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SERUM CHROMIUM, MAGNESIUM AND ZINC LEVELS IN SUDANESE TYPE 2 DIABETIC PATIENTS

Badreldin Elsonni Abdalla, MSc. [1], Abdelgader A. Diab, MSc. Hani Yousif Zaki, MSc. [1], Khalid Eltom Ali, PhD.

1. Department of Biochemistry and Nutrition, Faculty of Medicine, University of Gezira.

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Correspondence:
Badreldin E. Abdalla, Department of Biochemistry and Nutrition, Faculty of Medicine, University of Gezira- Sudan. P. O. Box 20, Telephone No. +249122146039 Fax No. +249511843415 Email: Badrola@yahoo.com, hazaki29@hotmail.com.

ABSTRACT

Objectives: The purpose of this study was to evaluate the difference in serum chromium, magnesium and zinc levels between diabetic and control groups, and to determine the correlations between these elements and serum glucose in patients with type 2 diabetes mellitus.

Methods: Forty patients suffering from type 2 diabetes and 30 controls were selected randomly. The level of serum chromium, magnesium and zinc were measured and compared between the two groups. Correlations of serum Cr, Mg and Zn with serum glucose were conducted.

Results: There was a very significant difference in some serum trace elements level between diabetic and control groups. Serum magnesium and zinc were significantly lower in diabetic group compared with the control group (P= 0.014, P < 0.0001 respectively). Negative but not significant correlations were shown between Cr, Mg and Zn and serum glucose.

ConclusioN: There is trace elements metabolism disorder in patients with type 2 diabetes mellitus. Magnesium and zinc could be considered suitable for inclusion in a nutritional supplement for diabetes with significant value for the treatment of diabetics and prevention of complications.

KEY WORDS: Trace elements • diabetes mellitus • chromium • magnesium• zinc.

الخلاصة

الأهداف: هدفت هذه الدراسة لمعرفة مستويات الكروم والماغنيزيوم والزنك بالمصل لدى مرضى داء السكري النوع الثاني السودانيين ومقارنتها بمجموعة الضبط المتجانسة، وإيجاد علاقات الارتباط بين مستويات هذه العناصر ومستويات سكر الدم.

الطريقة: أربعون مريضاً تم أخذهم كمجموعة دراسة كما تم أخذ مجموعة ضبط مكونة من 30 شخص أصحاء ، وتم قياس مستويات جلكوز الدم ، الكروم ، الماغنيزيوم والزنك للمجموعتين.

النتائج: أظهرت التحاليل الإحصائية وجود فروقات معنوية في بعض مستويات هذه العناصر بين مجموعة الدارسة ومجموعة الضبط ، فقد لوحظ انخفاض مستويات الماغنيزيوم والزنك بمصل مجموعة المرضى مقارنة بمجموعة الضبط بفروقات معنوية (P = 0.014 , P = 0.0001)، كما أظهرت هذه الدراسة وجود علاقة عكسية بين مستويات هذه العناصر (الكروم ، الماغنيزيوم والزنك) ومستويات سكر الدم.

الخلاصة: نخلص من هذه الدراسة أهمية عنصري الماغنيزيوم والزنك لدى مرضى السكري النوع الثاني ووجوب إدخالهما كمكملات تغذوية لأثرها الفعال في العلاج والوقاية من مضاعفات السكري.

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INTRODUCTION

Diabetes Mellitus (DM) is a chronic disease characterized by a disorder of the glucose metabolism associated with a reduced ability of tissues to respond to insulin (insulin resistance). DM causes high morbidity and mortality derived by chronic micro-vascular complications such as retinopathy, nephropathy, or neuropathy and macro-vascular complications such as ischemic cardiac problems, cerebral vascular accidents, peripheral vascular disorders (1). With its associated complications, diabetes was reported to be the fifth leading cause of death in the United States (2). DM is now one of the major health problems in Sudan resulting in 10% of all hospital admissions and mortality. A small population based study in 1993 of a sample of 1284 adult men, showed a prevalence of 3.4% of type 2 diabetes (3).

Combination of genetic and environmental risk factors contributed to DM pathogenesis (4). The clinical research suggests that the homeostasis of trace elements can be disrupted by diabetes mellitus. On the other hand, research also suggests that early imbalances of specific elements may play an important role in upsetting normal glucose and insulin metabolism (5). In fact deficiency of single element or certain combinations of elements such as Cr, Mg, and Zn have been shown to predispose a person to glucose intolerance and to promote the development of diabetic complications (6). Chromium is an essential nutrient involved in the metabolism of glucose and lipids. Suboptimal dietary intake of Cr is associated with diabetes and cardiovascular diseases. It has been reported that Cr and biotin combination reduce insulin resistance, hyperglycemia and lipid profiles in patients with type 2 diabetes (7-8). The data showed that Cr decreases the levels of cytokines and oxidative stress in diabetes (9). There are also reports of decreased Mg among those with diabetes (10-11). A population-based study suggested that Mg intake may protect against the development of type 2 diabetes in a Chinese population (12). The lower Mg' levels in diabetic subjects could be a consequence of reduced insulin action and increased protein catabolic processes (13). Hypomagnesemia seems to be associated with high mortality in critically ill patients with type 2 diabetes (14). Evidence of Zn and associated metallothionein involvement in the pathogenesis of type 2 diabetes is emerging (15). Zn complexes are proposed to improve hyperglycemia and insulin resistance in type 2 DM animals (16).

The purpose of this study is to compare the serum Cr, Mg, and Zn concentrations of Sudanese patients with type 2 diabetes and healthy controls.

