associated with low levels of Magnesium and Zinc. From the results of the current study, it is recommended that, Patients with diabetes should receive Magnesium and Zinc Supplements to delay or minimize long term complications of diabetes.

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