METHODS

Study design; a cross-sectional study in type 2 diabetic Sudanese patients was carried out in Abo Agla Diabetes Centre in Wad Medani city– Sudan. Forty diabetic patients of age 40-70 years (30 males and 10 females) attended the centre for regular checkup were enrolled in the study. In the controls, apparently healthy non diabetic 30 individuals were recruited. The criteria for the diagnosis of diabetes mellitus was a positive glucose tolerance test, showing fasting blood glucose >140 mg/dl (>7.8 mmol/l). The study was recommended by the University of Gezira ethics committee. Patients and controls were informed about the objectives of the study, and written approval consent was obtained. Determination of blood glucose, Cr, Mg, and Zn After an overnight fasting 5ml of venous blood were drawn, serum was separated for determination of fasting blood glucose by the enzymatic colorimetric method. Flame technique of atomic

absorption spectrometry (GBC 932 Plus) was used for determination of Cr, Mg and Zn concentrations in the serum.

Statistical analysis The values are presented as mean ± SD. Student's t-test was applied for data analysis. Correlations were used to assess the associations between the blood glucose, Cr, Mg, and Zn. *P* value of <0.05 was considered statistically significant.

RESULTS:

Table 1 summarizes the mean blood glucose, Cr, Mg, and Zn in diabetic patients and healthy controls. As expected the blood glucose was significantly higher in patients (P < 0.0001). In type 2 diabetic group, serum magnesium and zinc levels were found to be significantly low (P= 0.014 - < 0.0001) as compared to the non-diabetic group. Although chromium was also lower in patients group compared to controls, the difference did not reach level of significance. Our study has shown negative correlation of blood glucose level with Cr, Mg, and Zn levels, but it was not significant (Table 2).

Table 1 Levels of glucose, Cr, Mg, and Zn in diabetic patients and control subjects

Parameters	**Subjects**		***P* value**
	Diabetic patients	**Control subjects**	
Glucose (mg/dl)	184.93± 67.55	89.80± 13.52	< 0.0001
Cr (ng/ml)	0.20± 0.15	0.22± 0.14	> 0.05
Mg (mg/dl)	1.22± 0.75	1.64± 0.60	0.014
Zn (µg/dl)	147.71± 0.38	152.0± 0.18	< 0.0001

Table 2 Correlations of serum glucose, Cr, Mg and Zn with glucose in type 2 diabetic patients

Correlation	**Glucose**	**Cr**	**Mg**	**Zn**
Glucose	1	- 0.232	- 0.10	- 0.160
***P* value**		> 0.05	> 0.05	> 0.05

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DISCUSSION

DM is a disease with severe complications and morbidity and needs more attention regarding metabolic control, since good control reduces the prevalence of complications. The minerals have been postulated as nutritional interventions secondary to the pharmacological approach in the treatment of diabetes (17). In our study the association between Cr and diabetes has not been established. However, the levels of magnesium and zinc decreased significantly in the sera of diabetic patients. The loss of these minerals might be attributed to impaired absorption and/or the excess excretion of these metals in urine (glycosuria) in these patients, which may induce a deficiency or marginal state of these minerals in blood of diabetic patients (18). Increased urinary excretion of minerals signifies a decline in renal function among diabetics and is often a sign of uncontrolled diabetes. The limited ability of the kidneys to retain minerals may be due, in part, to states of hyperglycemia among those with diabetes (19). Moreover, the negative correlation between levels of studied metals in patients with DM suggests that the imbalance in their levels tends to decrease the hypoglycemic action of insulin that play an important role in the pathogenesis of DM. Considerably deficiency of Mg and Zn has been frequently reported in DM as a contributing factor to the etiology of diabetic complications such as hypertension, retinopathy, and thrombosis (20). DM has been suggested to be the most common metabolic disorder associated with magnesium deficiency, having 25% to 39% prevalence (21). In both children and adults, the association between magnesium deficiency and insulin resistance has been observed; hypomagnesaemia per se increases the incidence of type 2 diabetes and could be an early predictor of complications (22-23). Several studies suggest possible mechanisms, whereby low serum magnesium levels may lead to development of type 2 diabetes. Magnesium can be a limiting factor in carbohydrate metabolism since many of the enzymes in this process require magnesium as a cofactor. A strong relationship between magnesium and insulin action has been reported, Mg may modulate the insulin signal transduction pathway, or may affect the hormone receptor affinity (24). Furthermore, experimental studies suggest that the high magnesium intake is associated with lower concentrations of certain markers of systemic inflammation and endothelial dysfunction such as C-reactive protein and interleukin-6 (25). In alloxan-diabetic rats, magnesium could exert cardioprotective effect through reduced plasma total cholesterol, triglyceride, and oxidative stress markers (26).

Epidemiological studies have demonstrated that exposure to low concentrations of Zn in drinking water is associated with an increase in type 1 diabetes (27-28). Zn supplementation ameliorates glycemic control and prevents renal pathological changes in genetically modified mouse models of type 2 diabetes (29). Recently, a role for zinc in improving peripheral insulin sensitivity has been suggested as it can potentiate insulin-stimulated glucose transport (30). Intriguingly, the link between zinc, diabetes and islet dysfunction has recently been demonstrated by genomewide association studies that identified an islet cell membrane zinc transporter, ZnT8, as one of the risk loci for type 2 diabetes. In a similar approach, polymorphisms in the zinc-buffering proteins metallothioneins have been associated to type 2 diabetes (31). Zinc–metallothionein complexes provide cytoprotection against free radicals and oxidative stress β-cells (32).

We conclude that magnesium and zinc levels were significantly affected in Type 2 diabetic patients. Deficiency of Mg and Zn may reduce insulin sensitivity and may increase risk of secondary complications. Our findings may become an alternative approach to be used clinically for diabetic

patients to prevent their diabetic complications.

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